ongitudinal and Transverse Control for Bituminous Pavers

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Projects amounting to approximately 67 miles of asphaltic concrete on new base, 92 miles of asphaltic concrete overlay on old surface, and 277 miles of bituminous mat overlay on old surface, were placed under contract in Kansas during 1958.

The materials for these projects were mixed in hot-mix plants and placed on the road through bituminous pavers. Because of the limit to which bituminous pavers can level or smooth a road surface, the problem of placing the mixture to a smooth grade line with a true crown confronts both the engineer and the contractor on each project, particularly on overlays. With modern high-speed traffic a smooth grade line and true crown are musts in pavement construction.

This paper describes the development of two attachments that have been placed on the leading makes of bituminous pavers and have been successful in aiding the operators to cause the paver screeds to follow a smooth theoretical grade line with a definite uniform crown.

This method of paving requires several normal operations, such as ascertaining a new grade line from the original profile and the use of pneumatic-tired rollers for compaction. This method of paving requires less over-all work on the part of the contractor, because the skin patching in all cases can be reduced, and in some cases eliminated.

THE longitudinal and transverse control hereafter described is the outgrowth of an tensive study of the bituminous paver motivated by irregularities in asphaltic surfaces, esults of the "lay it and see how it rides" method of laying hot-mix. The purpose of is paper is to show how the usefulness of the floating screed can be extended to far bend that which has been expected in the past.

Not many years back automobiles were traveling at speeds of 50 and 60 mph and at ose speeds a long gentle sag in the road surface was not noticeable. Now with speeds creased to 70 and 80 mph and with automobiles improved tremendously in operating d riding characteristics, this same long gentle sag becomes an abrupt bump.

Each year many miles of roads in Kansas become rough and distorted from their orinal condition yet their structural adequacy is still basically sound. This condition unubtedly also exists in other states.

Each year Kansas has been faced with the problem of making these roads smooth ain. In all cases short of reconstruction, some form of bituminous material is used, d until only recently, except for overlays on concrete, the bituminous material has een a road-mix, blade-laid type of construction.

The results of this method of construction are satisfactory, however, in avoiding the pense of constructing costly detours, the work was done under traffic causing inconenience and danger to the traveling public. Three years ago this type of construction as changed to make use of plant-mix machine-laid methods. The traffic problem was lved and most opinions are that the quality of the mixture had been improved, however e riding surface, to say the least, was left with something to be desired.

Blade-laid method of construction can produce a good riding surface because of the ntinuous shifting of the mixture with the motor-grader to areas of the roadway where epressions exist in the subgrade. The shifting is both lateral and longitudinal. The cations and limits of irregularities are of little concern to anyone except the blade operator. In a sense the leveling is accomplished automatically and the placement thicknesses are evidenced only by depth cores.

With machine-laid methods of construction the leveling is accomplished by skin patching, and to restore a satisfactory surface by this method is difficult or almost i possible because of the absence of ample material to shift, coupled with the lack of space in which to operate a motor-grader efficiently.

The problem at hand becomes very plain in that the bituminous paver needs help in placing asphalt to a true crown along a smooth grade line meaning that longitudinal an transverse control of the paver becomes increasingly important.

The present-day paver is advertised to possess an inherent automatic leveling prin ciple which is true only in short areas, lengths of less than the machine's wheel base pull arm length. The leveling claim is accepted by contractors and engineers alike a when irregularities show up on the final surface their presence is accredited to have come from the subbase. The result of this complacency is that advancements and im provements made on the bituminous pavers have all been in the direction of speed, po and output leaving the leveling capabilities both longitudinally and transversely exactl at the stage they were when the floating screed was first invented. In all fairness it should be stated that advancements have been made in consolidation or compaction of mixture prior to strikeoff which have improved the surface texture and final compacti of the asphalt surface.

Under present operational methods there is no positive control in either the longitu dinal or transverse direction. The paver is simply set on the surface and sent down road with the hope that the results will be good, after which the engineer gives it the driving test to judge its riding qualities. At times the desire to obtain a smooth ridin surface is even overshadowed by efforts to hold the amount of material used to a mini mum.

All bituminous pavers can be equipped with a crown or slope indicator that is attac to the screed at the rear of the machine. The obvious fact that very few of the machi are equipped with these devices should be reason enough that an indicator at that stag

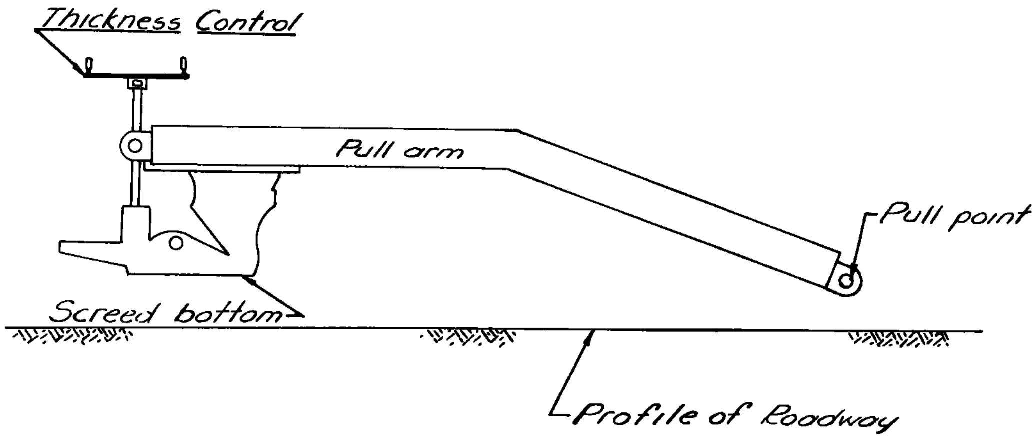

Figure 1.

of the placing of the mixture is inadequate. Further reasoning will prove that such an indicator only shows the slope of the crown of that part of the surface course which ha already been placed. Corrections made from this method of measuring are like walki in the dark; they are made in ignorance of the condition of the crown of the subbase a-head. At this time this is the only crown control available.

Pavers can also be equipped with an auxiliary screed or roller extending backward from the floating screed to extend the length of the screeding action of the machine.

'his is another negative approach in that the asphalt mix is placed to conform to a surace in the rear of the machine; a surface that has already been placed. The auxiliary creed or roller to be effective in these circumstances must force the floating screed hereby taking away its freedom and floating action.

The solutions to these two problems are similar in character to those mentioned exept that the point of attention must be moved forward to the center of control which is he area around the pull points. The pull point, of course, being the point at which the creed is suspended and by which the screed is towed.

This shift of attention can be immediately and easily accomplished on pavers where hickness adjustments are made in the front by raising and lowering the pull points.

On pavers with the thickness control on the rear of the floating screed the solution s not quite so simple, but nonetheless possible. The parts involved in the description

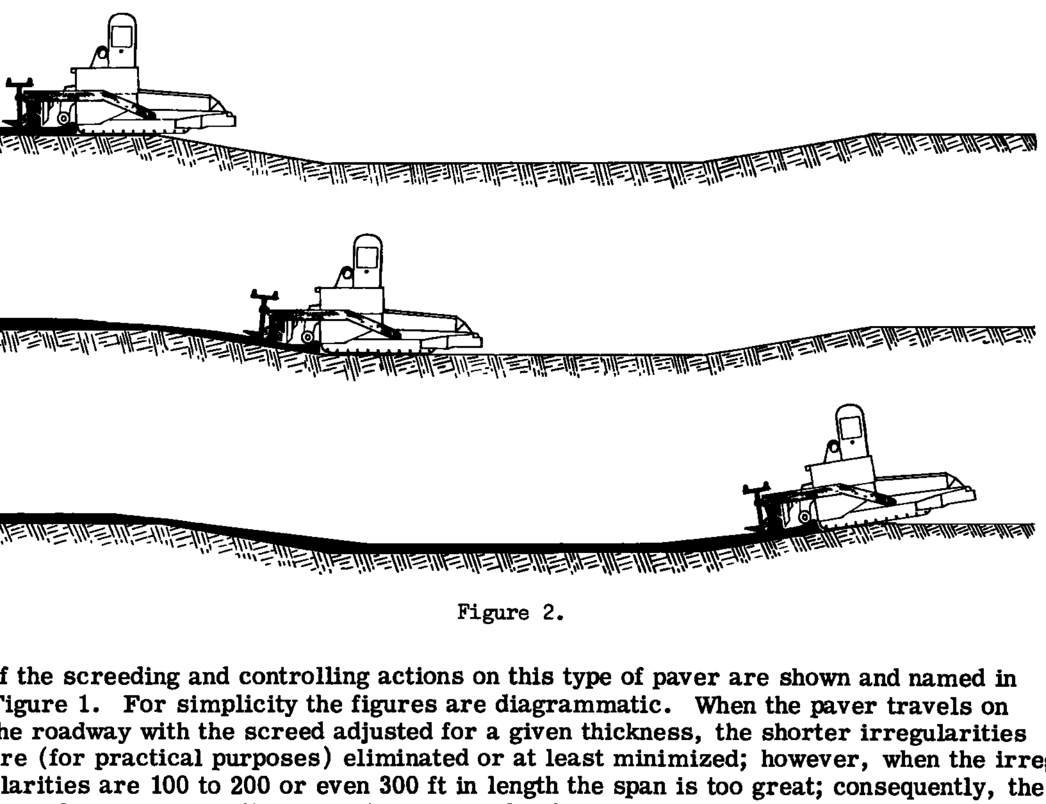

Figure 2.

f the screeding and controlling actions on this type of paver are shown and named in 'igure 1. For simplicity the figures are diagrammatic. When the paver travels on he roadway with the screed adjusted for a given thickness, the shorter irregularities re (for practical purposes) eliminated or at least minimized; however, when the irreglarities are 100 to 200 or even 300 ft in length the span is too great; consequently, the creeding action is effective only at the ends of the irregularity. In Figure 2 the screed ravels through a long sag with its thickness control at a given thickness setting. The efect of the screed is that in Figure 3 the length between crests of the irregularity is inreased and the length of the bottom is decreased while the depth of the irregularity is nchanged.

A more detailed look at the screeding action in Figure 4 reveals that the pull point ravels a line parallel to the profile of the road, and because the pull point is in front of he screed the screed bottom is tilted to conform to the irregularity before the screed ottom arrives at the irregularity thereby minimizing the roughness. Therefore it may e said that the pull point travels along a line parallel to the profile of the road and the creed bottom follows along a smoother profile spreading and compacting a mixture to flattened or evened profile.

In Figure 5, suppose that an imaginary line is projected forward from the screed ottom to about the pull point to a new point called the projected point that lies in the ame plane as the screed bottom. In Figure 6 the screed again travels the same sag

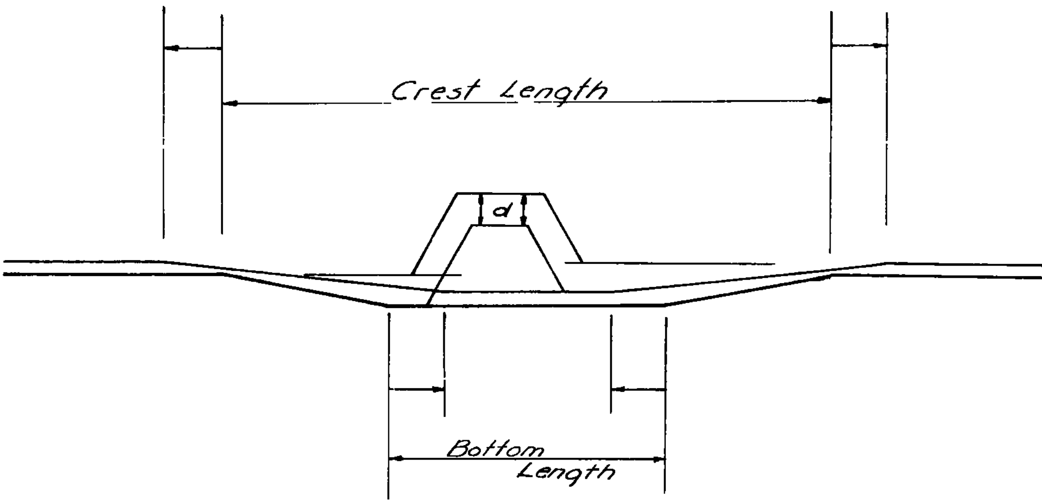

Figure 3.

with a given thickness setting thereby showing the course of travel of the projected point and that the screed bottom follows the projected point in the same manner in whi it follows the pull point.

In Figure 7 the screed bottom follows the projected point and the projected point is controllable by turning the thickness control on the screed. The screed again travels the sag in Figure 8; however, on this trip the projected point is caused to travel a line smooth in profile instead of allowed to follow the natural line parallel to the roadway profile and the screed bottom follows.

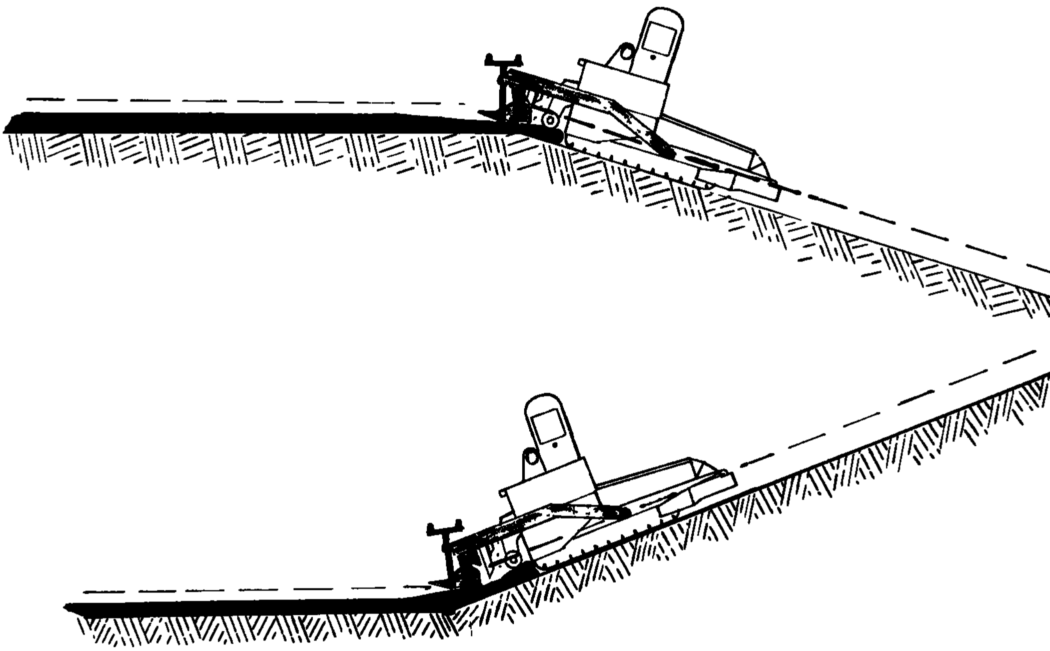

Figure 4.

To now, the projected point has been imaginary for explanation purposes. A projection at this location on the machine is impossible; however, in Figure 9 an offset linkage arrangement can be easily placed over the pull arm and pull point. The projected point

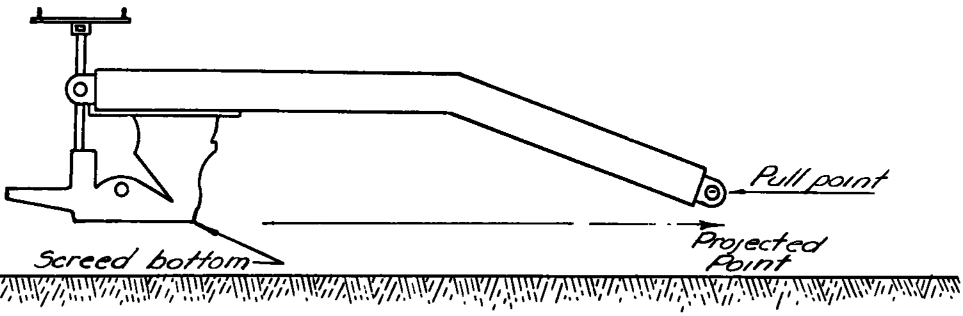

Figure 5.

is now real and no longer imaginary and can be maneuvered into ascending or descending positions by turning the thickness control. In Figure 10 the screed once more travels the sag with adjustments being made on the thickness controls so that the real projected point travels the theoretical grade line. The screed bottom (as described earlier) also follows the theoretical grade line thereby eliminating the sag.

With the longitudinal control achieved, the transverse problem in Figure 11 is approached by attaching the same linkage on the opposite side of the paver and placing a carpenter's level or slope indicator between the forward ends of the two projection arms. The allowance for crown may be provided for on the cross member between the forward ends of the projected arms or adjusting the turnbuckle placed in the linkage at the rear.

In summary, the projected point in one side of the paver is maneuvered with the thickness control to conform to an erected string line as the paver moves forward and the projected point on the opposite side is maneuvered with its respective thickness con-

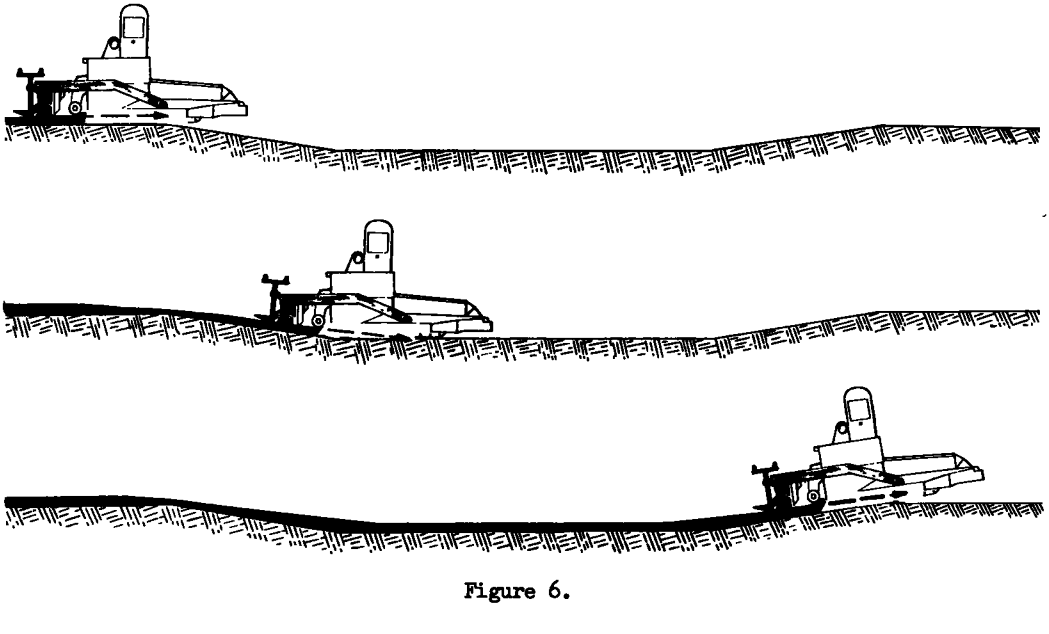

Figure 6.

trol along a similar line conforming to the indication dictated by the level between the two projected points. The screed then, because of design principle, must follow with a constant crown to a smooth grade line.

These two controls require the screed operators to disregard recommendations made by the manufacturer. Their instructions have been "Don't over control" and "Don't adjust for more than ⅛ inch in one machine length of travel." However, for these controls to be effective, the operator on the side of the paver next to the string

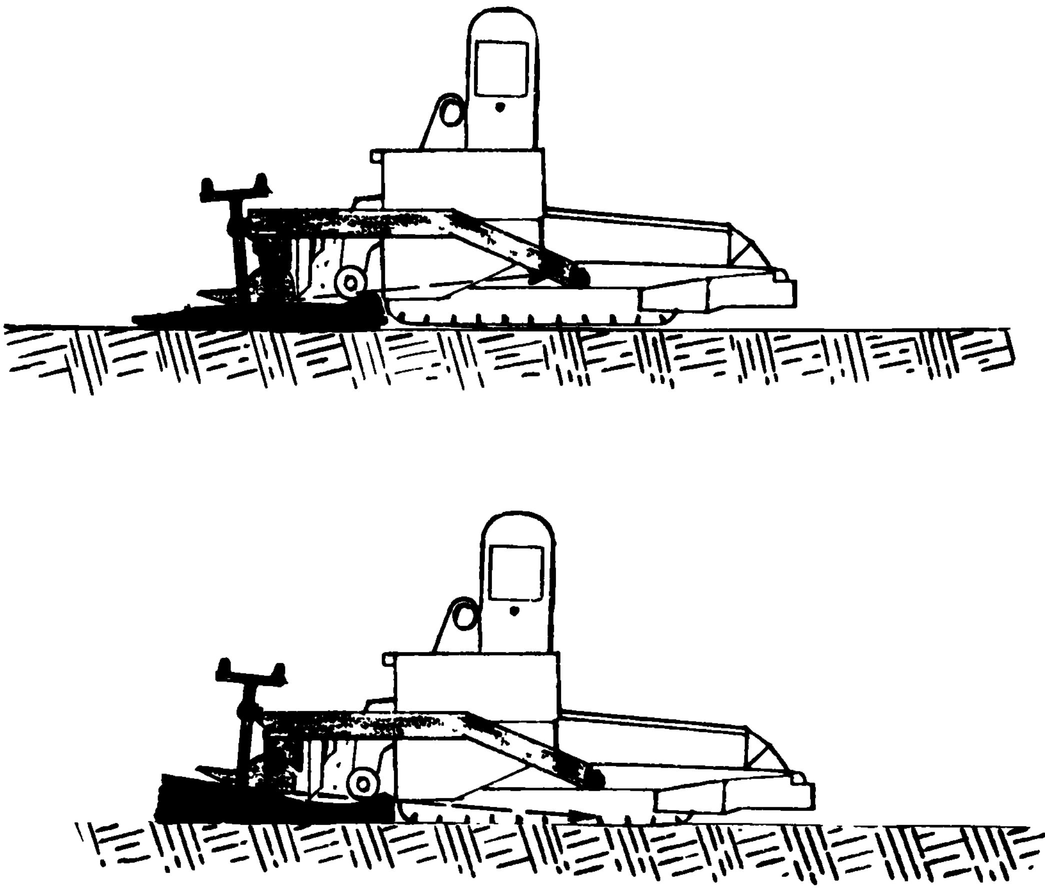

Figure 7.

line must cause the marker below the projected point to conform to the string line, re gardless of the direction or speed necessary to turn the thickness control. Similarly, the level between the front ends of the projected points must be held in a level positior regardless of the direction of adjustment or the speed in which it is made.

The string line referred to is erected near the center line of the road 6 or 8 in. out side of the area on which the mat is spread. The string line is erected to a grade line determined from profile elevations taken at 25-ft intervals along the center line of the road. In Figure 12 the grade line may be determined by plotting the profile to a distorted scale; horizontal—1 in. = 25 ft, and vertical—1 in. = ½ ft. This combination o scales magnifies the irregularities to the proportions that a mechanical adjustment ca be made visually and the thickness values which would be the necessary thickness at the respective points are easily measured on the profile and entered in the field book.

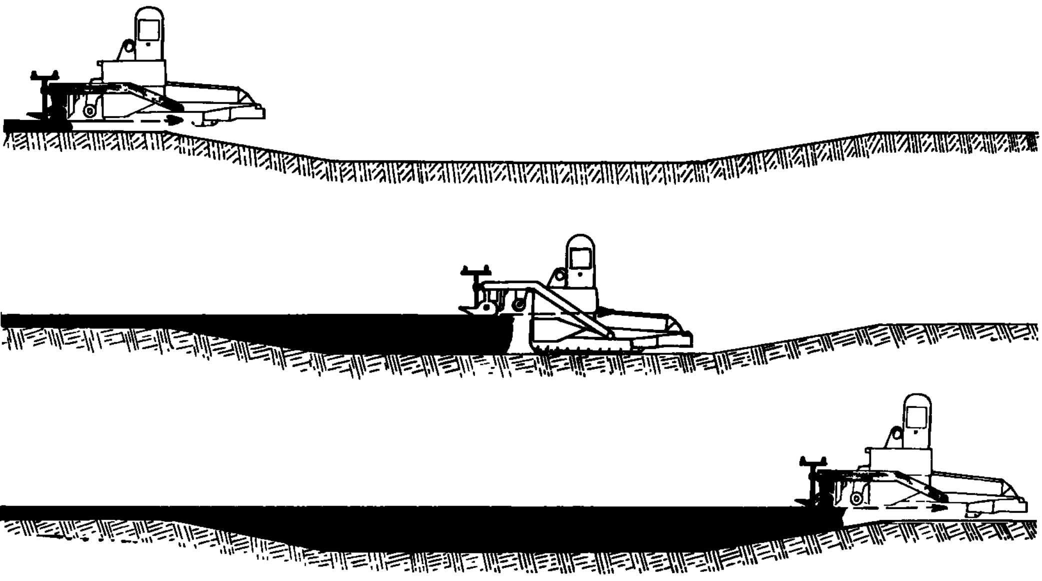

Figure 8.

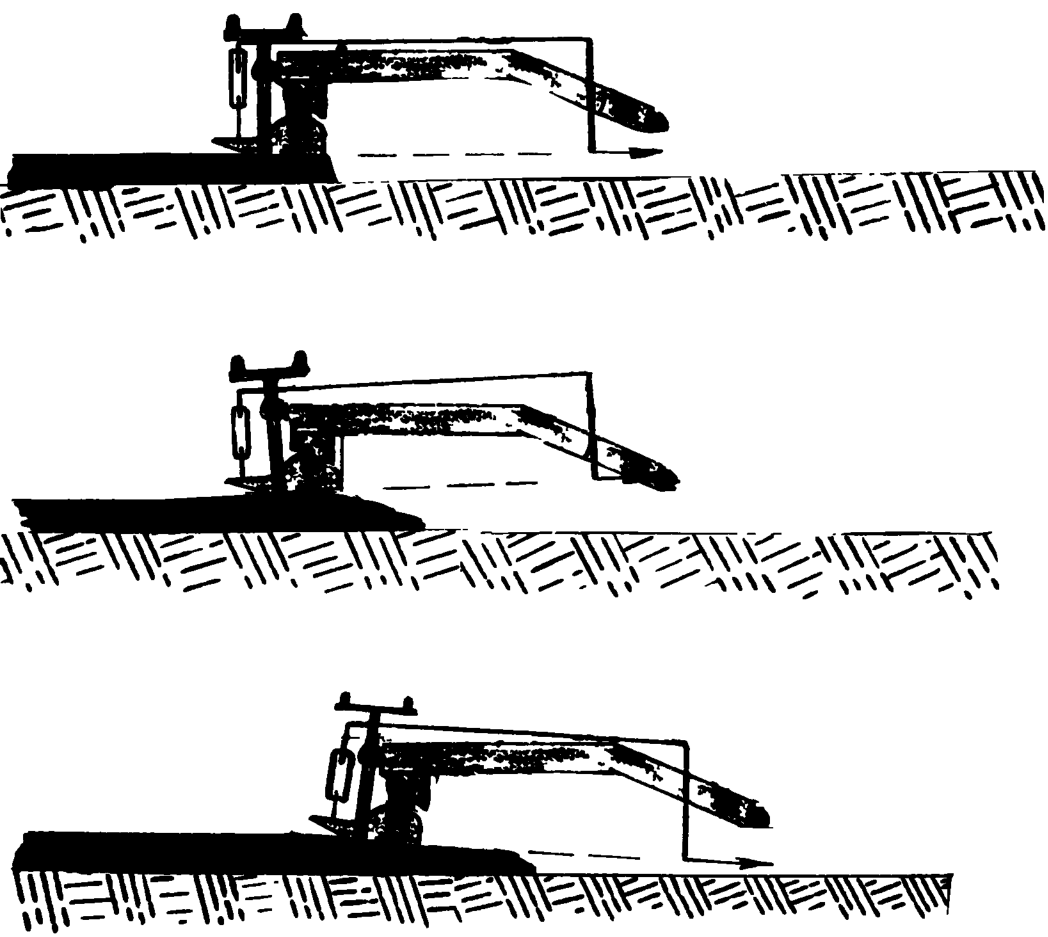

Figure 9.

The grade line can also be calculated longhand or with the electronic computer. Whether the calculations are made longhand or on the electronic computer there are several possible methods, the most satisfactory is possibly by projection. Using this approach the adjusted elevation of the second 25-ft point is determined by a ratio between the elevations of the first and fifth, the first is assumed to be correct. The adjusted elevation of the third point is determined by the ratio between the adjusted eleva-

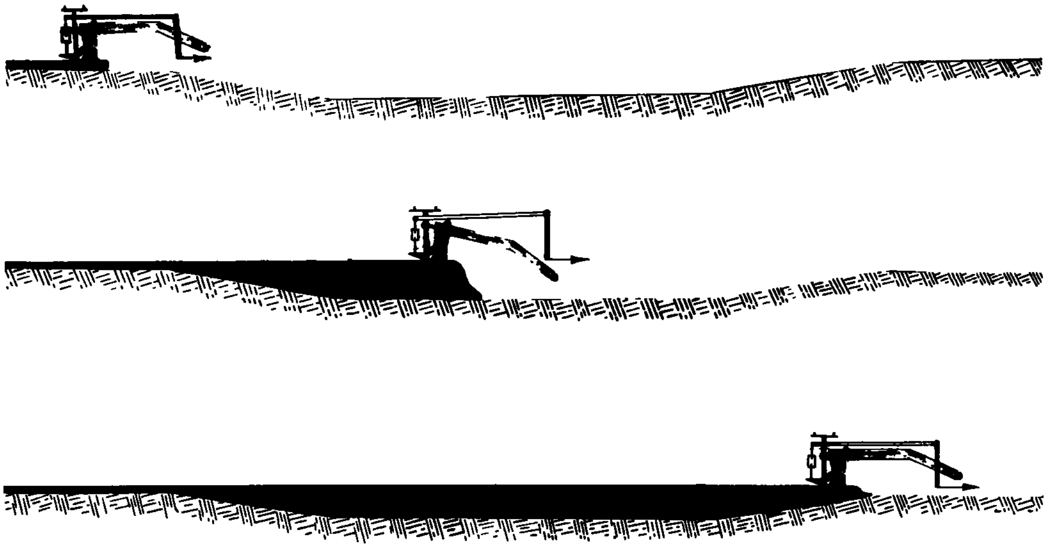

Figure 10.

tion of the second point and the actual elevation at the sixth. Once more the adjusted elevation at point number 4 is determined by the ratio between the adjusted elevation at number three and the actual elevation at number seven. This calculation along the entire profile will result in a smooth grade line. In either case the respective placement thickness values are entered in to a field book for reference at the paving site.

Interference of the string line with the batch truck operation is avoided by driving to grade large nails at the 25-ft points and attaching the string only a short distance in front of the paver thereby allowing the batch trucks to pass between nails not too far distant in front of the paver.

The placing of the mixture on the second half of the road is done in the same manner as the first except that the center line side on the second laydown is guided along the surface of the first half laydown instead of the string line.

There are many applications of the longitudinal and transverse controls to asphaltic concrete paving. Quite often the profile at the center line is smooth while the edges have become distorted, in which case the profiling is not necessary and the use of only the transverse or crown control will produce a satisfactory surface. The two controls are applicable to paving on horizontal curves by resetting the transverse control. Through transitions the resetting can be prorated or a string line can be erected for both sides of the paver. The surface of a laydown next to curb and gutter can be match with the lip of the gutter in the same manner that the surface is laid to a string line.

To say that these controls have produced gratifying results is putting it mildly. The results are visible to the eye and the ride test is unnecessary. Sagging and bulging center line and scalloped edges have been replaced with long graceful lines.

This does not mean that it all comes easily and automatically because about the time every thing is going along fine an operator pulls a boner and a ripple is formed. This has been one objection to this approach and certainly is a valid criticism; where human

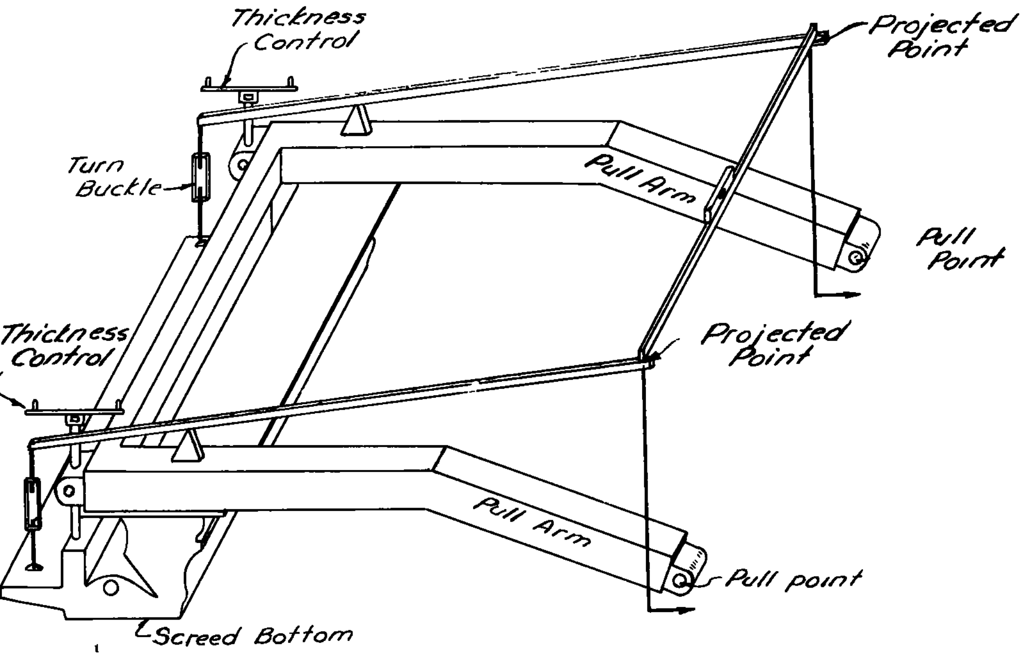

Figure 11.

ement is involved mistakes are made. However, this is no different from other con-
truction work in that these mistakes can be held to a minimum or even eliminated with
ooperation between contractor and engineer.

It is the author's opinion that bituminous surfacing of higher surface quality can be
roduced with a little more effort on the part of the engineer and less work effort and
ore skillful operational effort on the part of the contractor.

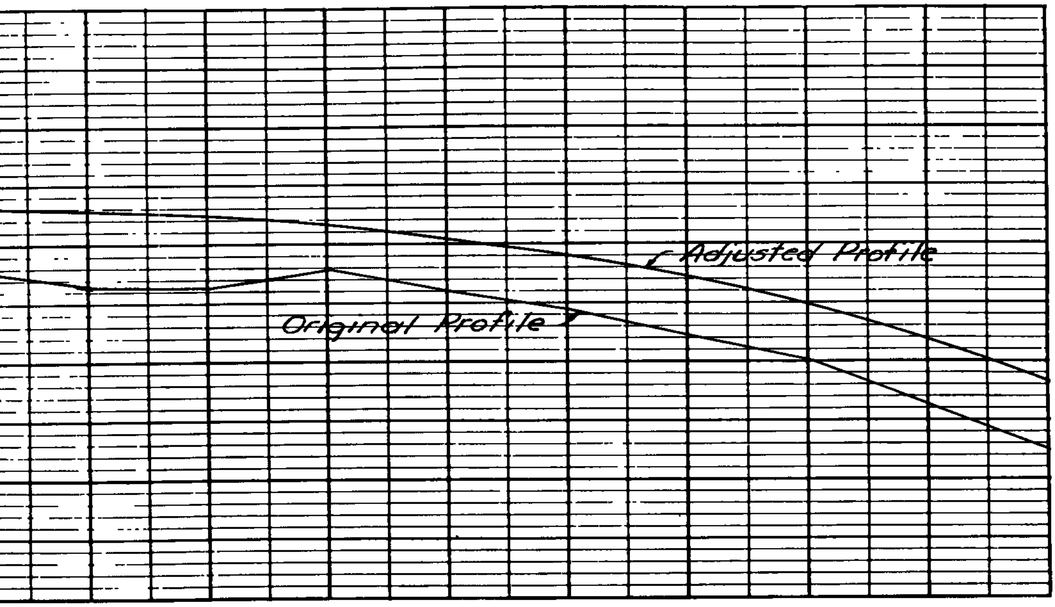

Figure 12. Scale: horizontal—1 in. = 25 ft; and vertical—1 in. = 0.5 ft.

It is also this author's opinion that the amount of material needed can be held to a minimum because there is no guessing and the risk of building high places higher wit blade work is eliminated.

Aside from the necessary effort on the part of the operator there are three "musts in this method to control: (1) the devices attached to the machine must be made stur and neat to details that will make them functionable and not vulnerable to vibration, (the devices must be constructed to include all paver linkage so that the devices will i dicate only the path of the screed bottom, and (3) the operators must make the adjus ments in such directions and at such speeds that the indicators are held at zero positi This approach does not mean that the manufacturer's recommendation of "don't over trol" is wrong, it simply means that adjustments made toward the true surface canno possibly be called over controlling.

There are reports that designs are now on the drawing boards for pavers with auto matic crown control and some form of longitudinal control. After reading the variou magazine articles on the use of electronics in longitudinal control, the question of co and versatility comes to mind. At the present the concern is with pavers now in oper tion and that will remain in operation until fully depreciated.

Two interesting notes might be mentioned. First, bases for asphalt are construct essentially in the same manner and with the same equipment as bases for concrete pa ment. Yet, no matter how accurately the base for concrete is placed the forms are s to tacked hub lines and on the same base asphalt construction has no positive control its operation. Second, in operating a bituminous paver an attempt is made to guide t screed in two directions—vertically and horizontally. For riding qualities the vertic direction is the most important. Yet, the control or indicator for the horizontal dire tion is located on the front of the machine while all of the devices and indicators concerning the vertical controls have been placed on the rear of the machine.