ABSTRACT: Apparatus for conditioning paving material which includes coarse aggregate in suspension, the apparatus consisting of a comblike structure which is immersed to a predetermined depth in the paving material to coact with finishing or operating elements. The comblike structure may take the form of a screen plate having a plurality of evenly spaced vertical slots, which screen plate may be adjustably positioned along the leading edge of paving material finishing elements of selected roadway construction equipment.
PAVING GROUT CONTROL DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention
The invention relates generally to heavy duty roadway paving equipment and, more particularly, but not by way of limitation, it relates to a paving operating element for displacing paving material aggregate in situ.

2. Description of the Prior Art
The prior art includes little or no teaching of such similar types of devices for controlling disposition of aggregate within paving material, especially such devices included as an operating element of a slip-form paving apparatus. While various other operating elements such as internal vibrators, various forms of vertically vibrating feed meter, etc. have been utilized in an attempt to settle the coarse aggregates sufficiently to insure a smoothly finished surface, such elements are not always successful with other than paving material of optimum consistency, liquidity, etc. The prior known paving devices utilize various forms of surface finishing elements to provide the final pavement top but it usually requires close inspection and continual manual working or patching of the surface to leave it in a uniformly finished condition.

SUMMARY OF THE INVENTION
The present invention contemplates a paving operating element for increasing the workability of a paving material surface by adjusting the size and consistency of grout material forming the surface of the pavement. In a more limited aspect, the invention consists of a screening plate member having a plurality of spaced vertical bars for immersion in and passage through paving material prior to contact with fine finishing elements; the screening plate member displaces the more coarse aggregate below a predetermined level while allowing the more easily finished grout material to be displaced thereabov.e. In one form, the screening plate is rigidly secured across the front of a vibrating finishing element, e.g. a vibrating screed of a slip-form paving assembly, such that it is controlled as to operating level and vibration simultaneously with the finishing element. Therefore, it is an object of the present invention to provide a grout screening plate which enables formation of a smoothly finished paving surface at increased speeds along a right-of-way.

It is also an object of the invention to provide such a screening plate which is operable independently of or in combination with selected pavement finishing elements of paving machinery.

It is still a further object of the present invention to provide a grout screening plate which may be integrally secured in composition with a pavement finishing element, the adjustment allowing for selection of the degree of separation of the more finely constituted grout material and the coarse aggregate suspended in the paving material.

Finally, it is an object of the present invention to provide a screening plate which may be moved through paving material to displace coarse aggregate downward to expose finer paving material having increased qualities of finish ability.

Other objects and advantages of this invention will be evident from the following detailed description when read in conjunction with the accompanying drawings which illustrate the invention.

BRIEF DESCRIPTION OF THE DRAWING
FIG. 1 is a functional representation of paving structure utilizing the present invention as it progresses along a pavement finishing layout;
FIG. 2 is a perspective view of a portion of one form of screening plate which may be employed in the invention depicted in FIG. 1;
FIG. 3 is a front view of a right side portion of a screen plate constructed in accordance with the invention;
FIG. 4 is a section taken along lines 4-4 of FIG. 3;
FIG. 5 is a skeletal side view of one form of slip-form paving assembly which may be employed utilizing a screening plate such as that of FIG. 3;
FIG. 6 is an enlarged vertical section through the metering screed and screening plate as employed in FIG. 5;
FIG. 7 illustrates the manner whereby the screening plate may be independently suspended from whatever the paving or finishing machine;
FIG. 8 illustrates an alternative form of screening plate which may be employed in the invention;
FIG. 9 is a section taken along lines 9-9 of FIG. 8; and
FIG. 10 depicts still another form of screening plate design which may be employed in the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT
Referring to FIG. 1, it is desirable to be able to operate upon rough-strewn paving material 10 to finish it into a smoothly surfaced pavement slab 12 along earth surface 14, pavement slab 12 having a continuously smoothed surface with no pocks or raised portions. Rough-strewn paving material 10 is constituted of a selected ratio of coarse aggregate material, such as large rocks 16, in suspension in remaining grout material 18 which may consist of medium and small sized rocks, sand and cement agents in liquefied form. A pavement finishing machine 20 is then moved along in the direction of arrow 22 to form the finished pavement 12.

The paving machinery 20 includes a suitable support structure 24. In one form this may be a self-propelled mobile frame assembly well-known in the art, and the support structure 24 suspends a finishing element 26 into the rough-strewn paving material 10 to strike-off or otherwise finish the paving material as by vibratile or such other finishing into the finished pavement slab 12. In accordance with the invention, the support structure 24 also suspends a screening plate 28 into the paving material 10 immediately in front of the finishing element 26 for the purpose of arranging coarse aggregate and grout material into optimum stratification for surface finishing. Thus, the screening plate 28 blocks passage of coarse aggregate 16 to force it downward toward subgrade 14 and below a coarse aggregate level 22 in the finished pavement slab 12. At the same time, the screening plate 28 allows finer grout material 18 to pass through and into contact with finishing element 26 which forms the final finish level 32 on pavement slab 12 at a selected distance above coarse aggregate level 30.

The screening plate 28 is susceptible of various discontinuous plate design, but in one form it is constructed as shown in FIG. 2. That is, a plurality of similarly J-shaped and equal sized steel bars 34 are secured in side by side relationship to form spaced 36 between each adjacent pair. The spaces 36 may be selected in accordance with paving material consistency but it has been found that a spacing of about three-quarters of one inch is sufficient for most purposes. The joining structure and supporting elements of screening plate 28 may take various forms, a particular design being further described below.

It is also contemplated that a paving finishing machine 20 utilizing screening plate 28 will be employed in coaction with internal vibrator elements 38 of well-known design. A plurality of such vibrator units 38 are displaced laterally across a paving right-of-way as supported by a plurality of support arms 40 suspended from a frame portion 42 (which may be a part of support structure 24). The vibrator units 38 are immersed in the rough-strewn paving material 10 immediately before screening plate 28 and these serve to set individual or unit portions of aggregate into finite motion such that separation and passage of screening plate 28 through paving material 10 is carried out with reduced resistance. The internal vibrator units 38 are a well-known, commercially available item as completely disclosed in a copending U.S. Patent Application Ser. No. 710,256 entitled "Slip Form Paving Apparatus," filed on Mar. 4, 1968 in the name of Swisher, et al.
FIGS. 3 and 4 illustrate structure for a right side portion 44 of a screening plate 28. The portion 44 is formed by upper plate 46 having a plurality of vertical plates 48 welded therebelow, the lower edge of the structure being secured by a diagonal plate 50 welded along the forward or leading lower edge of plurality plates 48. A plurality of J-shaped bars 34 (FIG. 2) are then welded in spaced arrangement to provide the grate-like structure of the screen plate 28. Each J-shaped bar 34 is welded in equispaced positioning with respect to adjacent bars the upper ends being welded to the leading edge of upper plate 46 while lower portions are welded to the inner side of diagonal portion 50.

A pair of clevis flanges 52 may be welded to the top surface of upper plate 46 at selected, spaced points to serve as support hangers as will be further described. The outside edge of screen plate portion 44 is constructed with a slightly upwardly tapered portion 54 and the extreme end is terminated by a vertical side plate 56 which is similar in shape to vertical plates 48. The taper portion 54 results from teachings well-known in the art which provide for such outer taper on paving operating elements so that the natural slump of the paving slab is allowed for. An opposite left side portion (not shown) of screen plate 28 would be a reversed, similar structure and would be secured in end-to-end alignment with plate portion 44 when in operative position.

An example of the screen plate 28 is shown in FIG. 5. Here, the screen plate 28 is utilized with a slip-form paver unit 60 as supported by a mobile frame assembly 62 for movement along a right-of-way. The slip-form paver unit 60 and mobile frame assembly 62 are similar to that structure which is particularly disclosed in the aforementioned pending U.S. Pat. application Ser. No. 710,256.

Slip-form unit 60 consists of a main rectangular frame 64 having a front frame 66 attached thereto, and each of frames 64 and 66 serve to support paving operating elements transversely across the roadway in operative engagement with paving material. Thus, as slip-form paver 60 progresses along the roadway it first contacts rough-strung paving material 68 for conditioning and surface finishing as pavement slab 70.

The particular operating elements along slip-form paver unit 60 are a distributor or reversible auger 72 followed by a primary or strike-off metering screed 74 which is supported in vertically adjustable manner by a hydraulic cylinder 76 and connecting rod 78 from front frame 66. Next come a plurality of vibrators 80 which are movably suspended by means of bars 82 and levers 84 for movement into and out of the paving material.

The screen plate 28 is secured to a vibrating screed 86 by an adjustable mechanism (to be described) and vibrating screed 86 is supported in vertically adjustable manner by a connecting rod 88 and hydraulic cylinder 90 secured to main frame 64. The vibrating screed 86 may receive vibrating oscillation from suitably powered vibrator 91, e.g. a commercially available pneumatic vibrator, which is rigidly supported on a vibratorm frame plate 93. Further finishing elements are oscillating extrusion screws 92 and 94 which are suspended at a preset level beneath frame 64 by means of eccentric assemblies 96 and 98, respectively. Eccentric assemblies 96 and 98 are each hydraulically adjustable, separately or in concert, to effect variation of the profile of the upper surface of pavement slab 70. Finally, a float finishing pan 100 is trailed behind frame 64 to place final finished surface on pavement slab 70.

The screen plate 28 is secured in adjustable but rigid position across the front face of vibrating screed 86 by structure which is shown more particularly in FIG. 6. Thus, the vibrating screed 86 consists of a cover plate 102 which is bent to form a sole portion 104, an angle portion 106 and a rising portion 108. A plurality of generally U-shaped support bars 110 are welded within cover plate 102 at spaced intervals across vibrating screed 86. Vibration frame plate 93 may be secured as by welding across the sole portion 104 of screen cover plate 102. A splash panel 112 may be affixed in diagonal disposition across the vibrating screed 86 to prevent collection of excess paving material thereon. Thus, vibrating screed 86 is supported by means of a collar bearing 114 which is pivotally secured between upper ends 116 and 118 of U-shaped support 110. Each of support plate plates 122 are formed to extend a flange 124 upward from the rear edge while a movable bolt retainer 126 is affixed to the forward upper surface to hold an adjustment screw or bolt 128. A lever arm 130 is bifurcated at a point 132 to extend a pair of parallel-disposed arms 134 for pivotal connection by means of a clevis pin and keeper 136 to upper flange 124. A threaded insert 138 carried on bolt 128 is pivotally affixed between bifurcated arms 134 by suitable pivot fastener 140. The forward end of lever arm 130 is then pivotally connected through a pair of clevis flanges 52 by means of a clevis pin and keeper 142.

A plurality of such adjustable lever arms 130 are provided across the length of screen plate 28. In the case as shown in FIG. 3, there would be two such adjustment assemblies each connected to a pair of clevis flanges 52 of the right side portion 44 of screen plate 28, and a similar arrangement would be included for adjusting the left side portion (not specifically shown). Thus, the adjusting bolts 128 can be rotated to vary the lever arms 130 upward or downward to displace screen plate 28 in like manner. This adjustment serves to vary the amount of grout material which is fed in directly below vibrating screed sole portion 104 and above the aggregate level 30 (FIG. 1).

In operation, the screen plate 28 in conjunction with vibrating screed 86 will function in the manner pictorially represented in FIG. 1. For each paving job, the height of screen plate 28 relative to vibrating screed 86 must be set in accordance with the consistency and slump of paving material, speed of operation, etc. This is effected by manipulation of the plural adjusting bolts 128 to raise or lower lever arm 130. During the paving operation, coarse aggregate and other large material will be forced in the direction of arrow 150 while the grout containing more fine finishing material will progress generally along the path of arrow 152 through screen plate 28 in deposition immediately below vibrating screed 86 for contact with the final finishing elements of the paver assembly, e.g. extrusion and screed mechanisms.

Hydraulic cylinders 90 and connecting rods 88 (FIG. 5) may be adjusted to set the overall level of vibrating screed 86, this being in consideration of the finish pavement level as finally extruded from the primary and secondary oscillation extrusion screws 92 and 94. The degree of submergence of coarse aggregate, or setting of coarse aggregate level 30 (FIG. 1), will vary in accordance with the vertical position of screen plate 28 with respect to vibrating screed 86. While a small degree of adjustment is desirable it does not require constant attention since there exists a fairly reliable uniformity in roadway paving material and the aggregate suspended therein.

FIG. 7 shows an alternative usage of a screen plate 28 wherein it is independently suspended from a frame 154, a main supporting structure of a selected paving machine. Thus, each of clevis flanges 52 may be pivotally connected to a support linkage 156 by means of a suitable clevis pin and keeper 158. Support linkage 156 is formed with a lower extension 160 rigidly suspended horizontally connected brace 162 which serves to bear against the rear side of one or more vertical plates 48. Support linkage 156 is further fitted with threaded bore 164 which is connected to a connecting rod 166 and a hydraulic assembly 168 connected to frame 154. Screen plate 28 is vertically adjustable by means of hydraulic assembly 168 and it may be suspended from frame 154 at any of various positions relative to remaining operating elements of the paving equipment. A plurality of vibrators 169 of commercially available type may be mounted at spaced intervals across the upper frame plate of screen plate 28.
S FIG. 8 illustrates another form of screening plate 170 which takes advantage of certain other design advantages. Referring also to FIG. 9, the vertical screening bars 172 are formed from a standard hardened steel rod stock, e.g., three-eighths inch steel rod. Thus, a plurality of screening bars 172 having rearward bent lower ends portions 174 are welded in equispaced si disposition across an upper plate 176. A plurality of spaced pairs of elevis flanges 178 are welded to the upper surface of plate 176 to provide suspension connection. A plurality of spaced vertical plate bars 180 provide substantial framing and each is rigidly connected as by welding to a transverse rod 182 which is likewise securely fastened to each of the vertical screening bars 172.

While the foregoing discussion as to screening members has dealt in large measure with vertically oriented structure, it should be understood that such design is not necessarily essential. The screening structure may consist of horizontal or transversely diagonal structural array so long as the great screening dimensions, about three-quarters inch in most cases, are maintained. Thus, a screen plate 190 of FIG. 10 is formed of gridlike structure which consists of horizontal bars 194. Horizontal bars 192 are spaced to provide optimal greater screening. The vertical bars 194 may be formed with rearward turned lower ends 196 to aid in directing coarse aggregate downward; however, the same function may be obtained by supporting the entire screening plate 190 in an attitude of forward ascending slope.

The foregoing discloses a novel screen plate element for use in optimally placing selected constituent elements of pavement material within the overall volume. The screen plate allows continuous separation of grout material with simultaneous submergence of more coarse aggregate material such that final finishing elements are able to extrude or screen a finish to a higher degree of smoothness with greater consistency. The invention enables the laying down of a pavement slab at increased speed per unit length per area of finished pavement while, at the same time, reducing the likelihood of flaws requiring manual attention.

While the invention is specifically described with respect to a slip-form paving assembly, it should be understood that it is susceptible of various uses either independently or in coaction with other finishing elements, such usages being associated with various forms of surface forming equipment, i.e., rail pavers, asphalt pavers, etc. Also, while a particular form of vertical bar screening plate structure is generally described and adhered to in the specification, it is contemplated that various other forms of perforate or discontinuous surface stock may be employed.

Changes may be made in the combination and arrangement of elements as heretofore set forth in the specification and shown in the drawings; it being understood that changes may be made in the embodiments disclosed without departing from the spirit and scope of the invention as defined in the following claims.

We claim:

1. A device for conditioning of wetted paving material containing coarse aggregate during a pavement surface forming operation comprising:
   - support means which is movable with respect to a bulk of paving material disposed at a location which is to be overlaid with a surface finished pavement;
   - surfacing means extending from said support means into contact with said paving material to form said paving material into a pavement surface of desired profile; and
   - screen means having plural openings therethrough and being spaced ahead of said surface forming means in contact with said paving material, at least a portion of said screen means having a forward ascending slope such that coarse aggregate material is force forced below said screen means while remaining paving material passes through said openings and into contact with said surfacing means for formation of said pavement surface.

2. A device as set forth in claim 1 wherein said surfacing means comprises:
screed means having a leading edge strike-off portion of desired profile; and
means attached to said screed means for imparting vibration thereto.

3. A device as set forth in claim 1 wherein said surfacing means comprises:
   - screen plate means having plural vertical slots, said plate means extending across said paving material, and said plate means having said forward ascending slope;
   - securing means rigidly holding said screen plate means along the front of said surfacing means; and
   - adjustment means for fixing the level of said screen plate means relative to said surfacing means to gain optimum pavement conditioning per consistency of paving material.

4. A device as set forth in claim 2 wherein said surfacing means comprises:
   - screen plate means having plural vertical slots, extending across said paving material; and
   - securing means rigidly holding said screen plate means along the front of said screed means; and
   - adjustment means for fixing the level of said screen plate means relative to said screen means to gain optimum pavement conditioning per consistency of paving material.

5. A device as set forth in claim 1 wherein said support means comprises, a slip-form paver assembly.

6. A device as set forth in claim 3 wherein securing means and adjustment means comprise:
   - lever arm means having one end pivotally secured to the said screen plate means and having the other end pivotally secured to said surfacing means;
   - threaded insert means movable held by said lever arm means at a point intermediate the ends; and
   - adjusting bolt means rotatably retained on said surfacing means and extending upward through said insert means in threaded engagement such that rotation of said bolt means will change the level of said lever arm and therefore said screen plate means relative to said surfacing means.

7. A device as set forth in claim 6 which is further characterized in that:
   - said support means is a slip-form paving assembly; and
   - said surfacing means is a vibrating screed operating element of said paver assembly.

8. A device as set forth in claim 1 wherein said screen means comprises:
   - screen plate means having plural openings of preset size as determined by the aggregate size of said paving material, said plate means extending across said paving material; and
   - securing means rigidly holding said screen plate means along the front of said surfacing means; and
   - adjustment means for fixing the level of said screen plate means relative to said surfacing means to gain optimum pavement conditioning per consistency of paving material.

9. A device as set forth in claim 8 which is further characterized to include; vibrator means secured to said surfacing means to impart vibration of predetermined frequency thereto.

10. A device as set forth in claim 1 wherein said screen means comprises:
   - upper plate means vertically adjutably secured to said surfacing means to extend across the front of said surfacing means;
   - a plurality of equispaced bars secured to the front of said upper plate means and extending downward into contact with said paving material, the lower end of said bars being bent rearwardly to a forward ascending slope; and
   - vibrator means for imparting vibratory motion to said upper plate means and plurality of bars.
11. A device as set forth in claim 10 which is further characterized in that:
said support means is a slip-form paver assembly; and
said surfacing means is a vibrating screed operating element
supported therefrom in finishing contact with said paving
material.
12. A device for conditioning of wetted paving material
containing coarse aggregate, comprising:
support means which is movable along a path with respect
to a bulk of paving material;
screening means disposed continuously across said support
means and generally transverse to said path, said screening
means having plural spaces directed therethrough in
generally horizontal disposition and having at least a por-
tion with a forward ascending slope;
suspension means connected to said support means and said
screening means to hold the screening means at a
predetermined depth in said paving material such that
forward movement of said support means causes said
screening means to force the coarse aggregate downward
away from the surface of said paving material;
screeding means supported from said suspension means;
vibrator means connected to said screeding means to im-
part vibratory motion thereto; and
linkage means rigidly connecting said screeding means to
said screening means, said linkage means being adjustable
to enable vertical adjustment of said screening means
relative to said screeding means.
13. A device as set forth in claim 12 which is further charac-
terized in that; said support means is a slip-form paver
assembly which includes plural, serially disposed paving ele-
ments supported beneath a main frame, said main frame being
supported by plural track elements which are movable in con-
cert along said path with respect to the bulk of paving materi-
al.