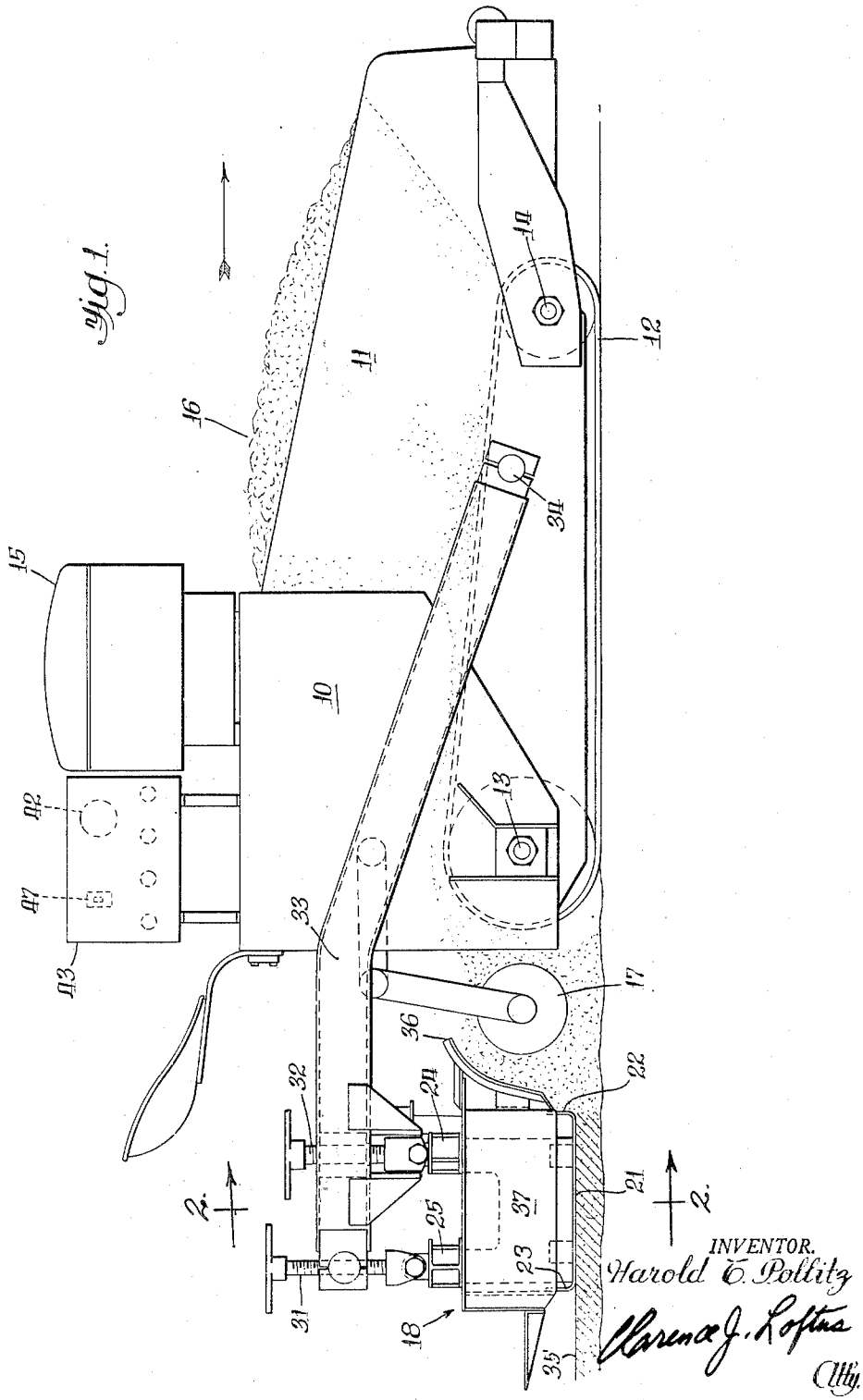
Aug. 7, 1956 H. C. POLLITZ 2,757,588

VIBRATING FINISHING MACHINE

Filed Jan. 13, 1953 2 Sheets-Sheet 1



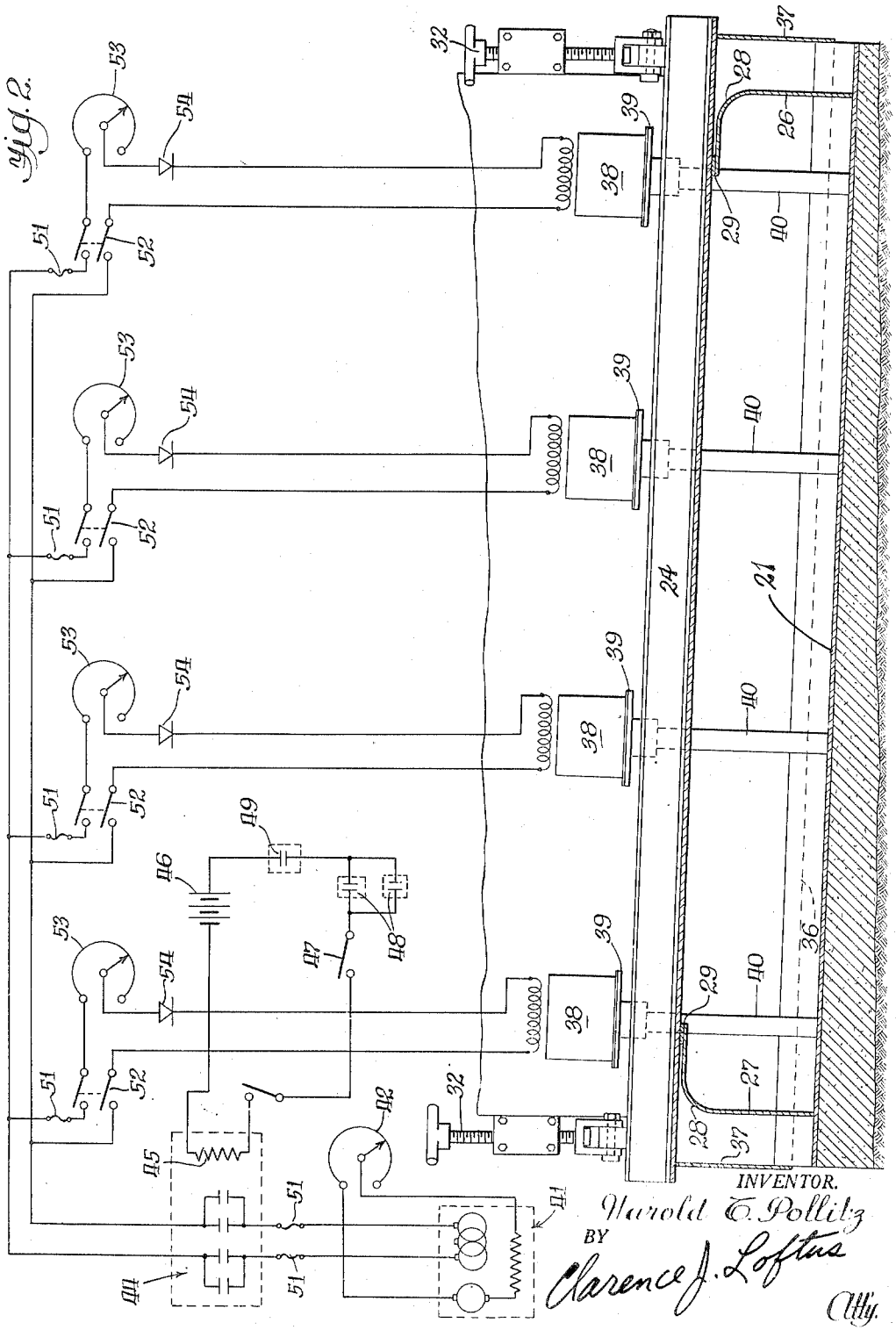
INVENTOR.
Harold C. Pollitz
Clarence J. Loftus
Atty.

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Filed Jan. 13, 1953 2 Sheets-Sheet 2

Fig. 2.



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VIBRATING FINISHING MACHINE

Harold C. Pollitz, Cedar Rapids, Iowa, assignor to Iowa Manufacturing Company of Cedar Rapids, Iowa, Cedar Rapids, Iowa, a corporation of Iowa

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5 Claims. (Cl. 94—48)

The present invention relates to surfacing machinery and particularly to a vibrating finishing machine adapted to spread surfacing material such as bituminous concrete, asphalt, crushed stone, etc., in a layer of controlled thickness having a smooth and uniform surface contour. The machine is specifically designed for handling bituminous concrete and asphalt mixtures and for practicing a novel method of compacting the paving material and smoothing its roadway surface.

It is a primary object of the invention to provide a vibrating finishing machine adapted to lay down a controlled thickness of paving material, with means for effecting adequate compaction of the material through its entire thickness, as well as over its upper surface.

A further important object of the invention is the provision of means for compacting the material of the road surface in such a manner as to not only exclude voids and air pockets within the concrete, but to allow the individual stones of the gravel or aggregate mixture to key themselves together and form themselves into an unusually dense, non-porous, rigid slab capable of withstanding greater loads than a less completely compacted pavement, and less subject to deterioration and the damaging effects of weather and traffic.

A further object of the invention is to provide a paving machine having means for applying a layer of paving material of unequal thickness, so as to afford any desired crown or other road contour, yet with means for effecting equal and adequate compaction of the material at its thickest points, as well as at its thinner portions. A related object is the provision of means for effecting thorough and adequate compaction of the road surfacing material at the thickest points of the layer of material being applied without causing separation of the asphaltic oils or other bituminous binder material from the aggregate, and without bringing about a tendency toward separation of the fines from the coarser aggregate material.

A further object of the invention is the provision of a vibrating finishing machine wherein the paving material is rapidly and thoroughly compacted throughout the entire thickness of the paving, without tendency toward breaking or crushing the individual stones or pebbles of the aggregate. Obviously, this results in producing a smooth, dense, watertight and wear resistant roadway surface, impervious to weather and capable of sustaining heavy traffic.

A further object is to provide a vibrating finishing machine adapted to lay a smoothly compacted layer of bituminous concrete or the like, wherein the mechanism is so designed and constructed as to be capable of laying the roadway at a greater speed than heretofore believed to be practicable or possible, whereby construction costs may be drastically reduced, and the quality of the finished road greatly improved.

A still further object is the provision of a vibrating finishing machine capable of rapidly laying a sheet of compacted bituminous concrete, for example, yet wherein the construction and relationship of the parts of the machine is such that it is capable of trouble-free operation over a long period of years without need of any unusual care of maintenance.

The foregoing objects are accomplished in the present invention by a unique vibrating finishing machine having features of construction differing considerably from prior art machines of the same general character, so that it is capable of compacting the paving layer applied to the roadway by a method different from the methods heretofore practiced in the art, and having important practical advantages thereover.

In this connection, it may be pointed out that studies of road surfaces laid by the best commercial machines heretofore available have indicated that the bituminous concrete mixtures put down by such machines are not thoroughly compacted throughout the thickness of the concrete layer, even though the surface may be so violently tamped as to cause considerable crushing of the larger particles of the aggregate and consequent defects in the surface. In conventional machines, the compaction is principally at the upper exposed surface of the material, and the underneath portions of the layer are frequently imperfectly compacted, with air pockets or voids which weaken the pavement and render it subject to failure.

The present machine and method avoids such failure by simultaneously subjecting the freshly laid mixture of aggregate and bituminous binder to the effects of heat, pressure and resonant subsurface vibration over a sustained interval of time, so that thorough compaction may take place. In the preferred embodiment of the invention, these results are accomplished by utilizing a relatively large, flat, heated screed activated by a plurality of synchronous electrical vibrators powered by a common electrical source so that they remain in phase with each other at all times, but are individually controlled as to the amplitude or intensity of the vibratory forces which they generate. Thus when individual adjustments have been made, the entire group of vibrators can be further controlled in unison by a master control device. This control is essential for laying variable thicknesses of material, crosswise and lengthwise. Moreover, these vibrators are of such a design that they exert their energy primarily in a vertical direction, and thus avoid losses of energy due to the ineffective lateral components of motion typical of rotary vibrators, for example.

With the arrangement employed in the preferred form of applicant's machine, the entire surface of the screed may be supported directly upon the top of the freshly laid bituminous concrete mixture, so that the weight of the screed and its associated parts will bear down on the paving surface, applying a moderate pressure over the entire width of the pavement being laid, and simultaneously vibrating the screed in such a manner that the vibratory energy is not expended on the surface of the material alone, but penetrates entirely through the layer of pavement and even into the soil thereunder. This is best accomplished by utilizing vibrators of comparatively small amplitude, but of frequency considerably higher than ordinarily used, since it has been observed that bituminous concrete mixtures have a natural resonant frequency of vibration at which the entire mass tends to vibrate most readily, and is thus capable of compacting itself most effectively. This resonant frequency of vibration of the mass may vary somewhat according to variable conditions, but excellent results are obtained in most instances by utilization of a series of vibrator units operating in substantially vertical plane and synchronously with each other at a frequency of 3600 impulses per minute. Moreover, this resonant vibration is facilitated in the form of the invention shown herein by the construction and resilient mounting of the screed,

which is of relatively small mass and, therefore, well adapted to vibrate at such speeds.

It is also to be noted that, as here employed, the screed is of considerable width, such as 18 to 36 inches in actual practice. This sustained period equals the width of the screed divided by the speed of travel. As an example, if the traveling speed is 6 inches per second the material is directly vibrated 3 to 6 seconds. This sustained treatment of the pavement has been found to be of value in allowing sufficient time for the aggregate particles to key themselves together, as the screed is moved thereover, and results in a very dense, firm mat.

A preferred embodiment of the invention is illustrated in the drawings hereof, wherein:

Figure 1 is a side elevation of a road surfacing machine as contemplated by this invention; and

Figure 2 is a detail sectional view taken substantially on the plane of the line 2—2 of Figure 1, with the electrical circuits of the device diagrammatically illustrated thereon.

As illustrated in the present drawings, the machine includes a tractor unit **10** and a hopper **11**, both mounted upon a track laying carriage **12** extending between axles **13** and **14** so that the entire tractor unit and its hopper may be self-propelled along the road, as by an internal combustion engine **15**, or other prime mover. It is contemplated that the hopper **11** will be periodically filled with a mixture of bituminous concrete or similar material indicated at **16**, which will be carried rearwardly through the machine by a central conveyor (not shown) and which will be deposited in the vicinity of a double ended transverse screw conveyor **17** so that it will be spread laterally to cover the width of the roadway surface in front of the screed assembly **18**. The screed comprises a relatively thin, substantially flat sheet metal plate **21** which may be 8 or 9 feet, more or less, in length to cover one or more traffic lanes of a typical highway or any substantially flat surface. As shown, it is provided with a short vertical front flange **22** and rear flange **23**. The opposite ends of the screed plate are mounted or supported from transverse beams **24** and **25** by riser portions **26** and **27** at the opposite ends of the plate **21**, and the risers are bent inwardly at **28** and secured to the cross beams at **29** so that the screed is flexibly mounted and comparatively free to vibrate. Also, the relatively thin sheet metal of the screed plate is of comparatively small mass, so that it is quite capable of vibration at the high frequencies utilized without material restriction due to either its mass or its mounting facilities. The screed plate may be heated from its upper side, in a known manner, by oil burners, electrical elements or the like (not shown) and may be adjusted independently at its ends by the two pairs of hand screws **31** and **32**, attached to beams **24** and **25** and secured to side arms **33** pivoted to the tractor unit at **34**, similar to the old fashioned horse and buggy arrangement. Thus, the entire screed assembly may rest directly upon the surface **35** of the paving material being laid, and the screws **31** and **32** may be set to provide for increasing or decreasing the depth or thickness of the layer. A suitable known crown adjusting device may also be provided, if desired. A mold board **36** is disposed in front of the flange **22** of the screed, but is separately secured to the beams **24** and **25** and end plates **37** so that it is not directly vibrated.

The screed is activated by four vibrators **38**, which are of known type and preferably spaced at substantially equidistant points along the forward edge of the screed plate. As shown, each of the vibrators is mounted on a supporting plate **39** at the upper end of a tubular pipe or rod **40** extending down to and welded to the screed plate **21**. The vibrators **38** are all of the reciprocating armature type, and in the preferred form of the invention are all powered from a common power source. This may be an alternating current generator, diagrammatically illustrated at **41** in Figure 2 of the drawings, and driven by the prime mover **15**. The power output may be governed by a control rheostat **42** connected in series and mounted on an instrument panel **43** at any convenient location on the machine (Figure 1). If desired, the frequency of current may also be varied by a governor on the prime mover **15**.

The output from the generator **41** passes through a fuse box to a main power contactor **44**, the electromagnetic winding **45** of which is connected to the storage battery **46** of the prime mover **15** through a hand operated shut-off switch **47**. The switch **47** may be conveniently mounted on the instrument panel **43** and, if desired, the circuit to the power contactor may also extend through a pair of steering clutch limit switches **48** and a traction clutch limit switch **49**, so that the operation of the vibrators will be interrupted whenever the machine ceases to advance. The circuit from the power contactor **44** extends to the several vibrators **38** through fuses **51**, vibrator switches **52**, vibrator control rheostats **53** and dry plate type rectifiers **54**. Thus, the alternating current supplied from the generator **41** is converted into a half wave, pulsating, direct current, which is supplied to the windings of the vibrators **38**.

It has been previously stated that the vibrators are of the reciprocating armature type, so mounted that their output energy is expended in substantially a vertical direction, so it is delivered to the screed plate **21** with the greatest degree of effectiveness, and achieves the greatest possible depth penetration into the road surfacing material. It is also to be observed that the several vibrators of the device all function in synchronism, since they are energized by the same power source, yet the amplitude or intensity of the vibrators may be individually controlled by manipulation of the four separate vibrator control rheostats **53**. Simultaneous control of the amplitude of all of the vibrators may be accomplished by adjustment of the generator control rheostat **42**. With this arrangement, it is entirely practicable to adjust the individual vibrators so that when a crowned road surface is being laid, for example, the vibrators above the thickest portion of the roadway exert the most violent vibration, with those at the thinner portions vibrating with progressively less intensity. This avoids separation of the fine particles or bituminous binder in the thin portions of the roadway while maintaining an adequate power output to insure deep penetration and thorough subsurface compaction at even the thickest portions.

From the foregoing it should be apparent that the present machine and method for compacting a bituminous concrete surface makes use of the fact that cohesive aggregate materials have a natural or resonant period of vibration at which the individual particles of the aggregate have been found to move most easily, and key themselves together with greatest facility. Moreover, the provision of a screed as here disclosed is of advantage in accomplishing this, in that it provides a physical structure capable of vibrating at the resonant frequency of the materials being handled. The screed is also sufficiently wide so that the materials under it are held in a heated and compressed state for an appreciable period of time, and thus vibrated at their resonant frequency long enough so that the individual particles of the aggregate have adequate time to key themselves into an unusually dense, solid surface. In addition to this, the present mechanism makes use of an arrangement wherein the energy expended by the vibrators may be precisely controlled across the entire roadway, so as to be expended where most effective to accomplish the desired degree of compaction.

Having thus described my invention, what I claim as new and desire to secure by United States Letters Patent is:

1. In a paving machine, a support, a screed having a vertically flexible screed plate suspended from said support, a plurality of vibrators connected to said plate at points spaced apart lengthwise thereof effective for im-

parting vertical vibration to lengthwise areas of said plate, means for varying simultaneously and to the same extent the intensity of vibration of said vibrators during operation thereof, and supplemental means for selectively varying the intensity of said vibrators individually during operation thereof, said vibrators providing means whereby said areas of said plate may be vibrated at the same intensity or at different intensities optionally during continued operation of said vibrators.

2. In a paving machine, a support, a screed having a vertically flexible screed plate suspended from said support, said plate being flat and substantially oblong in plan and of considerable width relative to its length, a plurality of vibrators connected to said plate at points spaced apart lengthwise thereof effective for imparting vertical vibration in the same directions to lengthwise areas of said plate, and means for varying the intensity of vibration of said vibrators either simultaneously to the same extent or individually to different extents during continued operation thereof, whereby said areas of said plate may be vibrated at the same intensity or at different intensities optionally during continued operation of said vibrators.

3. In a paving machine, a support, a screed having a vertically flexible screed plate suspended from said support, said plate being flat and substantially oblong in plan and of considerable width relative to its length, a plurality of electromagnetic vibrators disposed above said plate spaced apart lengthwise thereof and respectively comprising a rod connected at its lower end to said plate adjacent the leading edge thereof and effective for imparting vertical vibration to a lengthwise area of said plate, and means for varying the intensity of vibration of said vibrators either simultaneously to the same extent or individually to different extents during operation thereof, whereby the lengthwise areas of said plate corresponding to said rods may be vibrated at the same intensity or at different intensities optionally during continued operation of said vibrators.

4. In a screed for compacting and finishing road surfacing material, a substantially oblong flat and vertically flexible screed plate, a plurality of vibrators connected to said plate at points spaced apart lengthwise thereof effective for imparting vertical vibration in the same directions to lengthwise areas of said plate, and means for varying the intensity of vibration of said vibrators either simultaneously to the same extent or individually to different extents during operation thereof, whereby said areas of said plate may be vibrated at the same intensity or at different intensities optionally during continued operation of said vibrators.

5. In a screed for compacting and finishing road surfacing material, a substantially oblong flat and vertically flexible screed plate, a plurality of electromagnetic vibrators disposed above said plate spaced apart lengthwise thereof and respectively comprising a rod connected at its lower end to said plate effective for imparting vertical vibration to a lengthwise area thereof, and means for varying the intensity of vibration of said vibrators either simultaneously to the same extent or individually to different extents during operation thereof, whereby the lengthwise areas of said plate corresponding to said rods may be vibrated at the same itnensity or at different intensities optionally during continued operation of said vibrators.

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