United States Patent

Nilsson

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[54] **MACHINE TO BE USED AS A CRANE, LOADER AND/OR EXCAVATOR**

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[52] **U.S. Cl.** **214/778,** 214/138, 214/770

[51] **Int. Cl.** **B66f 9/00**

[58] **Field of Search**.....214/770, 771, 138, 140, 773, 214/774, 775, 776, 777, 778, 779

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Primary Examiner—Robert G. Sheridan
Assistant Examiner—John Mannix
Attorney—Moore and Hall

[57] **ABSTRACT**

A crane loader or excavator having first and second booms pivoted end to end, plus an auxiliary boom connected intermediate its ends to an intermediate portion of said first boom. Hydraulic cylinders are connected at one end of the auxiliary boom to said second boom and at the other end of the auxiliary boom to the base vehicle and an arm pivotally connected at each end to the auxiliary boom and the base vehicle.

16 Claims, 10 Drawing Figures

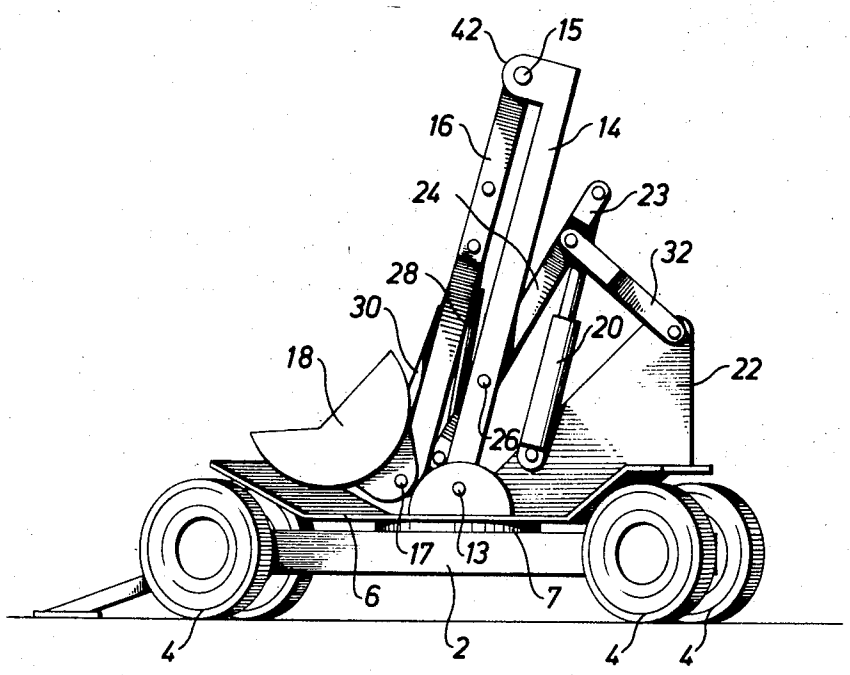

Fig. 1

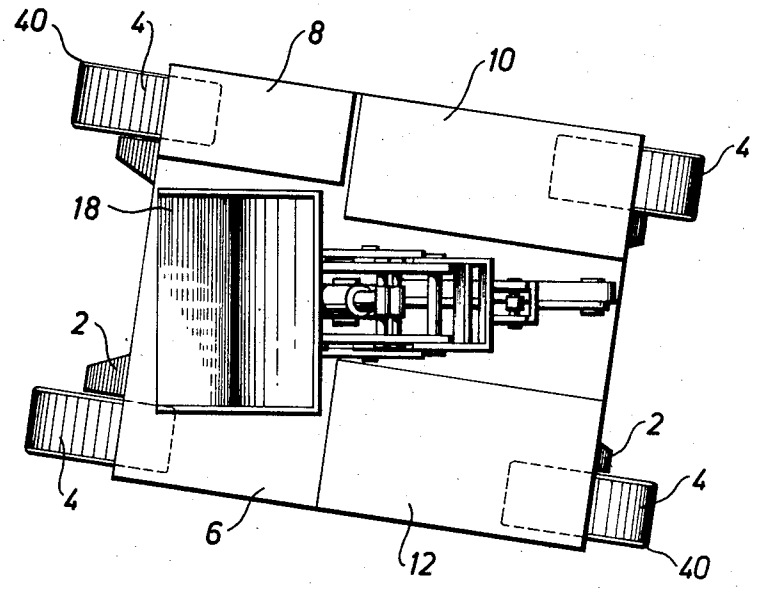
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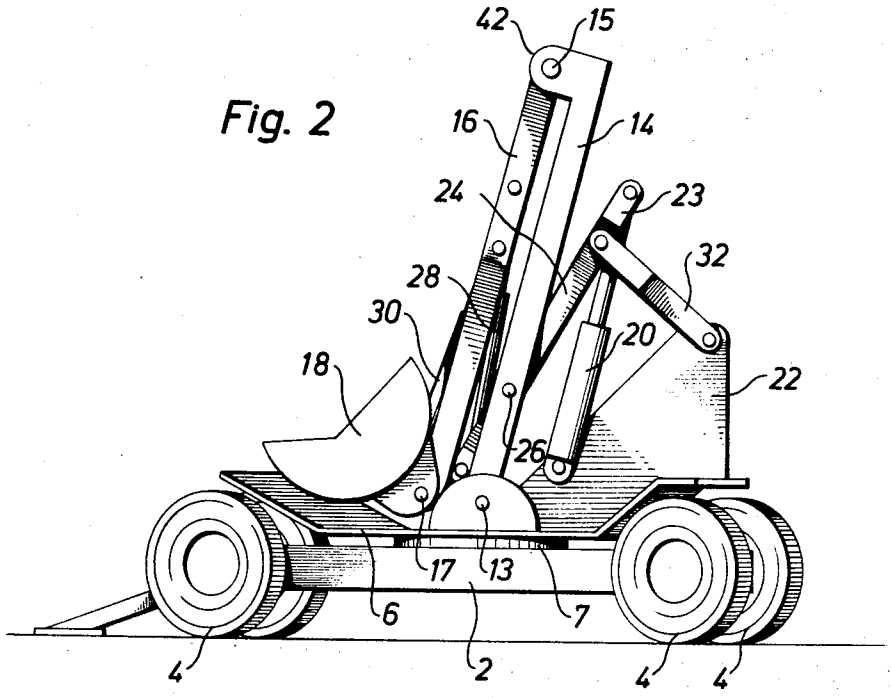
Fig. 2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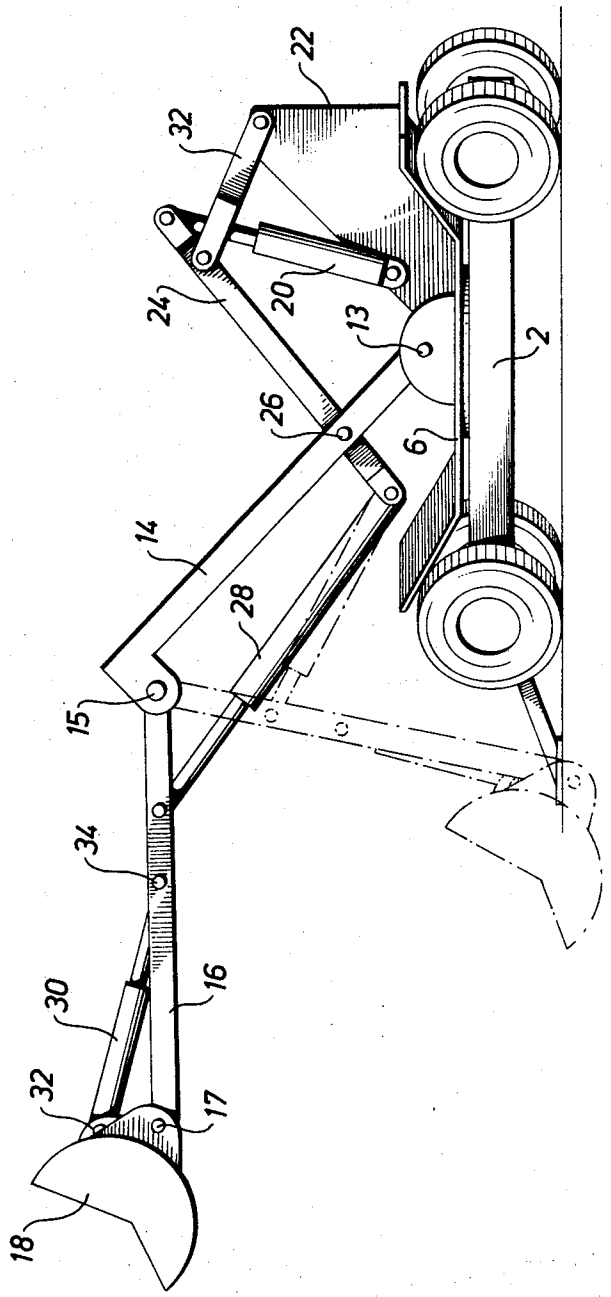

Fig. 3

Fig. 4

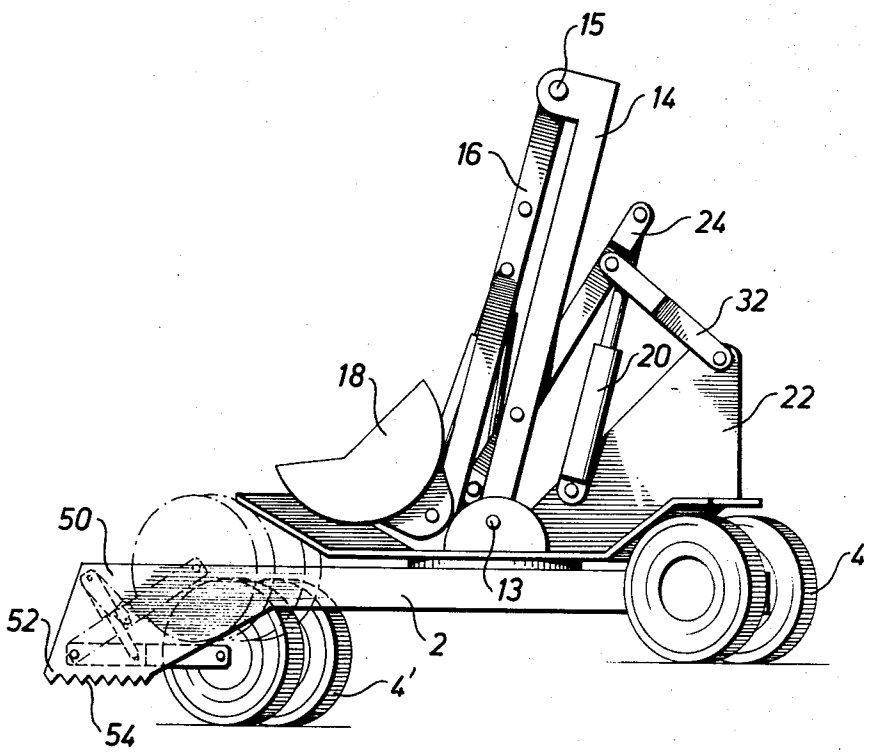

Fig. 5

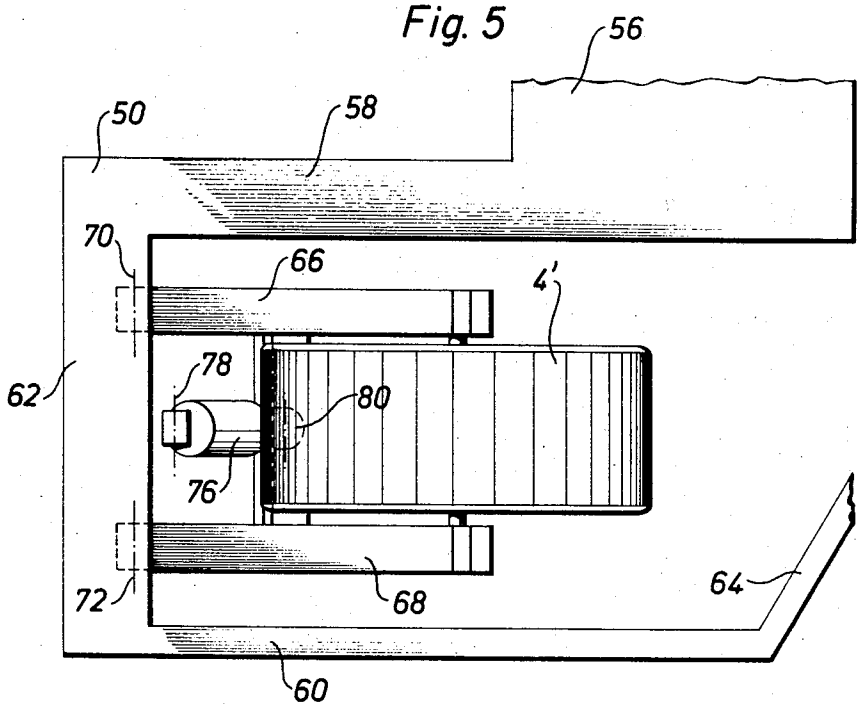

Fig. 6

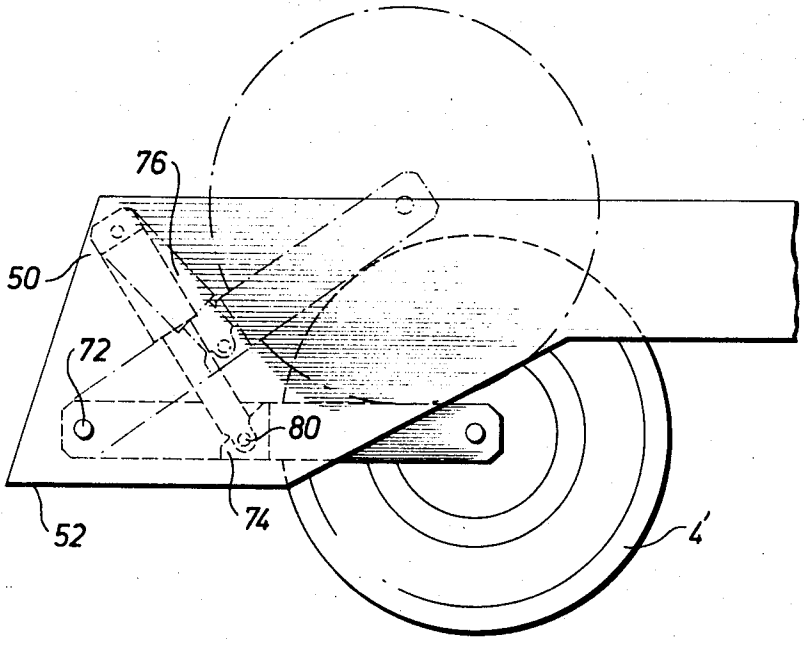

Fig. 7

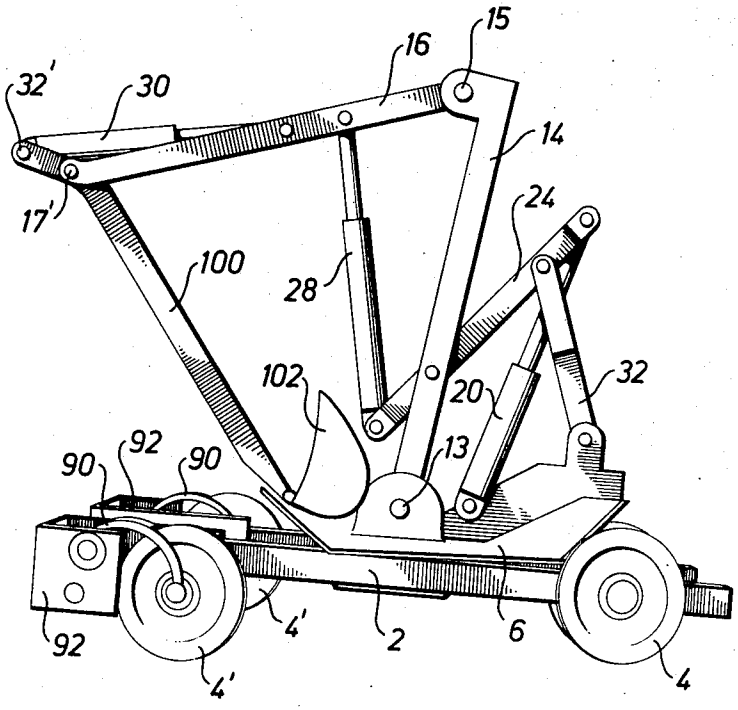
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Fig. 8

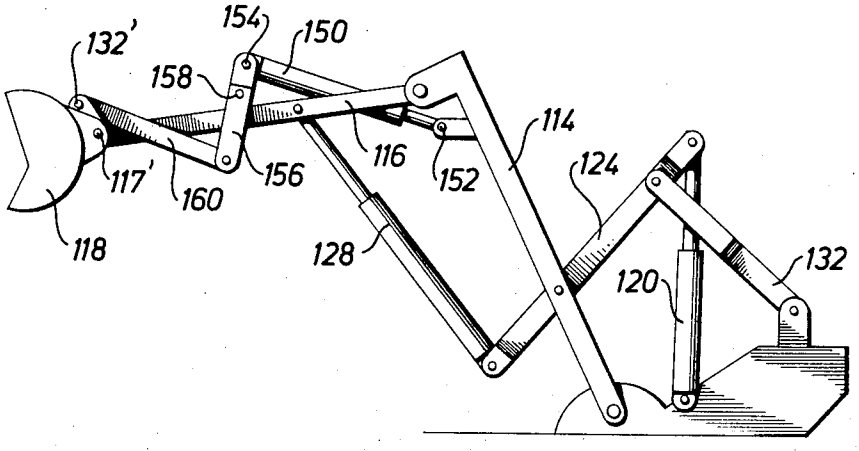
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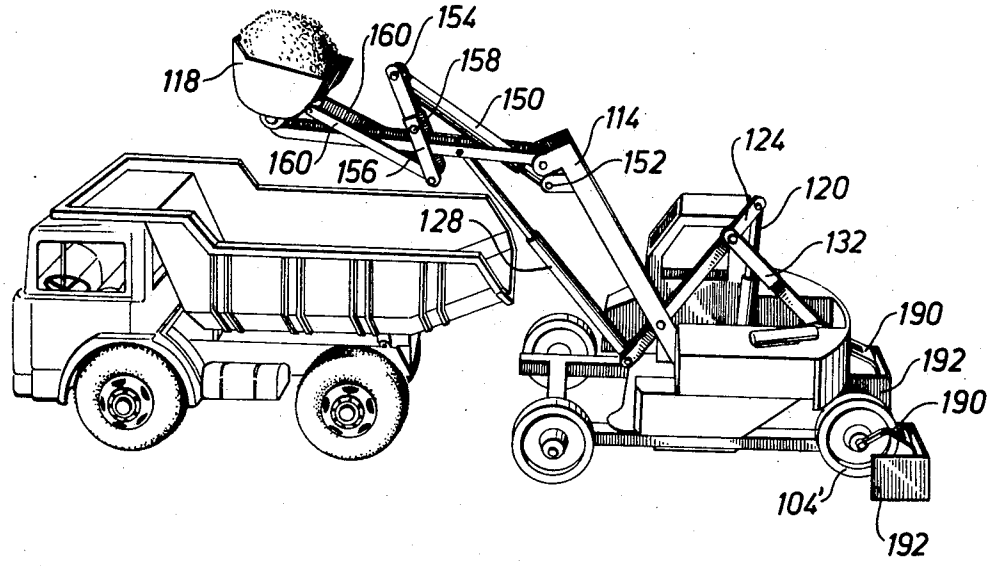
Fig. 9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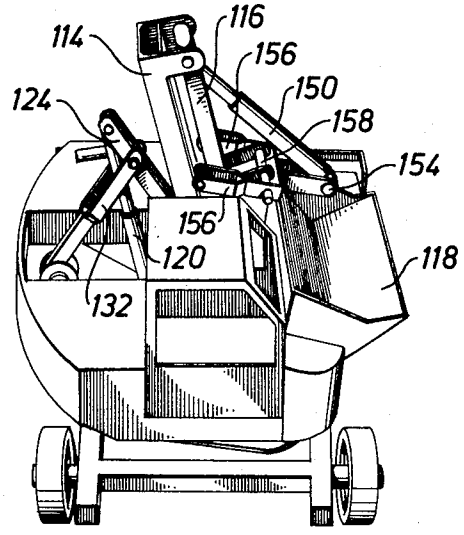
190
104'
192

Fig. 10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MACHINE TO BE USED AS A CRANE, LOADER AND/OR EXCAVATOR

This invention relates to a machine to be used as a crane, loader and/or excavator, comprising a chassis, an engine house and a first boom which at one end is pivoted in the chassis and at the other end carries a pivoted second boom that carries at its free end a working appliance, e.g., an excavator bucket, assembly, lifting hook or similar.

Hydraulic operation of the two booms in machines of the above type is already known and many designs have been produced for this purpose. One disadvantage of hydraulically operated booms is that a machine which is to have a large capacity requires hydraulic motors of very high power which occupy a large space and necessitate the hydraulics to be of the correspondingly large proportions. The aim of the invention has been to reduce the need for hydraulic motors of high power, while maintaining or increasing the loading capacity, by improving the driving and operating mechanisms of the two booms.

In accordance with the invention, this has been achieved by making a first hydraulic motor arrangement act between the second boom and the front end, viewed in a direction towards the working appliance, of an auxiliary boom pivoted between its end in the first boom, the movement of which relative to the chassis is restricted, and by making a second hydraulic motor arrangement act between the rear end of the auxiliary boom and the chassis.

The above auxiliary boom will act as a lever in operating the two booms carrying the working appliance by means of the hydraulic motor arrangements, which, due to the favorable leverage ratios, will be capable of mobilizing appreciably larger forces, considered in relation to their capacities, than has been possible so far. For a load of 4 tons at the outer end of the second boom to be set in motion, for instance, when this end is at the most unfavorable position as regards the disposition of the forces, the hydraulic motor arrangement acting at the rear end of the auxiliary boom will have to exert a force of only about 16 tons. This extremely remarkable improvement can be utilized either to appreciably increase the loading capacity of the machine in comparison with machines known so far, or to reduce its outside dimensions while maintaining its loading capacity.

In the latter case, for a loader and/or excavator, it will be possible, while using only a few moving parts and maintaining at least normal reach for the excavator bucket, to construct an extremely compact unit that can travel and work in constricted passages and tunnels in a way that has not been possible previously by means of known machines. This can be accomplished by pivoting the first boom at a low level on the chassis and by making the excavator bucket and the first and second booms capable of retraction practically fully within the limits of the horizontal dimensions of the machine.

In one constructional version of this loader and/or excavator, the maximum distance between the pivot of the excavator bucket on the second boom and the pivot of the first boom on the chassis is 1.5 – 2.5 times the largest distance between the point of attachment of the first boom on the said pivot and the horizontal outside dimension of the machine. Preferably, this ratio is 2 – 2.5 . Another constructional version is characterized by the fact that the maximum distance between the pivot of the excavator bucket on the second boom and the pivot of the first boom on the chassis is 1.5 – 2 times the greatest height above ground level of the machine when the excavator bucket is completely retracted.

The above compactness can be enhanced further, in a machine of the above type that is supported on wheels, by making the wheels on at least one axle retractable into the chassis of the machine, and by providing the chassis in the vicinity of the retractable wheels with legs. In this way, the vertical clearance required for the machine can be reduced still further if necessary. If the wheels are made so as to be individually retractable, this can be utilized to take up irregularities in the surface on which the machine is standing. In addition to the above advantages, the legs of the machine will also contribute, during operation of the machine, towards elimination of the very considerable wear of the wheels of the machine which otherwise occurs. Furthermore, each wheel can be fitted in a mainly horizontal and rectangular frame, one end of which carries the pivot for one end of a swing arm device which extends towards the center of the frame and there supports the wheel at its other end. When the wheels are let down to the ground, the swing arm device is mainly horizontal, while it is at an angle to the horizontal plane when the wheels are retracted. The swing arm device may be operated by one or more hydraulic motors acting between a pivot at one end portion, and near the top, of the frame, and a pivot situated between the ends of the swing arm device. The pivot of the said swing arm device in the said end portion is thereby situated near the bottom of the frame, and the said outer end portion projects below the general plane of the frame and forms one of the legs when the wheels are retracted.

The swing arm device can also be made so as to be free to oscillate, the hydraulic motors or similar being omitted, in which case the wheels can be let down by lifting up the chassis of the machine through pressing the working appliance against the ground. The hinged wheels are then secured in the lowered position by means of a locking arrangement which prevents upward movement of the swing arm device. When the machine, from the position when it is standing on its wheels, is to be made to rest on the legs, the procedure is to be reversed, i.e., the machine is lowered onto the legs with the aid of the working appliance after the said locking arrangement has been released.

It is also known in connection with excavators to make use of ancillary equipment in the form of a drag boom, onto the end of which there is fitted a drag shovel. In order to replace the ordinary shovel by such a drag boom with its shovel, it has so far been necessary also to replace most of the operating mechanism of the working appliance, i.e., at least the part corresponding to the second boom, and to replace this boom by a corresponding boom with an attached drag boom.

In accordance with an advantageous constructional version of a machine in accordance with the invention, the second boom and also the driving mechanism of the normal excavator bucket are constructed in such a way that it is possible to remove the normal in a simple way and to attach the drag boom directly to the end of the

second boom, and to operate this with the drawing mechanism of the formal bucket.

The invention will now be described more closely by reference to the attached drawings which show a number of constructional versions, some of the presentation being restricted to main outlines with the emission of details inessential from the point of view of the invention, in order to facilitate understanding of same.

FIG. 1 shows a view from above of a first constructional version of a machine in accordance with the invention which has been constructed as a tunnel excavator,

FIG. 2 shows a side view of the same machine with the omission of some parts shown in FIG. 1,

FIG. 3 shows a view similar to that in FIG. 2, in which, however, the moving parts of the machine assume positions other than those in FIG. 2 in order to illustrate the method of working of the boom operating mechanism,

FIG. 4 shows, in a side view, another constructional version of a machine in accordance with the invention which has been constructed as an excavator, with retractable wheels and legs,

FIGS. 5 and 6 show, schematically, a view from above and from the side of the construction of the wheels and the legs,

FIG. 7 shows a third constructional version of a machine in accordance with the invention which has been constructed as an excavator with a drag boom and legs and retractable wheels of a design different from that in FIGS. 4 – 6,

FIG. 8 shows , in a side view, another constructional version of the operating mechanism of the working appliance on a machine in accordance with the invention, and

FIGS. 9 and 10, in perspective views, show an excavator equipped with the operating mechanism according to FIG. 8.

The loader and/or excavator shown in FIGS. 1 – 3 comprises a chassis or frame 2 carried on wheels 4. A platform 6, as indicated at 7, is pivoted at a low level on the chassis 2 about a vertical shaft that is not shown here. On this platform 6 there are fitted a driver' s cab 8, hydraulics 10 and a driving motor 12. These latter may be of a conventional type and will not be described more fully. The hydraulics actuates the hydraulic motors described below in greater detail. A double excavator boom 14 consisting of two parallel members rigidly connected to one another is pivoted about a horizontal shaft 13 at a low level on the platform 6. At the other end of the excavator boom 14 there is a double bucket shaft 16 which also consists of two parallel members rigidly connected to one another, which is pivoted in the excavator boom about a shaft 15 and carries at its other end an excavator bucket 18 pivoted about 17. The components 14, 16 and 18 are capable of rotation in the same vertical plane in the way indicated in FIG. 3 and are for this purpose driven hydraulically by two hydraulic motors. One of these hydraulic motors 20 acts. and is pivoted, between a finshaped projection 22 attached to the platform 6 and the forked end 23 of an auxiliary boom 24 that is pivoted, at a point 26 between its ends, between the two parallel members of the excavator boom 14. Furthermore, a hydraulic motor 28 is pivoted by its ends at the other end of the auxiliary boom 24 and between the two parallel members of the bucket shaft 16. A third hydraulic motor 30 is pivoted on the excavator bucket 18 and between the two parallel members of the bucket shaft 16, at points 32 and 34 respectively. The hydraulic motor 30 serves to operate the bucket relative to the bucket shaft 16. The above hydraulic motors can be positioned and secured in position independently of one another. The motion of the auxiliary boom 24 relative to the chassis is restricted by an arm 32, the ends of which are pivoted about the finshaped projection 22 and the auxiliary boom 24 respectively.

The arrangement consisting of an auxiliary boom 24 operated by two hydraulic motors 20 and 28 is very advantageous from the point of view of the disposition of the forces. A load of 4 tons at the bucket 18 when, from the point of view of the forces, this is at the most unfavorable position, requires a force of only 16 tons at the hydraulic motor 20 in order to be set into motion.

In FIGS. 1 and 2, the excavator boom 14, bucket shaft 16 and bucket 18 are shown in the fully retracted and inoperative position. As will be seen, these components are then positioned largely inside the limits of the horizontal dimensions of the machine. This has been made possible by the special operating mechanism 20, 24 and 28 and by the fact that the excavator boom 14 and the bucket shaft 16 are almost the same length and are folded up against one another at a slight inclination when in the retracted position. In this way, space is made for the bucket 18. Furthermore, the greatest height of the machine is relatively small, owing to the excavator boom being pivoted at a low level on the chassis 2. In this way therefore, in the constructional version shown, a very compact machine has been created that requires little space and can travel and work in constricted passages, tunnels and the like, in a way that has not been possible so far with known machines. Despite this compactness, the excavator bucket 18 has a long reach, which in the constructional version shown is at least twice the distance between the two pairs of wheels. At the same time, the excavator bucket 18 can reach practically all points between the horizontal outside contours of the machine and a circle whose radius is the greatest reach of the bucket 18 owing to the fact that the platform 6 is pivoted on the chassis 2. It will also be evident that attachment of the excavator boom 14 to the chassis of the vehicle at a low height contributes to the great stability of the vehicle while at work.

The above can be illustrated in the following way. The maximum reach of the excavator bucket is determined by the maximum distance between the pivot 17 of the excavator bucket on the bucket shaft 16 and the pivot 13 of the excavator boom 14 on the chassis. This distance is 1.5 – 2.5 times the greatest distance between the point of attachment of the excavator boom 14 on the pivot shaft 13 and the horizontal outside contour of the machine. This distance, in the constructional version shown, is the distance between the said point of attachment on the pivot shaft 13 and a point 40 on the periphery of one of the wheels 4. Preferably, this ratio is 2 – 2.5. Furthermore, the maximum distance between the pivot 17 of the excavator bucket 18 on the bucket shaft 16 and the pivot 13 of the excavator boom

14 on the chassis is 1.5 – 2 times as great as the greatest height above ground level of the machine with the excavator bucket fully retracted, i.e., the height above ground level of the point 42 in FIG. 2 in the constructional version shown.

The machine in FIG. 4 is fully identical with the machine in the previous FIGS. as regards the components attached to the chassis. In the machine in FIG. 4, however, the design of the front end of the chassis is different in order to permit retraction into the chassis of the forward pair of wheels. The front corners of the chassis 2 therefore project forward, and at the same time the projecting portion 50 at every corner is extended downwards, so that its underside 52 should form a supporting surface when the wheel 4' is retracted into the chassis. The underside 52 may be provided with teeth 54 or similar protuberances in order to promote friction. The arrangement as a whole, when the wheels 4' are fully retracted, can be such that the chassis 2 is largely horizontal as indicated on the drawing. Detailed design of one of the portions 50 and the retraction mechanism for the wheel 4' are shown in FIGS. 5 and 6 which depict the left-hand portion 50 of the machine in FIG. 4. In FIG. 5, the line 56 delineates the front edge of the chassis, the position of which may be generally the same as that of the front edge of the machine in FIGS. 1 – 3. The portion 50 also extends somewhat to the side of the actual chassis 2 and forms in a horizontal plane a largely rectangular or parallel-trapezoidal frame made up of side members 58, 60 a front member 62 and a rear inclined member 64 which is joined to the main body of the chassis 2. At the front end of the frame 50, in the vicinity of its underside 52 there are pivoted, as indicated at 70 and 72 two arms 66 and 68. The arms 66 and 68 are parallel and extend towards the center of the frame 50 and carry between them the wheel 4' which is capable of rotation in a way not shown in greater detail. The arms 66 and 68 are further cross-connected by a tie bar 74. A hydraulic motor 76 acts between a pivot, indicated by 78, tat the front end and near the top of the frame 50 and a pivot, indicated by 80, in the tie bar 74.

As will be seen in FIG. 6, the arms 66 and 68 are largely horizontal when the wheel 4' is in the "down" position and are at an angle to the horizontal plane when the wheel is retracted.

Although this in not shown in FIGS. 4 – 6, all the wheels of the machine may be arranged so as to be individually retractable. The retractable wheels, for instance in conjunction with the hydraulically actuated operating mechanism, may also be partially retractable, so that the height of the machine can be reduced while it is still resting on all wheels. It will be evident that this can be achieved by the piston of the hydraulic motor 76 being capable of continuous adjustment between its two extreme positions.

The arrangement incorporating retractable wheels confers a number of advantages. When the excavator bucket of an excavator is in operation its wheels are often subjected to hard wear, which is however eliminated in the machine in accordance with the invention, owing to the fact that the wheels can be retracted. Furthermore, by individual retraction of one or more wheels, fully or partially, the machine can be adapted to irregularities in the ground, and, particularly in work in constricted passages and tunnels, it is very advantageous that the overall height of the machine can be reduced by retraction of the wheels. The frame 50 protects the wheel and its retraction mechanism in both the extended and retracted positions and, in comparison with the machine in FIGS. 1 – 3, increases only to a negligible extent the horizontal dimensions of the machine, which will be evident from the fact that the distance between the axles, when the wheels are down, is the same as in the machine according to FIGS. 1 – 3.

It is also possible to omit completely the hydraulic piston in an arrangement of largely the same type as that in FIGS. 5 and 6, so that the retractable wheels can oscillate freely on the pivots 70, 72. Lowering of the wheels can then be accomplished by lifting the chassis with the aid of the working appliance 14, 16, 18 when the bucket 18 is resting on the ground. The wheels are then secured in the lowered position by a locking arrangement which prevents upward movement of the arms 66 and 68. When the machine which has its wheels down is to be brought to rest on its legs, the procedure is to be reversed.

The above way of lowering the wheels may also be available, as an added safety measure, together with a hydraulic mechanism for lowering of the wheels, e.g., the constructional version described.

The constructional version according to FIG. 7 is an example of a machine whose retractable wheels can oscillate freely, without the invention of hydraulic pistons, by means of bent forked swing arms 90 which correspond to the swing arms 66, 68 in FIGS. 4 – 6. The legs here have the shape of boxes 92 inside which the arms 90 are pivoted. In the position shown in FIG. 7, the swing arms 90 are secured by a mechanical device not visible in the FIG. which prevents the chassis from dropping down onto the legs/boxes 92.

In the machine according to FIG. 7, the two booms 14 and 16, the auxiliary boom 24 the arm 32 and the hydraulic motors 20 and 28 are furthermore the same as, and act in the same way as, in the previous FIGS. Hydraulic motor 30 is also the same. The bucket 18 of the previous constructional versions has however been replaced by a drag boom 100 with its attached drag shovel 102 the operating mechanism of which is not shown for the sake of clarity. The drag shovel arrangement 100–102 is of the conventional type generally available on the market. In contrast to the conventional arrangement, however, it is only necessary in a machine according to the invention to demount the bucket 18 at the end of the boom 16 and to replace this by the drag boom 100 whereby the pivots 17' and 32' coincide with the corresponding pivots 17 and 232 in the previous FIGS. In order to mount a drag boom on previously known machines, it was necessary earlier on to replace on the machine almost the whole mechanism operating the working appliance. It is easy to see that the arrangement according to FIG. 7 results in considerable savings in time and labor in comparison with previous methods.

FIGS. 8 – 10 finally show another constructional version of the invention, in which connection FIG. 8 illustrates the operating mechanism for the working appliance, in this case a bucket 110. In FIGS. 8 – 10 the parts which correspond to the parts in previous FIGS.

have been given the same designation numerals but with the addition of the prefix 1. Since the functions of the components in question are exactly the same as those of corresponding components in previous FIGS. they will not be described here in greater detail. In order to further illustrate the flexibility of the machine according to the invention, however, the hydraulic cylinder **30** in the previous constructional versions has been replaced by a lever mechanism actuated by a hydraulic cylinder **150**. The hydraulic cylinder is pivoted at **152** in the boom **114** and pivoted at **154** in an arm **156** which is pivoted in the boom **116** at **158**. At the other end, the arm **156** is formed into a fork, both legs of which are pivoted to arms **160** which are themselves pivoted at **132'** . Further working of the mechanism **150–160** should be clear from FIGS. **8–10** without further description. The machine according to this invention is further shown in FIGS. **9** and **10** with a rotatable superstructure which is not described in detail, comprising a driver's cab, hydraulic driving motor etc. In FIG. **9**, furthermore, the wheels **104'** are shown in the retracted position so that the machine rests on the legs **192** which is the working position of the machine.

As will be seen, the machine shown in FIGS. **9** and **10** is of an extremely compact construction and is well suited to travel and work in constricted passages, tunnels etc. Although the foregoing specification has primarily concentrated on this aspect, i.e., the compactness, of an excavator, an engineer will realize without difficulty that the invention is not restricted to such constructional versions. The power-saving arrangement consisting of an auxiliary boom actuated by hydraulic motor devices can also be utilized for many other applications on loaders and/or excavators, cranes and similar appliances, in which connection the invention can be utilized either to construct machines with an extremely high capacity while ignoring the matter of size, or, as in the constructional versions above, it can be utilized in such a way as to construct a compact machine.

What I claim is:

1. A machine that may be used as a crane, loader, and/or excavator, comprising in combination:

a. a mobile chassis,

b. a first boom that has an outer end, an inner end and a portion intermediate said inner and outer ends, said inner end being pivotally attached to said chassis,

c. a second boom that has an outer end, an inner end and a portion intermediate said inner and outer ends, said inner end of said second boom being pivotally connected to the outer end of said first boom,

d. a working appliance attached to the outer end of said second boom,

e. an auxiliary boom that has an inner end, and outer end and a portion intermediate said inner and outer ends,

f. the intermediate portion of said first boom being pivotally interconnected to the intermediate portion of said auxiliary boom,

g. a first hydraulic motor arrangement interconnecting the outer end of said auxiliary boom with an intermediate portion of said second boom,

h. a second hydraulic motor arrangement interconnecting the inner end of said auxiliary boom with said chassis,

i. an arm pivotally interconnecting the intermediate portion of said auxiliary boom with said chassis, and

j. means for moving said working appliance with respect to the end of said second boom.

2. A machine in accordance with claim **1** wherein at least one of said hydraulic motor arrangements consists of a simple piston-and-cylinder device.

3. A loader and/or excavator equipped with an excavator bucket in accordance with claim **1**, characterized in that the first boom is pivoted at a low level on the chassis; that the excavator bucket, the first and second booms and the auxiliary boom are capable of being retracted practically fully within the limits of the horizontal outside dimensions of the machine; that the first and second boom are almost the same length and are positioned largely parallel to one another when fully retracted.

4. A machine in accordance with claim **3**, characterized in that the maximum distance between the pivot of the excavator bucket on the second boom and the pivot of the first boom on the chassis in between about 1.5 – 2.5 times the greatest distance between the point of attachment of the first boom on the lastnamed pivot and the horizontal outside dimension of the machine.

5. A machine in accordance with claim **3** characterized in that the maximum distance between the pivot of the excavator bucket on the second boom and the pivot of the first boom on the chassis is between 1.2 – 2 times the greatest height above ground level of the machine when the excavator bucket is fully retracted.

6. A machine in accordance with claim **3**, which machine is supported on wheels, characterized in that the wheels on at least on axle are retractable into the chassis of the machine, and the chassis in the vicinity of the retractable wheels is provided with legs.

7. A machine in accordance with claim **6** characterized by the wheels being individually retractable.

8. A machine in accordance with claim **6** wherein all the wheels of the machine are retractable into the chassis.

9. A machine in accordance with claim **6** wherein each of the retractable wheels is carried, so as to be capable of rotation, at the end of its own swing arm device, the other end of which is pivoted inn the chassis of the machine.

10. A machine in accordance with claim **9**, characterized in that the said other end of the swing arm device is pivoted at one end of a largely horizontal and rectangular frame or box, whereby the swing arm device extends towards the center of the frame or box and there carries the wheel at the said one end.

11. A machine in accordance with claim **10** wherein the swing arm device is mainly horizontal when the wheels are lowered to the ground and is at an angle with the horizontal plane when the wheels are retracted.

12. A machine in accordance with claim **11**, characterized in that the pivot of the swing arm device is situated near the bottom of the frame, and by the fact that a hydraulic mechanism for its operation consists of one or more hydraulic motors which act between a pivot at

one end portion, and near the top, of the frame, and a pivot situated between the ends of the swing arm device.

13. A machine in accordance with claim 12 wherein one end portion of the frame projects below the general plane of the frame and forms a leg when the wheel is retracted.

14. A machine in accordance with claim 6 wherein the retractable wheels are partially retractable into the chassis, in order to permit reduction of the height of the machine while it is still supported on the partially retracted wheel(s).

15. A machine in accordance with claim 6 wherein the machine is capable of lifting up the chassis, when the excavator bucket is resting on the ground, with the aid of the booms operating the excavator bucket, in order to lower the retractable wheels to the ground, and the wheels are capable of being secured in the lowered position with the aid of a mechanical locking device.

16. A machine in accordance with claim 3 wherein the second boom and the operating mechanism interacting with the second boom in order to operate the excavator bucket is designed in such a way that the bucket can be easily demounted and replaced by a drag boom with drag shovel attached, which drag boom is thereby capable of operation by the said operating mechanism.

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