

Jan. 29, 1963

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3,075,436

SOIL COMPACTION MACHINE

Filed May 6, 1960

8 Sheets-Sheet 1

FIG. 1.

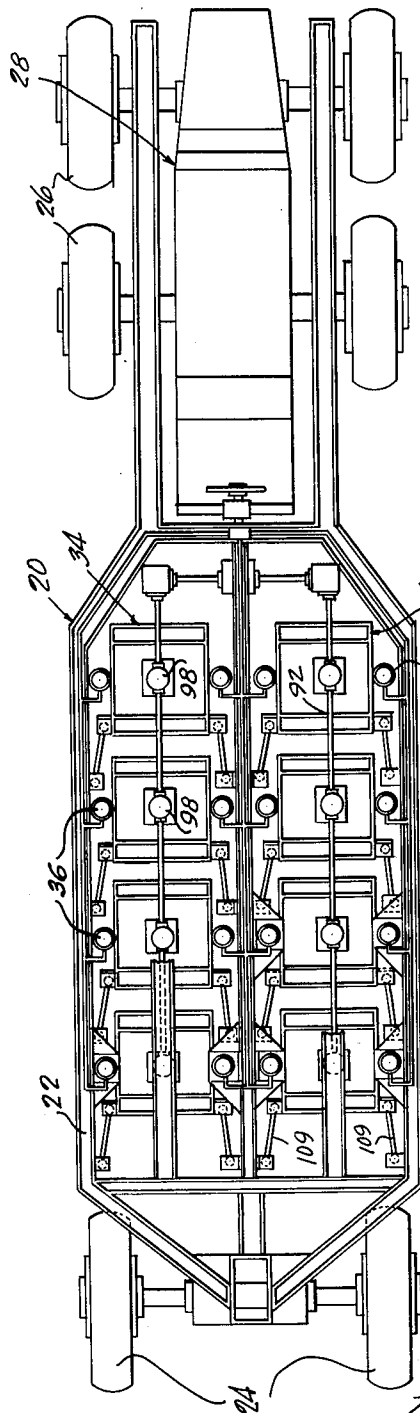


FIG. 5.

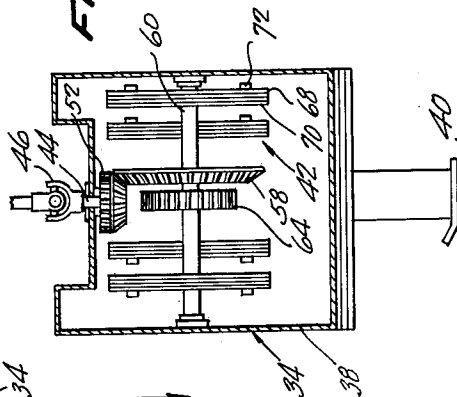
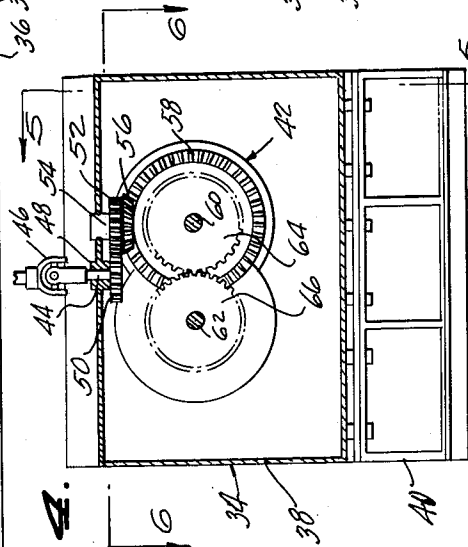


FIG. 4.



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3,075,436

SOIL COMPACTION MACHINE

Filed May 6, 1960

8 Sheets-Sheet 2

FIG. 2.

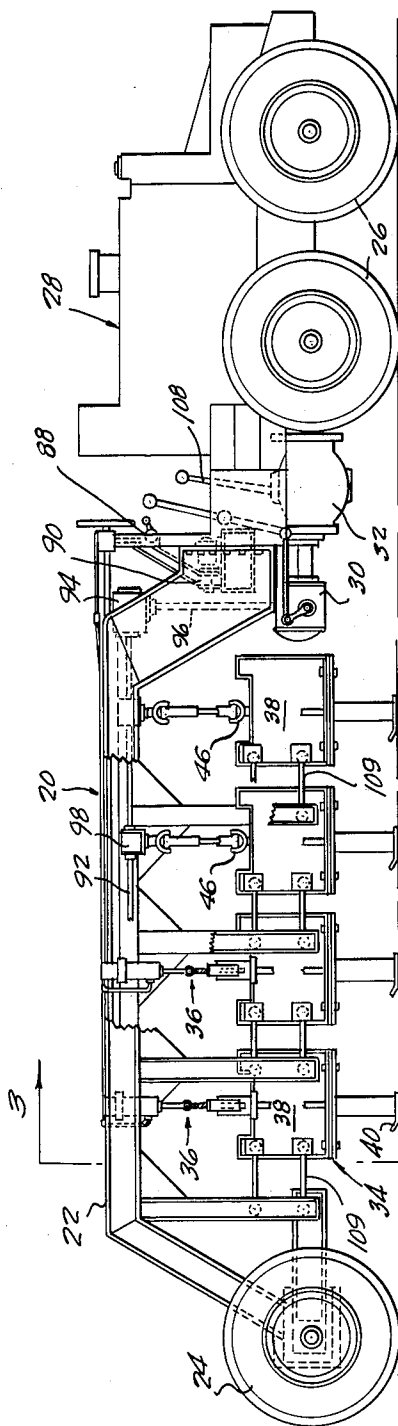


FIG. 17.

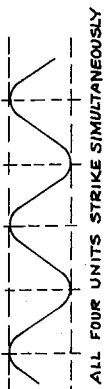


FIG. 18.

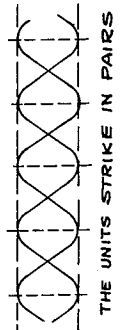


FIG. 19.

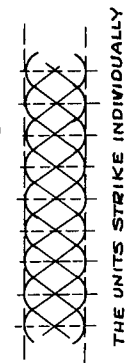
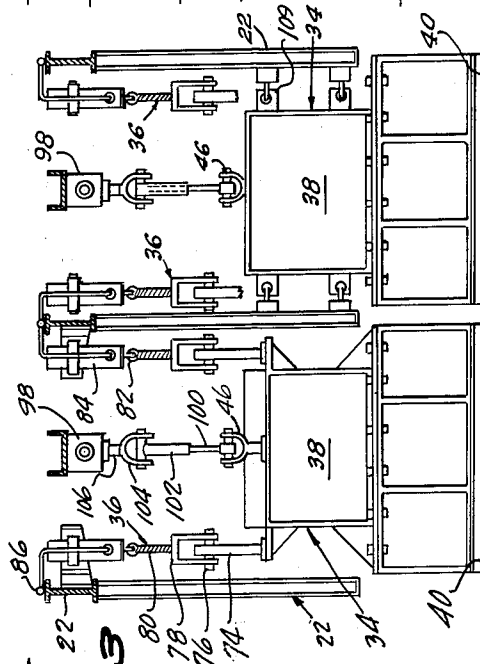


FIG. 3



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3,075,436

SOIL COMPACTION MACHINE

Filed May 6, 1960

8 Sheets-Sheet 3

FIG. 6.

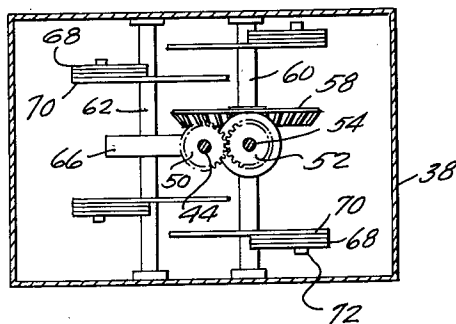


FIG. 7.

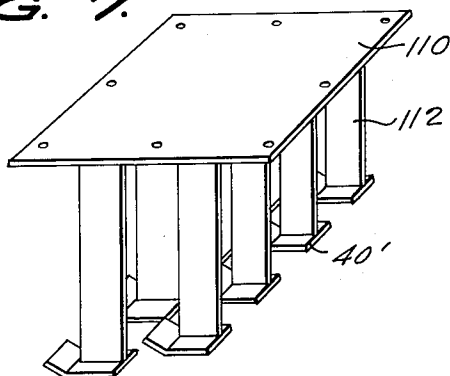


FIG. 8.

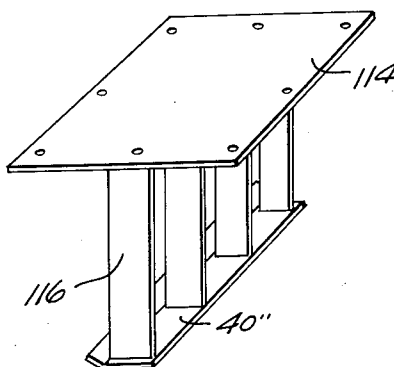
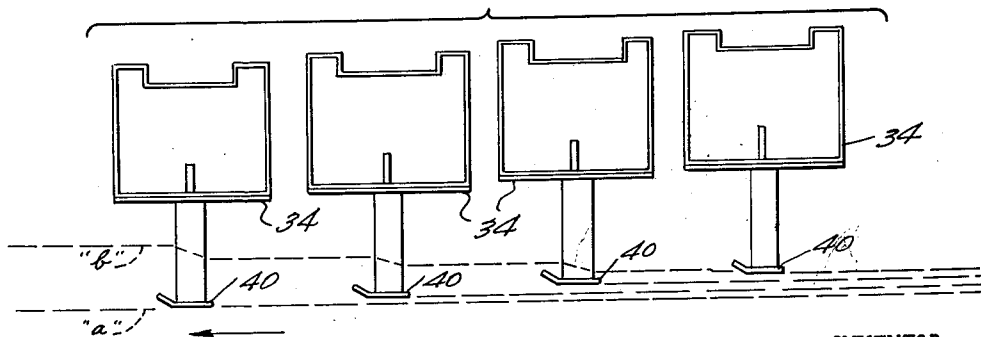


FIG. 9.



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Jan. 29, 1963

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3,075,436

SOIL COMPACTION MACHINE

Filed May 6, 1960

8 Sheets-Sheet 4

FIG. 10.

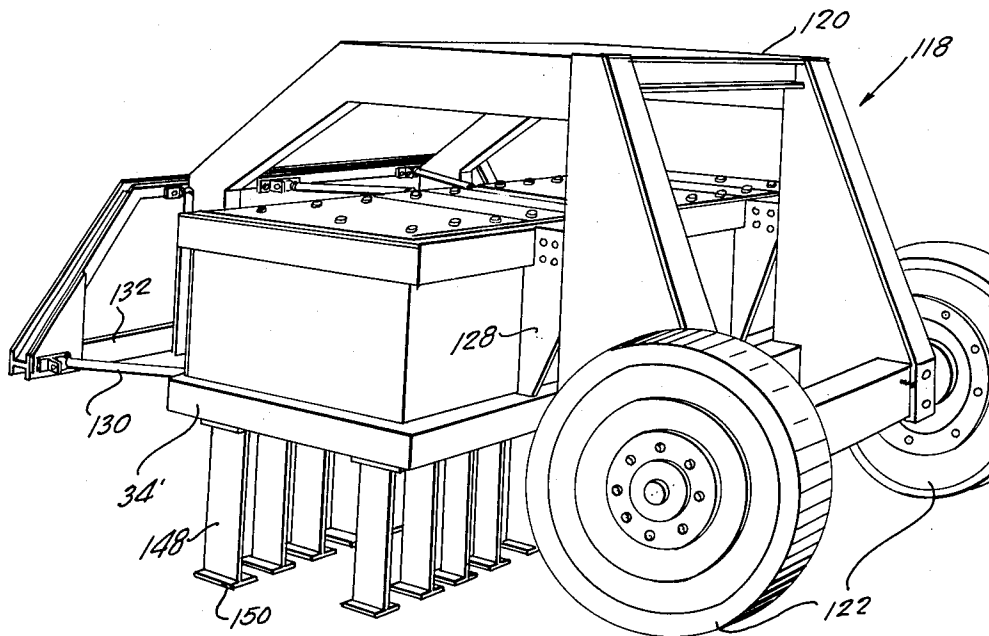
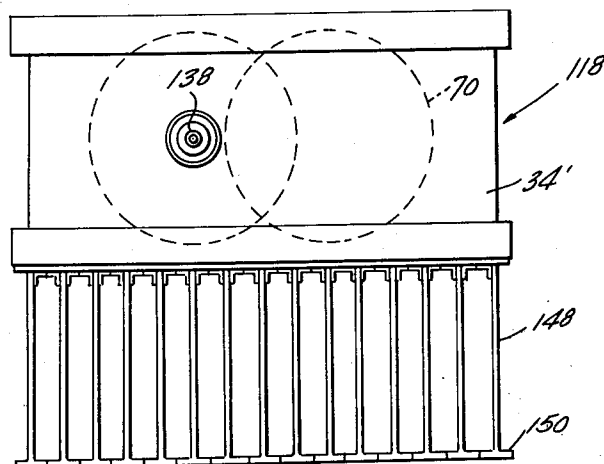


FIG. 12.



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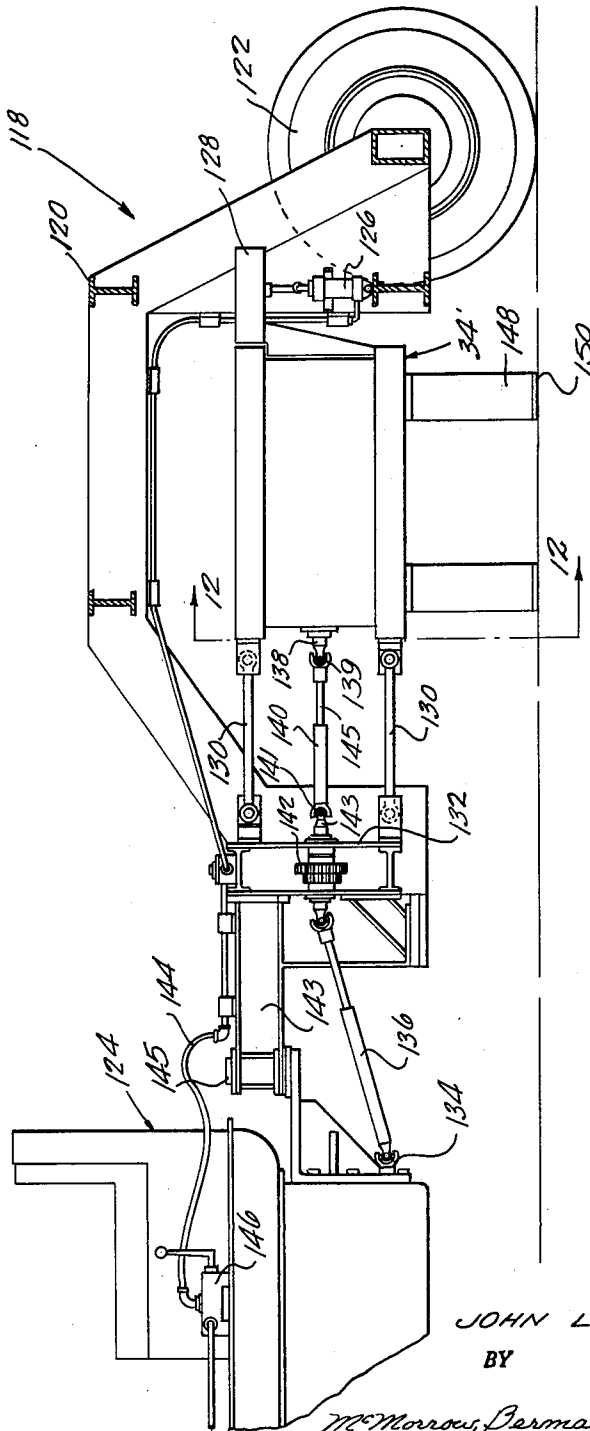
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SOIL COMPACTION MACHINE

Filed May 6, 1960

8 Sheets-Sheet 5

FIG. 11.



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Jan. 29, 1963

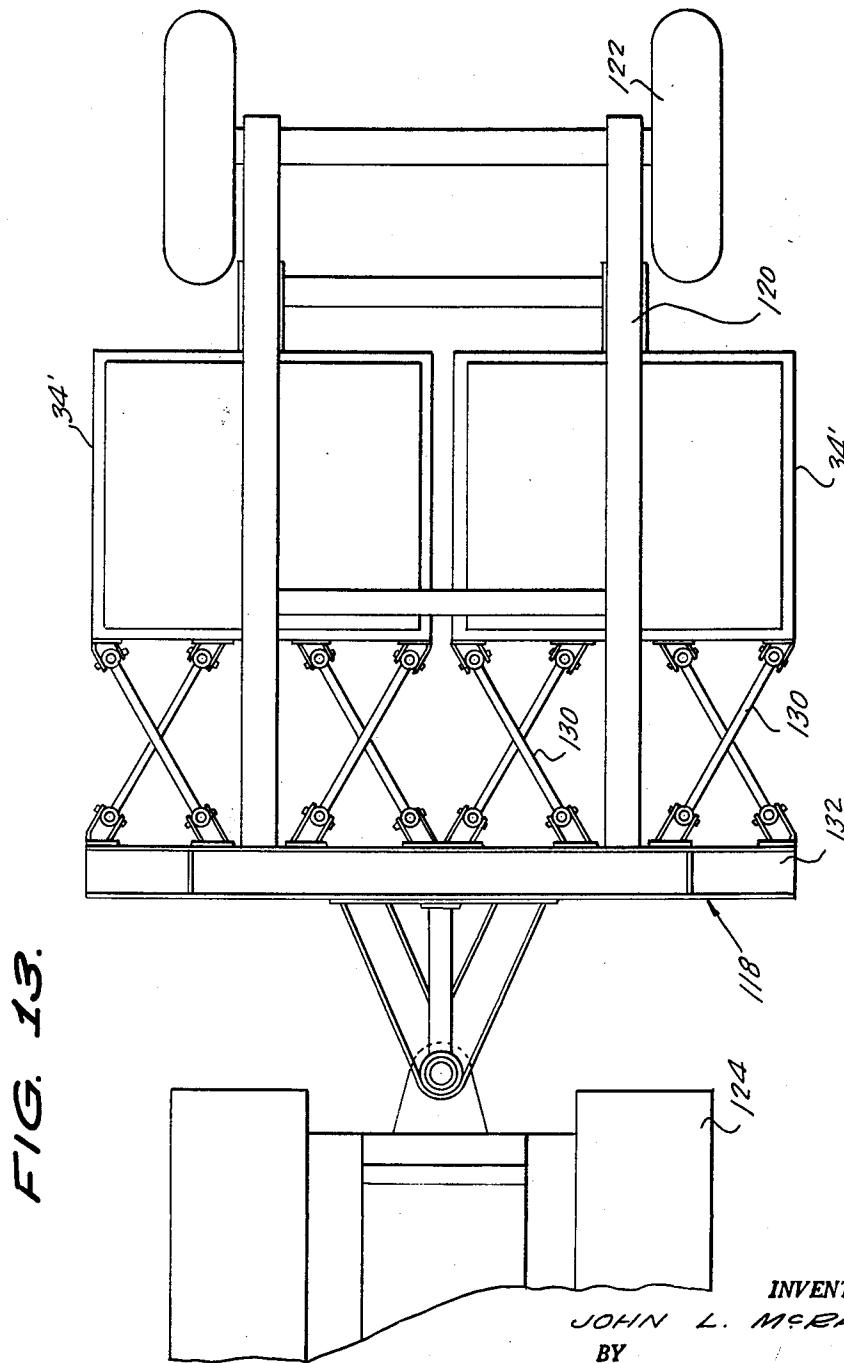
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3,075,436

SOIL COMPACTION MACHINE

Filed May 6, 1960

8 Sheets-Sheet 6



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3,075,436

SOIL COMPACTION MACHINE

Filed May 6, 1960

8 Sheets-Sheet 7



Jan. 29, 1963

J. L. McRAE

3,075,436

SOIL COMPACTION MACHINE

Filed May 6, 1960

8 Sheets-Sheet 8

FIG. 15.

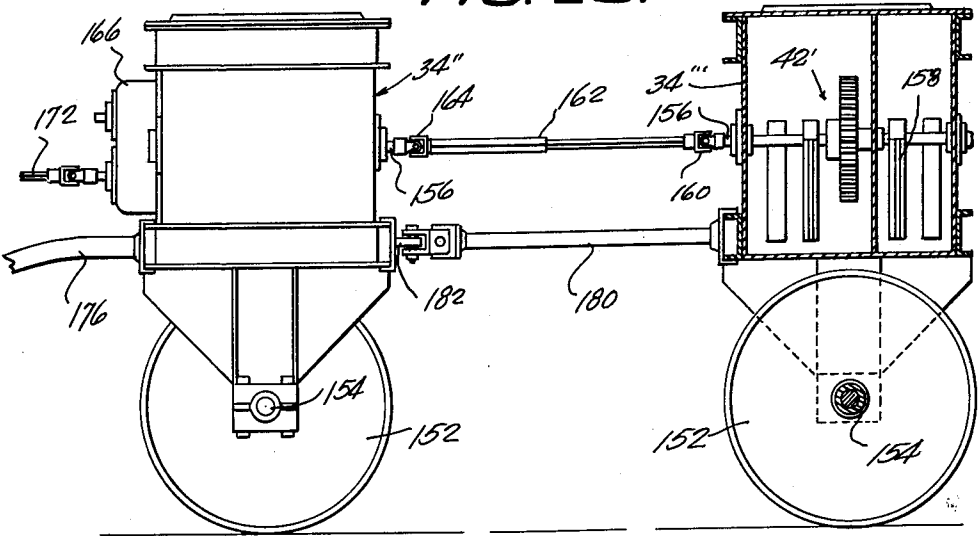
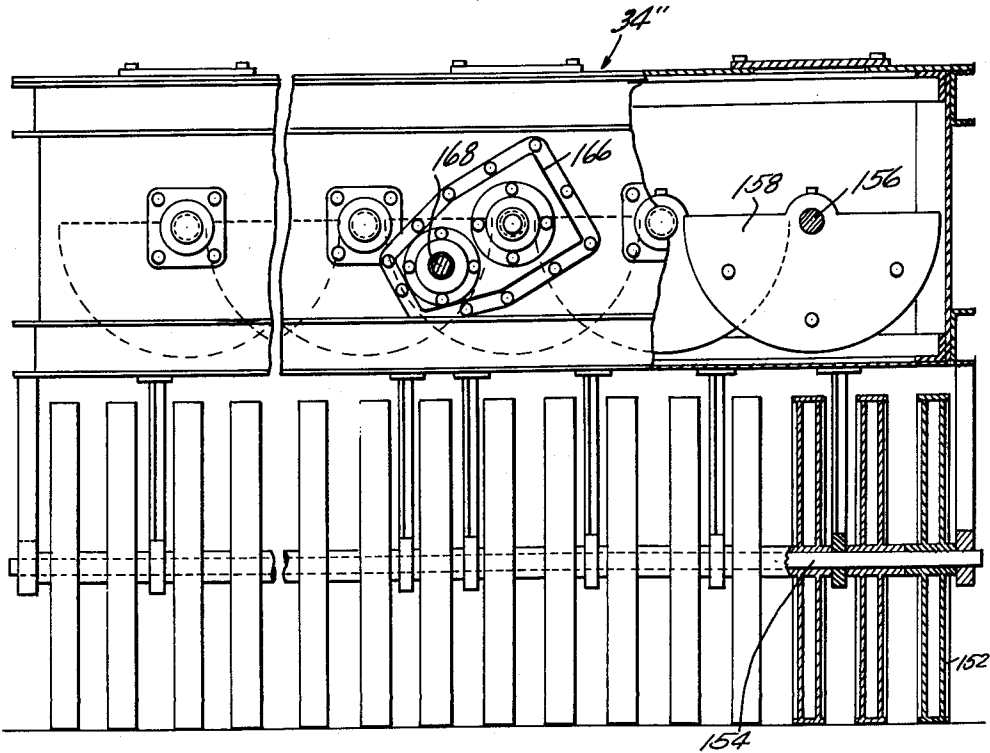


FIG. 16.

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1

3,075,436

SOIL COMPACTION MACHINE

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Filed May 6, 1960, Ser. No. 27,394

6 Claims. (Cl. 94-49)

The present invention relates to a machine for compacting or tamping soils to develop a solid earth surface for a base for roads, airstrips, construction sites, or the like.

In the preparation of a base for a road, airport strip, or other area in which it is desirable to have a dense soil base, it is extremely important that the layers of soil be uniform by compacting in the bottom layer to the top layer. Previously proposed and presently in use are soil compacting machines of various types. Rollers have been employed and vibrators have been employed either singly or in conjunction with a roller but the same have not been entirely successful for many reasons. A chief defect is that the rollers apply a squeezing action which did not overcome the friction between the particles of the soils being compacted and the vibrator is then employed and serves to partially overcome the friction of the soil particles so that the particles move with respect to each other and develop a more compact mass and reduce by the squeezing action of the rollers.

A primary object of the present invention is to provide a soil compaction machine having tamping shoes arranged in tandem relation so that when the machine is driven over a ground surface, the tamping shoes penetrate a layer of uncompacted soil and provide, as the machine is moved, a completely compacted surface which is of uniform density from the bottom of the soil layer to the top of the layer.

Another object of the present invention is to provide a soil compaction machine which lends itself to compacting a soil layer at a single pass.

A further object of the present invention is to provide a soil compaction machine having tamping shoes which serve to strike or tamp soil on a ground surface, the tamping shoes and mechanisms operating the same and being arranged so that they may be driven in unison, alternately, in pairs, or individually as desired.

A still further object of the present invention is to provide a soil compaction machine having a plurality of tamping shoes independently suspended so that they adjust themselves to uneven ground surfaces with ease and facility.

Yet another object of the invention is to provide a soil compaction machine having a plurality of impact tamping units in which the sequence of the units may be varied so that the units strike the ground in any sequence desired, this being accomplished by varying the relative position of the eccentric weights of the units and permitting adjustment in total impact load against the earth for each downward stroke and also adjustment in the frequency with which the earth is struck while maintaining a given relatively low-frequency, high-amplitude motion for each individual oscillator mechanism, thus producing high frequency vibration in the earth by means of a series of low frequency impact tampers. This results in the larger mass of the earth being consolidated by high frequency impulses while the localized mass at the surface is being compacted by the sharp penetrating blows of the individual impact shoes.

These and other objects and advantages of the present invention will be fully apparent from the following description when taken in conjunction with the annexed drawings, in which:

FIGURE 1 is a top plan view of the soil compaction machine according to the present invention;

2

FIGURE 2 is a side elevational view of the assembly shown in FIGURE 1;

FIGURE 3 is a view on an enlarged scale, taken on the line 3-3 of FIGURE 2;

FIGURE 4 is a sectional view of one of the units of the assembly of FIGURE 3;

FIGURE 5 is a view taken on the line 5-5 of FIGURE 4;

FIGURE 6 is a view taken on the line 6-6 of FIGURE 4;

FIGURE 7 is an isometric view of a modified form of the tamping shoe structure employed with the machine of the present invention;

FIGURE 8 is an isometric view of another modified form of the tamping shoe structure;

FIGURE 9 is a schematic view of four units working at various levels in loose soil to be compacted;

FIGURE 10 is an isometric view of a modified form of the machine according to the present invention;

FIGURE 11 is a side view in elevation of the assembly of FIGURE 10;

FIGURE 12 is a view on an enlarged scale, taken on the line 12-12 of FIGURE 11;

FIGURE 13 is a top plan view of the assembly of FIGURE 10;

FIGURE 14 is a plan view of a still further modified form of the machine, a portion of one unit being broken away and with the top removed;

FIGURE 15 is a side elevational view partially in section of the assembly of FIGURE 14;

FIGURE 16 is a front elevational view of the assembly of FIGURE 14, with a portion of the interior exposed;

FIGURE 17 is a schematic view showing the vibratory action of the machine of FIGURES 1 to 9, with all the units working in unison;

FIGURE 18 is a schematic view showing the vibratory action of the machine of FIGURES 1 to 9, with the units working in pairs; and

FIGURE 19 is a schematic view showing the vibratory action with the units working individually.

Referring in greater detail to the drawings in which like numerals indicate like parts throughout the several views, and with particular reference to FIGURES 1 to 6, inclusive, the soil compaction machine of the present invention is designated generally by the reference numeral 20 and it includes a frame 22 supported for movement over a ground surface by steerable front wheels 24 and the pairs of wheels 26 of a prime mover 28 at the rearward end of the machine.

The prime mover 28 has a power takeoff 30 and a transmission 32 interposed between the power takeoff 30 and the engine of the prime mover 28.

Within the frame 22 are a plurality of pairs of soil compacting units 34 arranged in lateral fixed spaced relation and positioned in tandem spaced relation.

Means is provided mounting the units 34 within the frame 22 for movement together from a position spaced above a ground surface to a position in engagement with the ground surface. This mounting means is designated generally by the reference numeral 36 and will be described in detail further on in the description.

As the units 34 are identical, only one needs to be described in detail. Each unit 34 includes a housing 38 and a tamping shoe 40 depending from the housing 38.

Within the housing 38 is a vertical thrust applying mechanism designated generally by the reference numeral 42. The vertical thrust applying mechanism is operatively connected to the housing 38 for imparting up and down impacting movement to the tamping shoe 40 with respect to the ground surface.

With reference to FIGURES 3 to 6, inclusive, the ver-

tical thrust applying mechanism 42 is shown to include a vertically disposed shaft 44 driven by a flexible coupling element 46. The shaft 44 is mounted in a bearing 48 in the upper wall of the housing 38 and a pinion 50 is carried on the lower end of the shaft 44. The pinion 50 is in meshing engagement with another pinion 52 mounted upon a stub shaft 54 having one end journaled in the upper wall of the housing 38.

The stub shaft 54 carries on its lower end a bevel gear 56 in mesh with another and larger bevel gear 58. The bevel gear 58 is fixedly secured on a first rotatable shaft 60 having its ends journaled in the side walls of the housing 38.

A second rotatable shaft 62 is arranged in parallel spaced relation with respect to the shaft 60 and also has its ends journaled in the side walls of the housing 38. The shafts 60 and 62 are disposed horizontally and carry means drivingly connecting the shafts 60 and 62 together so that they rotate in opposite directions. This driving means is best shown in FIGURE 4 and it consists in a first spur gear 64 mounted on the shaft 60 in meshing engagement with a second spur gear 66 mounted on the shaft 62.

With reference to FIGURE 6, eccentric weights 68 are carried by each of the shafts 60 and 62 and a disc 70 attaches the weights 68 to each of the shafts 60 and 62. The weights 68 are disposed on each side of the spur gear 64 and connected to the shaft 60 by the one disc 70 on each side of the spur gear 64, with the other weights 68 on each side of the spur gear 66 and connected to the shaft 62 by another disc 70 on each side of the spur gear 66.

Each weight 68 is conformably shaped to a sector of a circle and is fabricated from a flat relatively thick sheet of heavy metal. As many weights 68 as are desired may be secured to each disc 70, bolts 72 serving as fastening means for fixing the weights 68 to the disc 70.

Means is provided operatively connected to the units 34 for effecting the upward and downward movements of the units 34 with respect to the ground surface. Specifically, this means consists of the mounting means 36 on each side of each unit 34 and having its lower end connected to the unit 34 and its upper end connected to the frame 22.

The mounting means 36 of each unit 34 consists in a post 74 rising from each side of the unit 34 intermediate the ends thereof. A horizontally disposed pin 76 extends through the upper end of each post 74 and a U-shaped clevis 78 has its legs pivotally connected to the pin 76.

A flexible cable 80 connects each clevis 78 to the free end of an actuating arm 82 of a hydraulic cylinder assembly 84. The cylinder of each assembly 84 is fixedly secured to an adjacent portion of the machine frame 22.

Conduit means as at 86 in FIGURE 2 connects each hydraulic cylinder assembly 84 to a control valve 88 and a hydraulic fluid pump and reservoir system as at 90, the pump being driven by the engine of the prime mover 28 in a conventional manner.

A driven shaft 92 extends longitudinally of the frame 22, as shown in FIGURE 2. One end of the shaft 92 is operatively connected in a gear box 94 to a vertical shaft 96 at the upper end of the latter. The lower end of the shaft 96 extends into the power takeoff 30 of the prime mover 28. The driven shaft 92 extends between the gear box 94 and other gear boxes 98 positioned above each of the units 34, the shaft 92 being in sections but having only a single reference numeral for reasons of simplicity.

The present invention provides individual telescoping-ly arranged universal joint coupling means operatively connected to a shaft 44 of each vertical thrust applying mechanism 42. This means is shown in detail in FIGURE 3 and it consists in the previously mentioned flexible coupling element 46 on the upper end of the shaft 44,

the square shaft 100 having its lower end connected to the element 46 and its upper end slidably within a hollow shaft 102 having a square bore therein. The upper end of the shaft 102 is pivotally connected to another flexible coupling or universal joint 104 carried on the lower end of an output shaft 106 which projects from the adjacent gear box 98 and is operatively connected to the driven shaft 92.

The speed of rotation of the driven shaft 92 is controlled by a conventional gear shift lever 108 projecting into the transmission 32.

Tow bars 109 extend between each unit 34 and an adjacent part of the frame 22 and have their ends connected for universal movement to the units 34 and the frame 22. There are four tow bars 109 connecting each unit 34 to the frame 22 against swiveling movement or tilting movement, but permitting upward and downward movement.

In FIGURE 7, the numeral 110 refers to the bottom plate of one of the units 34. A plurality of posts 112 are arranged in two rows in staggered relation and carry on their lower ends tamping shoes 40'. The posts 112 are dependently carried by the plate 110.

In FIGURE 8, the numeral 114 represents the bottom plate of a unit 34 and the numeral 116 represents a single row of posts depending from the plate 114 and carry on their lower end a single tamping shoe 40'.

With reference to FIGURES 10 to 13, inclusive, a modified form of the soil compaction machine of the present invention is shown and designated generally by the reference numeral 118.

In this form of the invention, an overhead frame 120 is supported at one end by wheels 122 and at the other end by attachment to a prime mover such as is designated in FIGURE 11 by the reference numeral 124.

A pair of tamping units 34' are arranged in lateral spaced relation beneath the frame 120 and are connected to the frame 120 for upward and downward movement into and out of the ground-engaging position. Each unit 34' has a plurality of posts 148 arranged in two rows in longitudinal spaced relation and carry on their lower ends tamping shoes 150, the posts 148 being dependently carried by the unit. A hydraulic cylinder assembly 126 is mounted on a lower portion of the frame 120 adjacent each of the rear wheels 122 and is operatively connected to the adjacent unit 34' by means of a support structure 128 projecting from the adjacent unit 34'. Upon admission of fluid into one end of the hydraulic cylinder assembly 126, the unit 34' is raised with the tow bars 130 serving as a parallelogram structure keeping the adjacent unit 34' level and against tilting movement when raised by the hydraulic cylinder assembly 126.

As shown most clearly in FIGURE 13, each unit 34' is connected by a pair of tow bars 130 adjacent each side edge thereof, the tow bars of each pair of tow bars criss-crossing each other and serving to prevent swinging movement of the unit 34' relative to the frame 120.

One end of each tow bar 130 is connected by a universal joint to the adjacent part of the unit 34' and the other end is similarly connected to a horizontal beam structure 132, forming a forward and lower portion of the frame 120.

The prime mover 124 has a power takeoff 134 connected by a flexible and telescoping coupling means, at 136 in FIGURE 11, to the driving means for the vertical thrust applying mechanism within the unit 34'. In this form of the invention, the input shaft 138 of the vertical thrust applying mechanism is connected by a flexible and telescoping coupling means to a gear box 142 into which extends the other end of the coupling means 136, the coupling means being the same as that shown and described in the form of FIGURES 1 to 6 wherein the input shaft 44 of the oscillating mechanism is connected to the output shaft 106 projecting from the gear box 98, and including a flexible coupling member 139 on the input shaft 138 of

5

the oscillating mechanism within the unit 34', a flexible coupling member 141 on the output shaft 143 in the gear box 142, a square shaft 145 carried by the coupling member 139 and slidably telescoping into a square bore provided in a hollow shaft 140 carried by the coupling member 141.

Suitable conduit means 144 and control valve means 146 connect each of the hydraulic cylinder assemblies 126 to the hydraulic fluid pressure system of the prime mover 124, in a conventional manner.

Within each unit 34' is the same vertical thrust applying mechanism 42 previously described with reference to the form of the invention shown in FIGURES 1 to 6. In FIGURE 12, dotted lines referenced by the numeral 70 indicate the disc 70 on which are carried the weights 68 of the previously described invention, the weights not being shown in this view. A draw bar 143 on the front of the frame 120 connects the machine 118 to a hitch element 145 on the prime mover 124.

With reference to FIGURES 14 to 16, inclusive, a further form of the machine of the present invention is shown in which there is no supporting frame but the units 34'' and 34''' have tamping shoes in the form of rollers 152 depending therefrom and rotatable about an axle 154 as a horizontal axis.

In this form of the invention, there are six shafts disposed horizontally above the legs in lateral spaced relation longitudinally of the axis of travel of the units 34'' and 34'''. One such shaft is shown in FIGURE 16 and designated by the numeral 156. The shafts 156 carry weights 158 on one side thereof for rotation therewith.

One of the shafts 156 projects forwardly of the unit 34''' and is connected by a universal joint 160 to a telescoping shaft assembly 162 at one end of the latter. The other end of the shaft assembly 162 is connected by another universal joint 164 to one of the shafts 156 of the unit 34'', such one shaft of the unit 34'' projects rearwardly of the unit 34''' in axial alignment with the projecting portion of the shaft 156 of the unit 34'', as shown most clearly in FIGURES 14 and 15.

A gear case 166 is carried on the front of the unit 34'' and has an input shaft 168 connected by a flexible coupling or universal joint 170 to one end of a telescopic shaft assembly 172 which has its other end operatively connected to the power takeoff of the towing vehicle, the towing vehicle being represented by a draw bar element 174, shown in dotted lines in FIGURE 14.

A tow bar 176, V-shaped in configuration, projects rigidly from the front of the unit 34'' and has its apex pivotally connected for swinging upward and downward movement of the unit 34'' to a hitch element 178 carried by the draw bar 174. Another tow bar 180, also V-shaped in outline, has its apex secured to a hitch element 182 on the back of the unit 34'' and is itself fixedly secured and projecting forwardly from the unit 34'''.

In operation, employing the machine 20, as above described with reference to FIGURES 1 to 6, the units 34 are normally held in the elevated positions by the admission of fluid under pressure into the cylinders of the hydraulic cylinder assemblies 84 of the mounting means 36 to raise the actuating arms 82. This raises all of the units 34 together and in unison and the machine 20 may be transported over roadways or the like to the place of operation.

Upon release of the fluid under pressure in the hydraulic cylinders, gravity will return the units 34 to the position in which the tamping shoes 40 engage the ground surface.

Upon the application of rotative power to the shaft 92 from the power takeoff 30, and at a desired speed as determined by the setting of the transmission 32, the vertical thrust applying mechanism 42 in each unit 34 will be set into operation.

The rotative power is transmitted through the pinions

6

50 and 52, bevel gears 56 and 58, to the shaft 60 and then by means of the spur gears 64 and 66 to the shaft 62 for rotation of the shaft 60 in one direction and rotation of the shaft 62 in the other direction. The eccentric connection of the weights 68 to the respective shafts 60 and 62 effects the transmittal of a large amplitude of vertical tamping movement to the housing 38 of each unit 34 and this tamping movement of the housing 38 results in the tamping shoes 40 striking the ground repeatedly to effect compacting of the soil on the ground.

With reference to FIGURE 9, the reference character "a" refers to a dotted line representing a substantially solid ground surface. Over the ground surface is distributed uncompacted soil to a height here illustrated as an example substantially equal to the level indicated by a dotted line and designated by the reference character "b."

It has been found that as the machine 20 travels in the direction indicated by the arrow in FIGURE 9, the tamping shoes 40 will penetrate to the bottom of the layer of uncompacted soil and start compaction at the bottom of the layer and compact upwardly, thus producing uniformity of density at the bottom of the layer to the top of the layer. This eliminates the undesirable condition of low density in the bottom of the layer of compacted soil which is frequently the result of compacting soil by the use of conventional compacting machines.

It has also been found that by varying the positions of the weights 68 with respect to each other when the machine is at rest, the units 34 may be made to apply thrusts vertically so as to have the shoes 40 strike the ground simultaneously, as in FIGURE 17, and represented by a wave form. Alternatively, the weights 68 may be arranged so that the striking movement of the units 34 is such that two units are striking at once while the other two are moving upwardly preparatory for making striking blows to the soil. This is represented in wave form in FIGURE 18. Also, the weights of the units may be adjusted relative to each other so that each unit strikes individually as represented by the wave form of FIGURE 19.

One of the principles of operation is that as the shafts 60 and 62 rotate, the weights 68 move outwardly from each other for part of the revolution of the shafts 60 and 62 and then move toward each other. This movement cancels out any vibratory movement in a horizontal plane and results in a large amplitude of vertical tamping motion for each unit 34.

The same results are obtained with using the machines shown in FIGURES 10 to 12, or FIGURES 14 to 16, with slight variations in the results.

Using the machine shown in FIGURES 14 to 16, the units 34'' and 34''' are not raised between tamping operations but are rolled over the surface of the soil with no power supplied to the vertical thrust applying mechanisms therein.

It is to be understood that the forms of the tamping shoes 40, 40' and 40'' are such that they may be interchanged for use with particular soils to meet specific problems in compacting such soils.

A feature of the invention is that by adjusting the frequency with which the shoes contact and strike the earth surface, by varying the relative positions of the weights, this provides a machine producing high frequency vibrations in the earth by means of a series of low frequency impact tampers, namely, the units 34, 34', 34'' and 34''', and their associated tamping shoes or rollers. The net result is that the larger mass of the earth is consolidated by high frequency impulses while the localized mass at the surface is being compacted by the sharp penetrating blows of the individual shoes.

It has been found that using the machine of the present invention in each of its forms, a single pass over the soil area to be compacted is all that is necessary to completely compact the soil for use as a base for roadways, landing

strips, or the like, wherever a compact soil surface is desired.

While it is shown in the machine 20, the units 34 are arranged in lateral fixed spaced relation and positioned in tandem spaced relation with the units of the respective pairs in linear alignment, in the machine 118 the units 34' are in lateral fixed spaced relation, and in the final form of the invention of FIGURES 14 to 16, the units 34'' and 34''' are in longitudinal spaced relation, other arrangements are contemplated within the scope of the invention as defined by the appended claims.

What is claimed is:

1. In a soil compaction machine, a frame supported for movement over a ground surface, a plurality of soil compacting units arranged in lateral fixed spaced relation mounted in said frame for movement together from a position spaced above a ground surface to a position in engagement with said ground surface, means operatively connected to said units and said frame for effecting the movement of said units, each of said units including a housing having a bottom, a tamping shoe depending from the bottom of said housing, and a vertical thrust applying mechanism within said housing and operatively connected to said housing for imparting up and down movement to said shoe with respect to said ground surface, tow bars extending from each of said units to an adjacent part of said frame and being universally connected at their ends for permitting movement of said units relative to said frame, said thrust mechanisms having an input shaft projecting out of the adjacent housing, an output shaft on said frame for each of the input shafts of said thrust mechanisms, and an individual telescoping universal joint coupling means connecting each of said input shafts to the adjacent output shafts.

2. The soil compaction machine according to claim 1 wherein said individual telescoping coupling means comprises a pair of shafts telescoping into each other and having a universal coupling on each of the free ends thereof connected to adjacent input and output shafts.

3. The soil compaction machine according to claim 1 wherein the tamping shoe in each unit comprises a pair of rows of spaced shoes arranged in longitudinally spaced relation below and spaced from the bottom of the housing of each unit and extending the full width of said bottom.

4. The soil compaction machine according to claim 1 wherein the tamping shoe in each unit comprises a pair of rows of spaced shoes arranged in longitudinally spaced relation below and spaced from the bottom of the housing of each unit and extending the full width of said bottom, the shoes of one of said rows being staggered with respect to the shoes of the other of said rows.

5. In a soil compaction machine, a frame supported for movement over a ground surface, a plurality of pairs of soil compacting units arranged in lateral fixed spaced relation positioned in tandem spaced relation within said frame, means mounting said units in said frame for movement together from a position spaced above the ground surface to a position in engagement with said ground

surface, hydraulic means operatively connected to said frame for effecting the movements of said units, flexible cable means connecting each of said units to said hydraulic means, each of said units including a housing having a bottom, a tamping shoe depending from the bottom of said housing, and a vertical thrust applying mechanism within said housing and operatively connected to said housing for imparting up and down movement to said shoe with respect to said ground surface, tow bars extending between each unit and an adjacent part of said frame and being universally connected at their ends for permitting movement of said units relative to said frame, each of said thrust mechanisms having an input shaft projecting out of the adjacent housing, an output shaft on said frame for each of the input shafts of said thrust mechanisms, and an individual telescoping universal joint coupling means connecting each of said input shafts to the adjacent output shaft.

6. In a soil compaction machine, a frame supported for movement over a ground surface, a plurality of pairs of soil compacting units arranged in lateral fixed spaced relation positioned in tandem spaced relation within said frame, means mounting said units in said frame for movement together from a position spaced above the ground surface to a position in engagement with said ground surface, hydraulic means operatively connected to said frame for effecting the movements of said units, flexible cable means connecting each of said units to said hydraulic means, each of said units including a housing having a bottom, a tamping shoe depending from the bottom of said housing, and a vertical thrust applying mechanism within said housing and operatively connected to said housing for imparting up and down movement to said shoe with respect to said ground surface, tow bars extending between each unit and an adjacent part of said frame and being universally connected at their ends for permitting movement of said units relative to said frame, each of said thrust mechanisms having an input shaft projecting out of the adjacent housing, a driven shaft extending longitudinally of said frame, a plurality of output shafts one for each input shaft operatively connected to said driven shaft, and an individual telescoping universal joint coupling means connecting each of said input shafts to the adjacent output shafts.

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	2,897,734	Bodine	Aug. 4, 1959
	2,908,206	Melanson	Oct. 13, 1959
	2,938,438	Hamilton	May 31, 1960