

July 23, 1946.

J. M. HAIT ET AL

2,404,493

AMPHIBIAN

Filed Jan. 8, 1942

3 Sheets-Sheet 1

FIG. 2

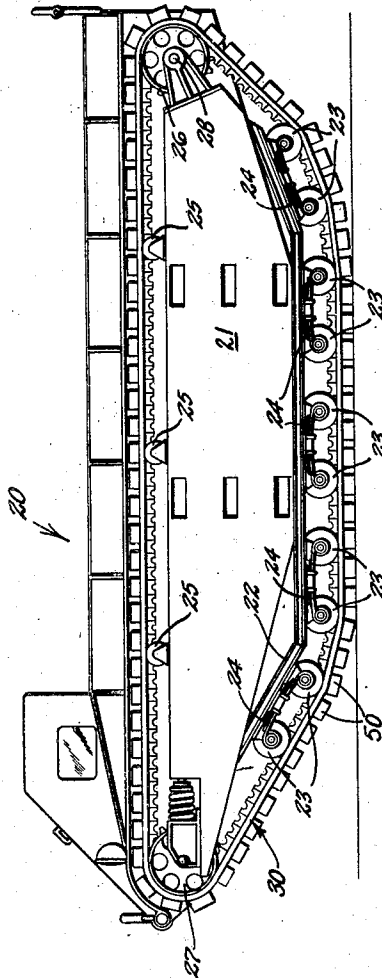
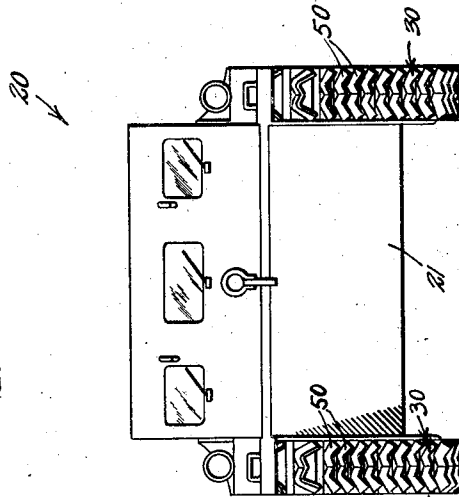


FIG. 1



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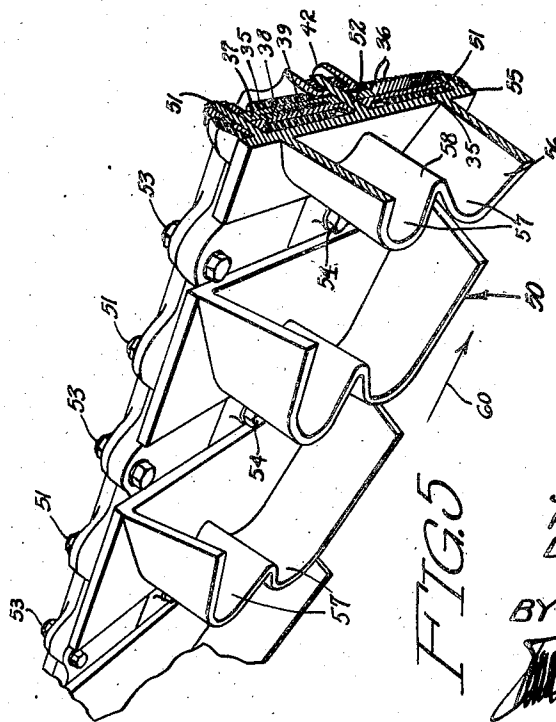
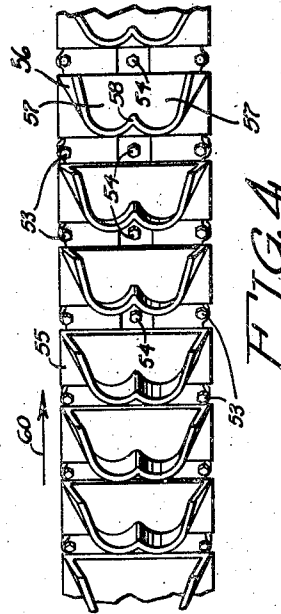
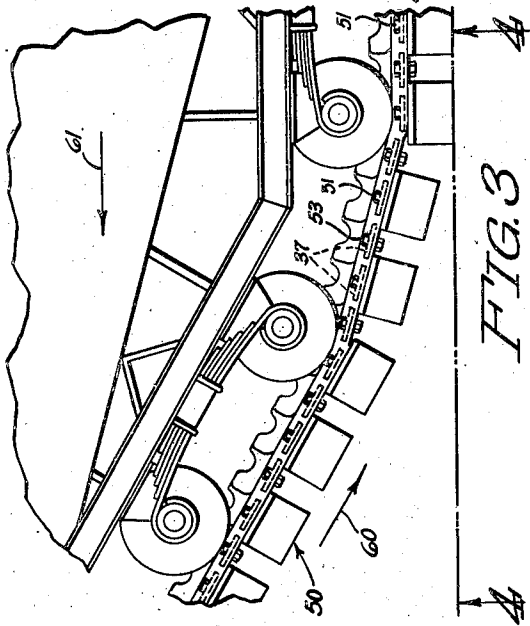
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3 Sheets-Sheet 3

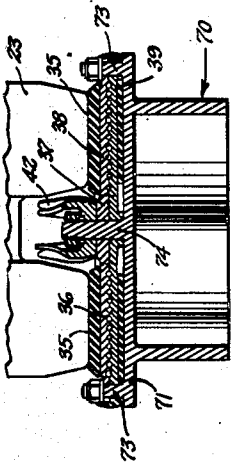


FIG. 9

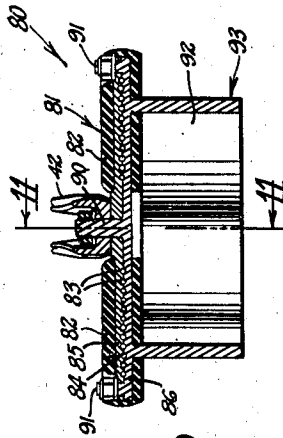


FIG. 10

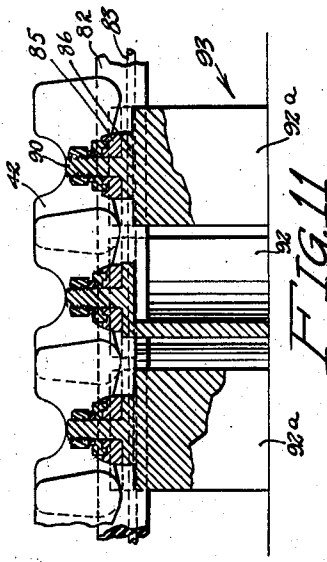


FIG. 11

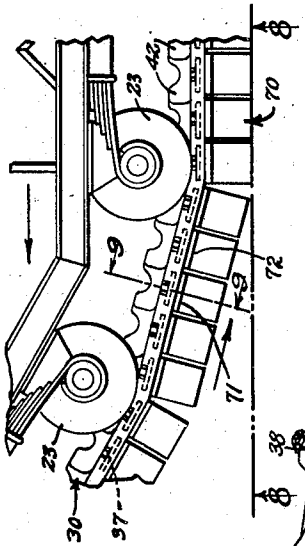


FIG. 7

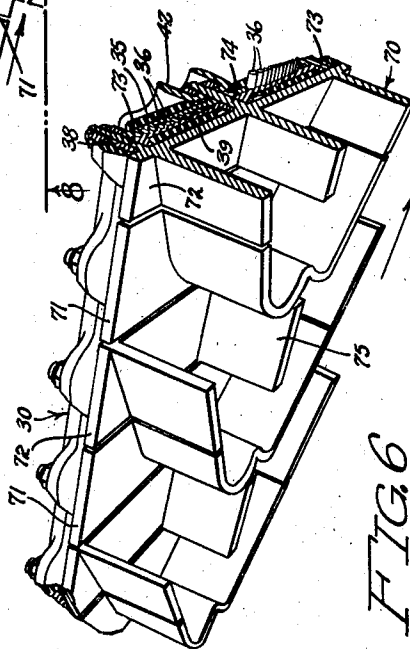


FIG. 6

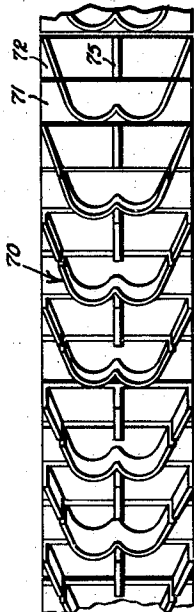
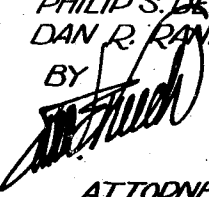


FIG. 8

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UNITED STATES PATENT OFFICE

2,404,493

AMPHIBIAN

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Application January 8, 1942, Serial No. 426,026

14 Claims. (Cl. 115—1)

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This invention relates to amphibian craft and particularly to amphibians employing endless traction belts for propulsion.

Many attempts have heretofore been made to develop amphibian craft adapted to be propelled on land or in the water by endless traction belts similar to those employed on land tractors generally. These attempts have so far been unsuccessful in that a suitable belt and propulsion grouser has not been provided which will produce an adequate speed of the craft in the water, render the craft dirigible, and at the same time stand up under the terrific strains to which this structure is necessarily subjected when the craft is traveling on land.

It is an object of the present invention to provide an amphibian having a belt and grouser construction which overcomes the deficiencies in amphibian design above noted.

Hitherto, the only known grousers which were reasonably efficient in converting into thrust the power applied to the traction belt have been of the unbalanced type and set up a side thrust which rapidly wore out the belts and the guides therefor.

It is another object of this invention to provide a relatively highly efficient grouser of the balanced type and which does not produce such a side thrust.

Our experimental work indicates that the most practical type of grouser, both from the standpoint of efficiency in propelling the amphibian in water, and from the standpoint of providing a support for the traction belts and for the craft when the latter is traveling on land, have substantial depth in the direction in which the belt travels. The difficulty in trying to use this more practical form of grouser, however, is that its depth or length in the direction of its travel makes it very awkward to mount this on the traction belt as this belt must follow a path which turns about fairly short radii at the idle and drive sprockets and the grousers of course have to turn about these radii with the belts. There is thus difficulty in providing a mounting of such strength as to prevent these grousers from being torn from the belts and at the same time give the belts the necessary flexibility.

It is therefore yet another object of the invention to provide a traction belt with the more practical type of grouser above mentioned and yet make this mounting a strong one while permitting the belt to retain the necessary degree of flexibility.

We have also found that the maximum degree of efficiency is attained with the more practical type of grouser above mentioned when these have definite spacings along the belt. This introduces problems in providing uniform

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support for the belt to which the grousers are connected.

It is a still further object of the invention to provide an amphibian propulsion mechanism in which the aforesaid type of grouser can be provided on the traction belt with the required spacings and yet give the belt adequate support when the amphibian is traveling on the land.

The manner of accomplishing the foregoing objects, as well as further objects and advantages, will be made manifest in the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a front elevational view of an amphibian in which is incorporated a preferred embodiment of the invention.

Fig. 2 is a side elevational view of Fig. 1.

Fig. 3 is an enlarged fragmentary view of a portion of Fig. 2.

Fig. 4 is a bottom plan view taken on the line 4—4 of Fig. 3.

Fig. 5 is a fragmentary perspective view of our preferred form of grouser with one of these in section to illustrate its mounting on a belt.

Fig. 6 is a view similar to Fig. 5 illustrating a modified form of our combined belt and propulsion grouser construction.

Fig. 7 is a view similar to Fig. 3 illustrating the tank as equipped with the construction shown in Fig. 6.

Fig. 8 is a bottom plan view of Fig. 7.

Fig. 9 is a cross-sectional view taken on the line 9—9 of Fig. 7.

Fig. 10 is a cross-sectional view similar to Fig. 9 but illustrating a second modified form of the invention.

Fig. 11 is a longitudinal sectional view taken on the line 11—11 of Fig. 10.

Referring specifically to the drawings, the amphibian 20 includes a hull 21 having a frame structure 22 provided on opposite sides thereof. Each of these structures is provided with a number of pairs of bogie wheels 23 mounted on springs 24, a number of idler wheels 25, a drive sprocket 26 and a spring-loaded idler sprocket 27. The sprockets 26 are mounted on power shafts 28 which connect through suitable transmission and clutch mechanisms (not shown) with a motor (not shown) provided in the hull 21.

Trained about the sprockets 26 and 27, so as to be guided by the bogie wheels 23 and the idle rollers 25, on each side of the hull 21, is a propulsion grouser belt 30.

The propulsion grouser belt 30 includes two endless bodies of rubber 35, two endless series of cables 36 and an endless series of clamps 37, each of which has an upper clamping plate 38 and a lower clamping plate 39. The clamps 37 are spaced longitudinally throughout the length of the belt 30 so that when the latter flexes, these

plates have articulating relation with each other, as clearly shown in Fig. 3.

Each bogie wheel 23 has the form of a double roller thereby providing a space for accommodating metallic guide members 42.

The belt 30 has assembled therewith propulsion grousers 50 which in the preferred form of the invention connect with alternate clamps 37 and provide end studs 51, and central studs 52 (see Fig. 5) for assembling these clamps and the guide members 42. The remaining clamps 37 and guide members 42 are assembled together by bolts 53 and 54.

Each grouser 50 (see Figs. 1, 3, 4 and 5) includes a base plate 55 on which the studs 51 and 52 are provided. Formed integrally with this plate and extending downwardly at substantially a right angle therewith is a grouser blade 56 which is shaped like a script E, 3 or W, depending from which angle it is viewed, so as to form two cups 57 which open rearwardly and downwardly.

The lateral portion of each blade 56 is preferably inclined inwardly from zero to thirty-five degrees from perpendicular with the plate 55, this being found to substantially increase the propulsive efficiency of the blade. The best angle of inclination is a function of the grouser velocity relative to the water. For example: At grouser speeds relative to water of 13.70 ft. per sec. an inclination of 30° gives maximum thrust while at 5.6 ft. per sec. a greater thrust results from a leading edge slope of 20°.

The cups 57 can be spaced centrally and operate satisfactorily but these preferably come together in the middle of the blade in a relatively sharp edge 58. The blade 56 has been found to possess a substantially greater efficiency where this edge is sharp than where it is flattened or where there is a central space provided between the two cups 57.

The base plate 55 of each grouser 50 is wide enough so that when mounted on a single clamp 37, as shown in Figs. 3, 4 and 5, its fore and aft edges underlie adjacent clamps 37 and provide support for these.

In operating the amphibian 20, power is applied to the drive shafts 28 to cause the belts 30 to travel annularly through their respective paths as indicated by the arrows 60 in Figs. 4 and 5. This causes movement of the amphibian 20 in the direction indicated by the arrow 61 in Fig. 3. The amphibian 20 is designed to float when placed in water and the travel of the grousers 50 through the water when the amphibian is floating therein propels the amphibian through the water. We have found the grouser 50 to be highly efficient and it possesses this quality without producing any side thrust, the main reaction forces being balanced.

It is also to be noted that the blades 56 of the grousers 50 present an extremely rugged supporting structure for supporting the amphibian when the latter is traveling on land. This is because of the curves and the central bend in each blade 56 which causes the various portions of this blade to be relatively uniformly disposed across the area of each plate 55.

In Figs. 6, 7, 8 and 9 a modified form of grouser 70 is illustrated. This grouser is similar in form to the grouser 50 excepting that it is divided, half being mounted on one base plate 71 and half being mounted on another base plate 72, these base plates being connected to the belts 30 by studs 73 and 74 in the same manner as the base plates 75

55 of the grousers 50 are adapted to be connected to these belts by studs 51 and 52. To provide adequate support for the middle portion of each of the plates 72 this has a downwardly extending blade 75.

The outstanding advantage of the grouser 70 is that it provides a uniform support for all of the metal clamps 37 in the belts 30 when the amphibian is traveling on land.

Figs. 10 and 11 show a third modified form of belt and grouser construction 80. This construction embodies a belt 81 which is similar to the belts 30 in that it includes two endless bodies of rubber 82, two endless series of cables 83 clamped by an endless series of clamps 84, each of which has an upper clamping plate 85 and a lower clamping plate 86. The clamps 84 are spaced longitudinally throughout the length of the belt 81 so that when the latter flexes, these clamps have articulating relation with each other in the same manner as the clamps 37 of the belts 30. The belt 81 also makes use of metallic guide members 42, one of these guide members being assembled with each clamp by a central stud 90 provided on the lower clamp plate 86. The ends of plates 85 and plates 86 are clamped together by studs 91 provided on the latter.

Cables 83 and clamps 84 are embedded in the endless bodies of rubber 82. Formed on the lower clamping plates 86 are wall sections 92 and 92a which together make up grousers 93. The sections 92 and 92a provided on the plates 86 are preferably similar to those wall sections provided on the base plates 71 and 72 of the grouser 70 so that the bottom plan of the grouser 93 is substantially like that of the grouser 70.

The particular advantage of the belt and grouser construction 80 is that it is lighter than one of the belts 30 combined with either the grousers 50 or the grousers 70.

While we prefer to mount the grousers of our invention on a rubber-metal belt as above described, it is to be understood that the term "belt," where used in the claims without qualifications preventing such a broad construction, embraces all forms of endless belts, chains, and the like, which might be adapted to carry said grousers.

We claim:

1. A propulsion grouser adapted for mounting on the external surface of an endless traction belt of an amphibian tank for propelling said amphibian in the water and supporting the amphibian on land, which grouser comprises: a blade disposed substantially normal to the plane of the belt, the various portions of said blade being of practically uniform depth, said blade being in the form of a pair of cups disposed side by side and opening downwardly and rearwardly, each of the lateral portions of said blade scooping water inwardly toward the longitudinal axis of said blade so that said water is trapped in said cups and forced downwardly by travel of said blade through the water; and means for attaching said blade to said belt.

2. In an amphibian craft, the combination of: a hull; a pair of endless belts; means for supporting said belts for endless movement in substantially vertical planes at opposite sides of said craft; an endless series of propulsion grouser blades provided on each of said belts for propelling said craft in the water or supporting the same on land, each of said grouser blades extending outwardly from said belt approximately at right angles to the latter and being shaped to

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include three changes in direction which forms a pair of cups disposed on opposite sides of the longitudinal axis of said belt and opening rearwardly.

3. A combination as in claim 2 in which the lateral extremities of each such grouser blade are slightly inclined inwardly from normal with the longitudinal axis of said belt and opening rearwardly.

4. In an amphibian craft, the combination of: a hull; a pair of endless belts; means for mounting said endless belts at opposite sides of said hull; means on said hull for driving said belts; and an endless series of propulsion grousers on each of said belts, each of said grousers including a metal blade which is symmetrical relative to the longitudinal axis of the belt to which it is attached and provides a pair of cups disposed along-side of each other and opening downwardly and rearwardly.

5. In an amphibian craft, the combination of: a hull; a pair of endless belts; means for mounting said endless belts at opposite sides of said hull; means on said hull for driving said belts, each of said belts including an endless series of reinforcing cables coextensive with said belt, an endless series of metal clamps clamping said cables at closely spaced intervals throughout the length of said belt, and masses of soft rubber coextensive with said belt, said rubber substantially enveloping said cables and end portions of said clamps; and an endless series of metal propulsion grousers secured to the aforesaid clamps of each of said belts so that said grousers are adapted to articulate relative to each other when said belts are flexed.

6. A combination as in claim 5 in which each of said propulsion grousers is formed to provide a pair of cups disposed side by side and opening downwardly and rearwardly, each of said grousers being divided transversely, one portion thereof being mounted on one of said clamps and the other portion mounted on a different adjacent one of said clamps.

7. In an amphibian craft, the combination of: a hull; a pair of endless belts; means for mounting said belts on said hull along opposite sides thereof; means on said hull for driving said belts, each of said belts including endless rubber bands, endless cables imbedded in said rubber bands and a series of metallic clamping plates imbedded in said rubber bands and clamping said cables, said plates being spaced longitudinally to permit articulation therebetween when said belts are flexed; and an endless series of propulsion grousers mounted on each of said belts, said grousers being secured to alternate clamping plates in each of said belts and underlying the remaining clamping plates disposed in between those to which the grousers are attached.

8. In an amphibian craft, the combination of: a hull; a pair of endless belts; means for mounting said belts on said hull along opposite sides thereof; means on said hull for driving said belts, each of said belts including endless rubber means, an endless series of reinforcing metal plates imbedded in said rubber means, said plates being adapted to have articulating relation with each other when said belt is flexed, and means for tying said plates together to prevent said belt stretching; and an endless series of propulsion grousers mounted on each of said belts, said grousers being secured to alternate reinforcing plates in said belts and being of such an extent

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that the plates in between those to which said grousers are attached overlap the grousers attached to adjacent plates.

9. In an amphibian propulsion mechanism, the combination of: an endless belt; and an endless series of grousers mounted thereon, each of said grousers including an impeller blade having substantial depth in the direction of movement of said belt and being divided transversely into a plurality of separate entities separately mounted on said belt so as to readily pass around a turning axis with said belt.

10. In an amphibian propulsion mechanism, the combination of: an endless belt; and an endless series of pairs of impeller blades mounted thereon, each of said blades including a relatively straight portion inclined to the direction of movement of said belt, thereby setting up a flow of water along said portion, and a relatively sharply curved portion in which said straight portion terminates and into which said flow delivers, said curved portion being cupped in said direction, the blades of each pair being oppositely inclined so that the forces set up by their movement in the water counter balance each other thereby substantially eliminating side thrust on said belt.

11. In an amphibian propulsion mechanism, the combination of: an endless belt; and an endless series of pairs of impeller blades mounted thereon, each of said blades including a relatively straight portion inclined to the direction of movement of said belt and disposed adjacent an outer edge of said belt, thereby setting up a flow of water along said portion toward the center of said belt, and a relatively sharply curved portion disposed close to the center of said belt and in which said straight portion terminates, said curved portion being cupped in said direction, the blades of each pair being oppositely inclined so that the forces set up by their movement in the water counter balance each other thereby substantially eliminating side thrust on said belt.

12. A propulsion grouser adapted for mounting on the external surface of an endless traction belt of an amphibian for propelling said amphibian in the water and supporting the amphibian on land, which grouser comprises: a blade disposed substantially normal to the plane of the belt, said blade being in the form of a pair of cups disposed side by side and opening downwardly and rearwardly, each of the lateral portions of said blade scooping water inwardly toward the longitudinal axis of said blade so that said water is trapped in said cups and forced downwardly by travel of said blade through the water; and means for attaching said blade to said belt.

13. A combination as in claim 12, in which the tips of said lateral portions of said blade are inclined inwardly from normal to the plane of the belt.

14. A propulsion grouser adapted for mounting on the external surface of an endless track belt of an amphibian for propelling said amphibian in the water and supporting the amphibian on land which grouser comprises a metal blade which is symmetrical relative to the longitudinal axis of the belt to which it is attached and provides a pair of cups disposed alongside of each other and opening downwardly and rearwardly.

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