United States Patent

[11] 3,584,547

[72] Inventor **Donald R. Davin**
Shelbyville, Ill.

[21] Appl. No. **787,484**
[22] Filed **Dec. 27, 1968**
[45] Patented **June 15, 1971**
[73] Assignee **Blaw-Knox Company**
Pittsburgh, Pa.

[54] **BOGIE SUSPENSION SYSTEM**
5 Claims, 3 Drawing Figs.

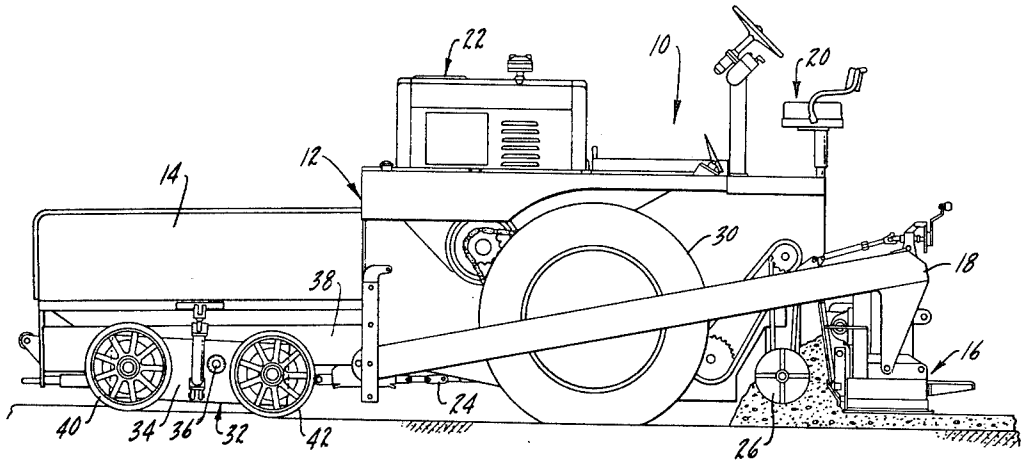
[52] **U.S. Cl.** **94/46,** 280/104.5
[51] **Int. Cl.** **E01c 19/48**
[50] **Field of Search** 94/44, 46, 50; 280/104.5

[56] **References Cited**
UNITED STATES PATENTS

1,897,934	2/1933	Hallett	280/104.5
2,132,059	10/1938	Trembly	94/50
2,391,948	1/1946	Couse	280/104.5
2,721,405	10/1955	Gardner	280/104.5
2,775,925	1/1957	Greiner	94/50
3,338,143	8/1967	Layton	94/46

Primary Examiner—Jacob L. Nackenoff
Attorney—Mondeville & Schweitzer

ABSTRACT: A suspension system for a tandem wheel system, such as the bogied front wheels on a paving machine, in which the wheel system is so mounted to a main vehicle that the rolling resistance is minimized. For a paver bogie having tandem wheels running over soft ground, the point of suspension of the bogie from the paver is located nearer the rear wheel axle than the front wheel axle.



PATENTED JUN 15 1971

3,584,547

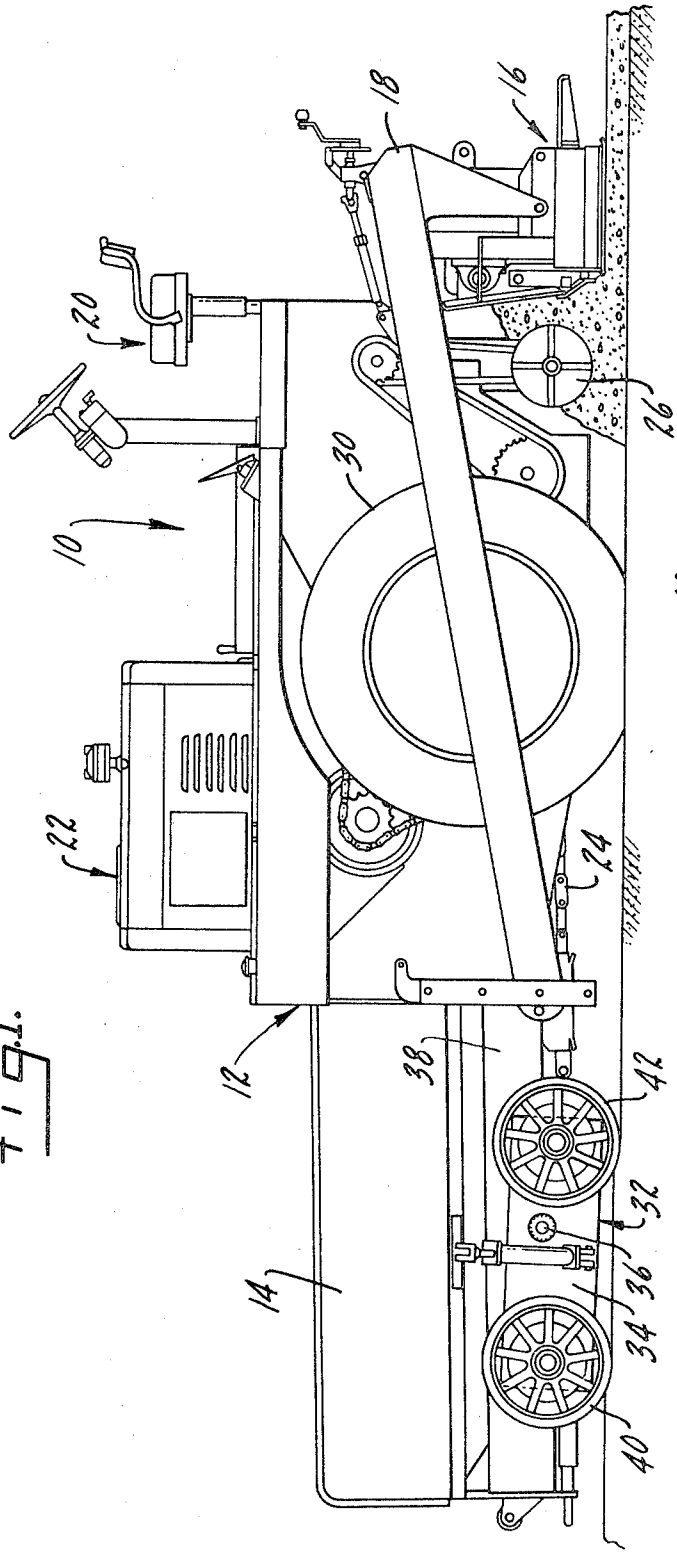


FIG. 1.

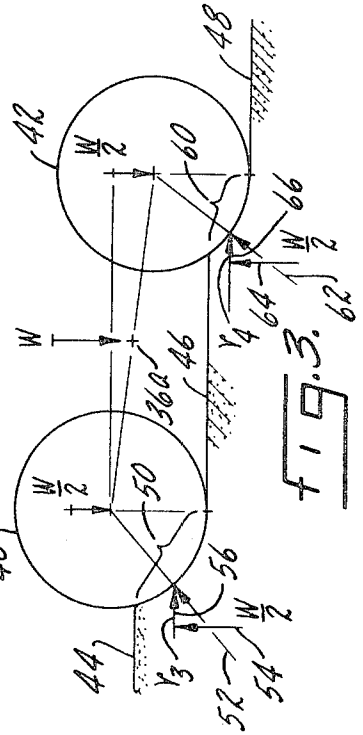


FIG. 3.

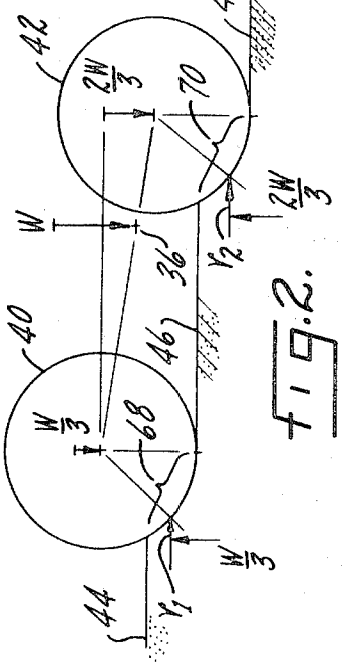


FIG. 2.

INVENTOR.
Donald R. Davin
BY Parker, Carter & Markey
Attorneys.

BOGIE SUSPENSION SYSTEM

This invention relates generally to altering the wheel loading of a vehicle to take advantage of the increased weight the soil ahead of the wheel will support when said soil has been precompacted. It is specifically directed to reducing the rolling resistance encountered in a tandem wheel system of the type currently used on construction equipment, such as concrete and asphalt paving machines which have bogied front wheels.

For convenience of description the invention will be described as embodies in an asphalt paver of the type illustrated in U.S. Pat. No. 3,236,163. In this type of paver the weight of the machine at the forward end is supported by a four wheel carriage, or bogie. The front wheels on each side of the bogie run on relatively uncompacted ground and the associated rear bogie wheels, which follow the same path as the front wheels, thereby run on precompacted soil. In prior constructions the bogie has been mounted to the main frame of the machine on an axis which is equally spaced between the bogie wheels. As a result the front bogie wheel in each bogie wheel system has encountered considerably greater rolling resistance than its associated rear bogie wheel, and the total rolling resistance is rather high.

Accordingly a primary object of the invention is to provide a tandem wheel suspension system in which, for a given supported weight, the rolling resistance encountered by the front wheel of a tandem, two wheel system adapted to run on soft ground is reduced as contrasted to prior arrangements whereby power consumption is reduced, steerability is improved, and a general improvement in the efficiency of the system is obtained.

Yet another object is to provide a tandem wheel suspension system in which the rolling resistance of the system is minimized by an optimum, utilization of the factors of load distribution and rate of compaction of soil of differing initial density.

A further object is to increase the bearing capacity of bogie wheels on a soft base by shifting some of the weight carried by the front bogie wheel onto the rear bogie wheel thereby equalizing the amount of penetration each wheel makes in the base.

Another object is to provide a bogie wheel suspension system for paving machines and the like in which the roadway "rutting" can be reduced.

Yet a further object is to provide a bogie suspension system for a paving machine having maximum flotation of the front wheels with a consequent marked improvement in the ability of the paving machine to pass over soft terrain.

Other objects and advantages of the invention will become apparent from the following description.

The invention is illustrated more or less diagrammatically in the accompanying figures wherein.

FIG. 1 is a side view of an asphalt paver which incorporates the present invention;

FIG. 2 is a view, largely diagrammatic in nature, of the present invention as applied to a bogie wheel system of the type shown in FIG. 1 illustrating the forces which comprise the rolling resistance in the system; and

FIG. 3 is a view similar to FIG. 2 illustrating the forces which comprise the rolling resistance in a typical prior art system.

Like reference numerals will be used to refer to like or similar parts from figure to figure of the drawing.

An asphalt paver is indicated generally at **10** in FIG. 1. The paver includes a main frame or body section **12** having a hopper **14** at the front end and a surface template or screed **16** at the rear or trailing end. The screed is supported from the main frame by structure indicated at **18**, the details of which are not pertinent to an understanding of the present invention. An operator's station is indicated at **20** and a source of power at **22**.

It will be understood that in normal operation the machine moves to the left as viewed in FIG. 1. Raw asphalt is dumped into the hopper **14** and conveyed rearwardly by a suitable conveyor system such as a slat conveyor, the return reach of which is indicated at **24**, to an auger **26** which distributes the material substantially uniformally in front of the screed **16**. The paver is supported by large rear wheels **30**, and a bogie **32**.

The bogie consists essentially of an auxiliary or subframe **34** which is pivotally connected by any suitable means, such as axle **36**, to an extension of the main frame **12**, said extension being indicated generally at **38**. The bogie frame carries a set of tandem bogie wheels **40**, **42**, which, in this instance, are rigid wheels. It will also be noted that in this instance the front and rear bogie wheels **40**, **42**, respectively are of substantially the same diameter. The bogie wheels are aligned one with the other and with the rear wheel **30** which is a conventional arrangement in the art. The opposite side of the paver, so far as the front end is concerned, is a mirror image of the side illustrated.

It will be noted that the means for pivotally connecting the bogie to the main frame of the paver, in this instance the axle **36**, is located at a point which is closer to the rear bogie wheel **42** than the front bogie wheel **40**.

Although the exact theory upon which the invention is based cannot be stated with absolute certainty, due for example to the still incomplete understanding of soil-mechanics, the following is offered as an explanation of the invention.

From FIGS. 2 and 3 it will be noted that the uncompacted terrain is indicated at **44**, precompacted terrain at **46**, and finally compacted terrain at **48**. The precompacted terrain is of course that terrain over which the lead bogie wheel **40** has passed, and the finally compacted terrain **48** is that terrain which has additionally been traversed by the rear bogie wheel **42**, and thereby subjected to the full load, in increments, carried by the bogie.

Referring now to FIG. 3, it will be noted that in prior systems the bogie axle **36** was located at the midpoint between the centers of the front and rear bogie wheels. As a result, the front bogie wheel **40** supported one-half of the weight W acting on the bogie, and the rear bogie wheel **42** supported the other half of the weight W, these weights being indicated as acting through the center of the wheels and represented by the symbol W/2.

Since the front bogie wheel **40** was in continual contact with the loosest, least compacted soil in the system a relatively large wedge of soil, indicated by the arc of contact **50**, was encountered by the wheel. For convenience of description the resultant of the resisting forces of the soil against the wheel has been indicated at **52**. It will be understood of course that in reality every increment of area of the soil resists the advance of the wheel, but that for convenience of description the sum of the infinite number of small forces may be represented by a single force acting against the surface of the wheel in a radial direction. Again, for convenience of description and understanding, the single force **52** may be resolved into a vertical force **54** and a horizontal force **56**. The vertical force **54** will of course be equal to the weight acting through the center of the wheel, W/2. The magnitude of the horizontal resisting force **56**, also indicated as 3 is a function of the density and compaction properties of the soil and the weight on the wheel among other factors.

Similarly, the area of contact of rear wheel **42** with the precompacted soil **46** may be indicated generally by the arc of contact **60**. Again, the sum of the infinite number of forces acting against the surface of the wheel may be represented by the force vector **62** which acts radially through the center of the wheel. Vector **62** may be factored into a vertical component **64** and a horizontal component **66**, also indicated as *r*4. Again the vertical component **64** will be equal in magnitude, and opposite in direction, to the weight W/2 which acts through the center of the wheel. However, the magnitude of the rolling resistance force *r*4 is somewhat less than the

force $r3$ associated with front wheel **40** since the wedge of soil with which wheel **42** is in contact is of substantially lesser extent than the wedge of soil with which front wheel **40** is in contact. In other words, the bank of soil up which rear wheel **42** must climb is of a lesser elevation than the corresponding bank of soil up which front wheel **40** must climb because of the precompaction of the soil by the front wheel **40**. Since the depth to which the rear wheel will sink is a function of the density of the soil, among other things, the rear wheel will not sink as far for a given weight as will the front wheel.

It will be noted however that the sum of the rolling resistance forces $r3$ and $r4$ is rather substantial due mainly to the fact that the front wheel **40** sinks a substantially greater distance into the soil than does the rear wheel **42**.

Referring now to FIG. **2**, it will be noted that for the same total weight W the sum of the rolling resistance forces in the system is considerably less than the sum of the rolling resistance forces in the prior art system of FIG. **3**.

Specifically, front wheel **40** is in contact with a wedge of soil along an area, indicated by the arc of contact **68**. This arc is considerably less than the length of the corresponding arc **50** in the corresponding front wheel of the prior art system due to the fact that the total weight imposed on front wheel **40** of FIG. **2** is only two-thirds as large as the weight imposed in the FIG. **3** system. The decrease in weight on front wheel **40** of FIG. **2** is derived from the fact that the axle **36** by which the bogie is mounted to the main frame extension **38** is displaced from the midpoint of the line joining the wheel centers. Specifically, in this instance in which the wheels are substantially equal in diameter, the bogie axle **36** has been placed closer to the rear wheel **42** than the front wheel **40** and, for convenience of illustration, it will be assumed that the distance of axle **36** from the center of rear wheel **42** is only one-half the distance between the axle and the center of front wheel **40**.

At the same time however the weight on rear wheel **42** of the system of FIG. **2** is 1½ times the weight on the corresponding rear wheel **42** of the system of FIG. **3** with the result that the rear wheel **42** of FIG. **2** sinks a greater distance into the precompacted soil than does rear wheel **42** of FIG. **3**. It will be noted however that even though the area of contact represented by the arc **70** of FIG. **2** is greater than the area of contact represented arc **60** of FIG. **3**, the sum of the forces resisting rolling movement of the bogie system of FIG. **2**, that is the sum of $r3$ plus $r2$, is less than the sum of $lr3$ and $r4$ which represent the rolling resistance of the FIG. **3** system.

It will be understood that, although the behavior of soil compaction is not completely understood as of this date, it is believed that the improved results of the present invention are due to the fact that the depth of compaction of soil is not directly proportional to the weight imposed on it. That is to say, soil which is of a greater density, that is which has precompacted, than a reference soil, tends to be depressed or compacted at a lower rate than noncompacted, soil.

It will be understood that the optimum placement of the bogie axle will depend upon many factors, including the compaction characteristics of the soil, the size of the wheels and possible even the speed of the vehicle. It might for example be feasible to attain the benefits of the invention with the bogie axle located at the exact midpoint between the wheel axles if the front wheel is of a larger diameter than the rear wheel since experience indicates that the rolling resistance $r1$ of the front wheel is also a function of the area of contact between the soil and the wheel. The concept therefore in its broadest aspect, consists of so proportioning the distance between the bogie axle and each of the wheel axles as will result in a minimum rolling resistance force for the given conditions of a given system, including the size of wheel, compaction characteristics of the soil and speed of movement of the wheel over the soil. In the practical embodiment chosen for illustration in which the front and rear wheels are of equal diameter, the advantages and benefits of the invention are derived by placement of the bogie axle closer to the rear wheel axle than the front wheel axle.

Although it will be obvious to those skilled in the art that variations and modifications may be made within the spirit of the invention, it is intended that the scope of the invention be limited by the scope of the hereinafter appended claims when construed in light of the pertinent prior art, and not in light of the foregoing exemplary description.

I claim:

1. In a tandem wheel system associated with a paving machine, said system being located at the forward portion thereof,

a plurality of wheel means mounted in tandem; and

a subframe assembly to which said wheel means are mounted;

said subframe assembly including pivotal connecting means for mounting the subframe to a main frame of said machine;

said connecting means being placed at a location rearwardly offset from the midpoint between said tandem wheel means, whereby the sum of the rolling resistant forces incurred by each wheel means is substantially at a minimum as the paving machine forwardly traverses a nonrigid surface.

2. The tandem wheel system of claim **1** further characterized:

firstly, in that the plurality of wheel means comprises two wheels,

secondly, in that the wheels are of such a diameter and width that each would make, when separately considered, substantially the same impression in a base of uniform density under a given weight, and

thirdly, in that the subframe pivotal connecting means is located closer to the trailing wheel than to the leading wheel.

3. In combination with a paver having a main frame supported in its rear end by main frame rear wheel means,

a multiwheel bogie for supporting the front end of a paver, said bogie including:

a bogie frame,

two pairs of tandemly disposed wheels carried by, and supporting, said bogie frame, and

means for pivotally connecting said bogie frame to the main frame,

the wheels in each of said pairs of tandem wheels being so placed, that the means for pivotally connecting the bogie frame to the main frame is located closer to the rear wheel than the front wheel in each set of tandem bogie wheels, thereby substantially minimizing rolling resistance to said wheels as said paver travels forwardly.

4. The combination of claim **3** further characterized in that:

the means for pivotally connecting the bogie frame to the main frame is an axle about which limited arcuate movement of the bogie frame may take place.

5. The combination of claim **4** further characterized in that:

the bogie wheels are rigid wheels.