CONSTRUCTION OF PORTLAND CEMENT CONCRETE PAVEMENT

TEXAS HIGHWAY DEPARTMENT
DISTRICT 12

1965

CORRECTIONS TO PAVING MANUAL

Page	Line	Corrections
14	15	Delete first comma.
14	18	Delete second comma.
17	15	Delete the word "and"
22	top	Insert the word "be" between "to" and "imposed"
26	16	Insert the word "that" after "(Figure 1)"
26	27	Hyphenate "fill-in"
26	28	Delete the word "will" between "which" and "results"
32	13	Delete the letter "t" in confusion - typographical error.
38	9	The word "sealing" should be "seating"
40	10	Insert "(see picture page 62-A)." after "ounces"
52	22	Should read "(Figure 28 & 31)"
55	17(end of 1st ¶)	Insert "Figure 16 & 17"
57	7	Insert "longitudinal float and" between words "the" and "straight-edges" (hyphenate)
58	7	Change the letter "o" to "a" in "practice" typographical error.
58	last	Insert the word "is" after "vibrator"
64	19	Insert "(top of page 63)." after "mentioned"
65	20	Insert "(see page 75)." after "forms"
68	4	Insert the word "while" between "screed" and "maintaining"

Page	Line	Corrections
77	18	Delete the word "a" before "suitable"
92	4	Add the word "horizontal" at the end of this line.
96	12	Insert "make" between "must" and "contact"
97	20	Insert "(Figure 48-A)" after the word "roll"
100	7	Insert "(page 62-A & 98)." after "spraying"
100	14	Revise "Fig. 52 & 52-A" to "Fig. 52, 52-A & 58-B"
100	16	Hyphenate "wheel-base"
100	24	Separate the words "conventional" and "finishing"
100	27	Separate the words "this" and "type"
101	21	Separate the words "transverse" and "and"
101	22	Insert a comma after the word "are"
103	9	Should be permanence instead of oermanence typographical error.
105	2	Add an "l" to "instal" - typographical error.
106	1	Insert "generally" after "installation"
107	1	First word should be subgrade instead of subgraed.
116	5	Change the word "when" to "before" and the word "but" to "and"

I N D E X

CONSTRUCTION INSPECTION OF CONCRETE PAVEMENT

The proper supervision and inspection of any type of construction work should be an art. This it can be, provided some basic concepts are accepted, some common objectives are acknowledged and a conscientious effort is continually exerted toward the attainment of these objectives.

Throughout the past 35 or 40 years many methods and devices have been developed for and by the construction industry. Many practices and techniques have been developed and many of them have become outmoded and obsolete, as many more most certainly will. However, the object of this presentation is to help the newcomers who enter the field and experienced personnel alike to attain a higher degree of proficiency by passing on to them some of the knowledge adquired by the practical experience of others and by research conducted by the engineering profession.

It is good practice to make the most efficient use of the construction machinery and its capacity. To be able to do this, the contractor must provide adequate correlated facilities and competent, skilled operators.[1] Sometimes the specifications do not clearly set forth enough details to require these provisions of the contractor and in these instances, unless he can be convinced of the advantages of such preparations, varying degrees of difficulties are quite likely to beset the members of the construction team. The

combined best efforts of all those involved should be directed toward the accomplishment of the principle objective of the work. In our case, this is to build a modern highway facility which is safe for the traveling public, properly constructed of good quality materials at a reasonable cost with the realization of a fair profit on the venture for the contractor.[1]

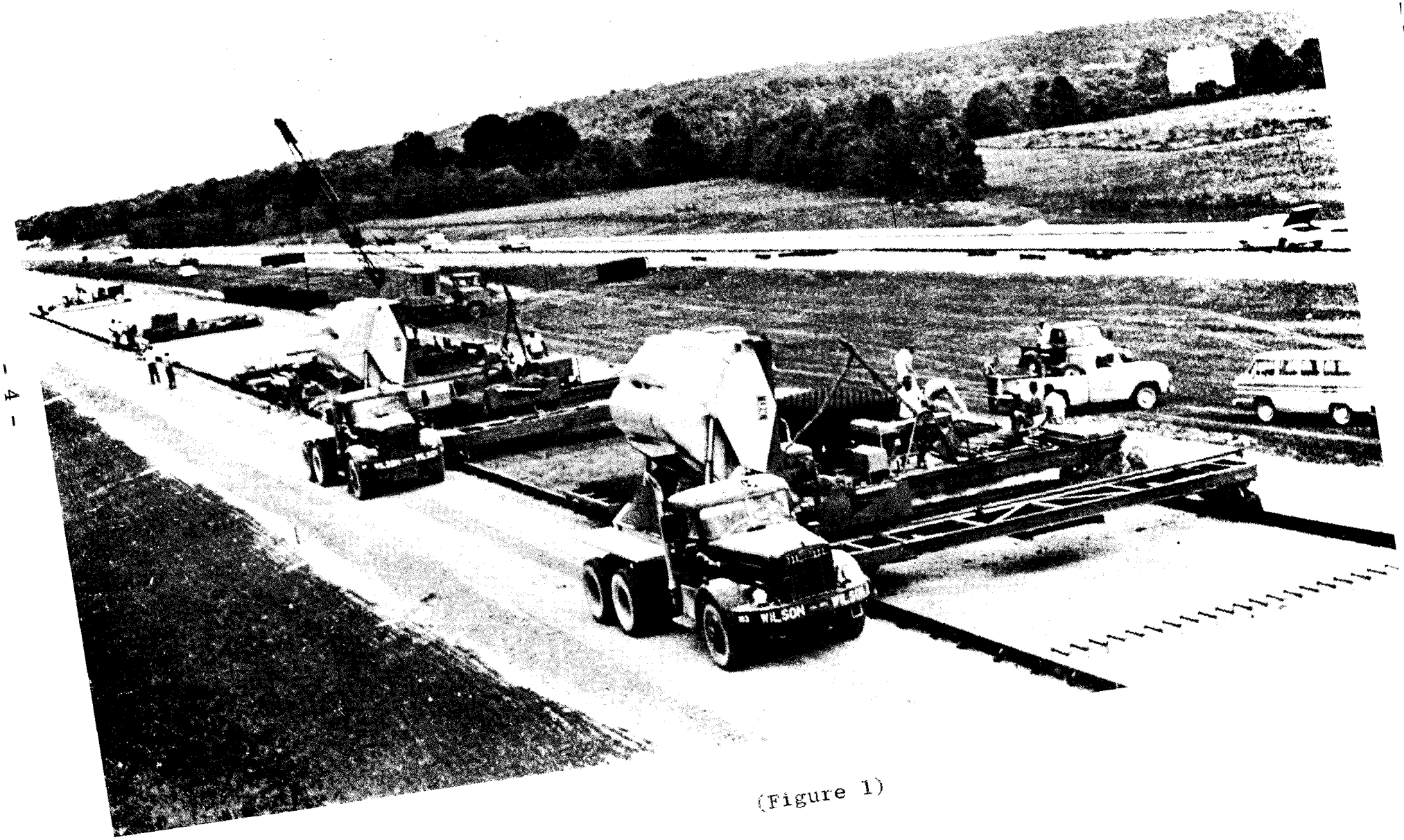
This so-called "art" is not easily acquired. One of the most important and necessary requisites is the mutual respect and proper attitude of the members of the construction team, namely, the inspector and the contractor. The proper attitude among the members of this team involves the realization that their objectives do not conflict, but, on the contrary, are identical, as set forth above; to provide a safe high quality facility at a reasonable cost which has resulted in a fair return to the contractor for his investment and labor. The achievement of this objective provides both parties with better trained personnel for subsequent projects, imparts confidence in the construction team, instills pride of accomplishment, enhances the reputation of all concerned and enables the contractor to stay in business. This mutual respect and proper attitude among the members of the construction team, then, becomes fundamental for the development of this so-called "art".[1]

It should be borne in mind also that neither the contractor nor the inspector, is responsible for the design

of the structure or for the designation of the type or quality of the materials specified for the job; this responsibility was one of the designer. Good and poor practices also exist in his field of operation and elements of design, either omitted from or incorporated into the plans, will often force the construction team into an operation which is poor practice and over which they have no control. These elements should be resolved prior to the beginning of construction, and in most cases have been, but, if not, such cases should be brought to the attention of the construction engineer who may be able to effect a correction of the condition.

Another one of the basic concepts necessary for good construction technique is the recognition and realization that the entire paving operation is actually an outdoor mass production "assembly line" operation.(Figure 1) The weather is one very important factor affecting this entire operation. In concrete paving, there is more surface area of the structure exposed outside the forms, per unit volume, than on any other type of concrete work. This indicates the need for a minimum of elapsed time between the placement and curing operations. The required mechanical equipment must be mobile and move along the form line efficiently and expeditiously. It must perform the necessary function and accomplish the desired results in the proper sequence at the proper time in a continuous operation.

The third basic concept for the attainment of



(Figure 1)

proficiency in this "art" is the realization of the fact that an accurately adjusted and properly operated machine will perform its specific operation in this mass production "assembly line" and will do a better job than a man or a group of men. The proper adjustments and operation of the various machines to accomplish their designated function will be discussed later on.

There are four principle areas of operation in the construction of concrete pavement. These are: (1) assembly, batching and hauling of the materials; (2) subgrading and forming; (3) mixing and placing; (4) finishing and curing.

(1) ASSEMBLY of the materials, BATCHING and HAULING:

Although this phase of the paving operation was taken up and discussed in some detail in the concrete design segment of this training program, some further attention is given to it here for the sake of continuity and development.

In order to maintain the "assembly line" progress of the work a continuous and uniform flow of batches must be maintained from the batching plant to the site of the paving operation. To provide this continuous, uniform supply line, the primary requirement is adequate space for the batch plant operation. Stockpiles, storage areas, maintenance areas, laboratory and office quarters should be arranged so that cross traffic interference is minimized, if not eliminated, between batch hauling vehicles and other essential traffic. Other objectives in the location of the plant site are to

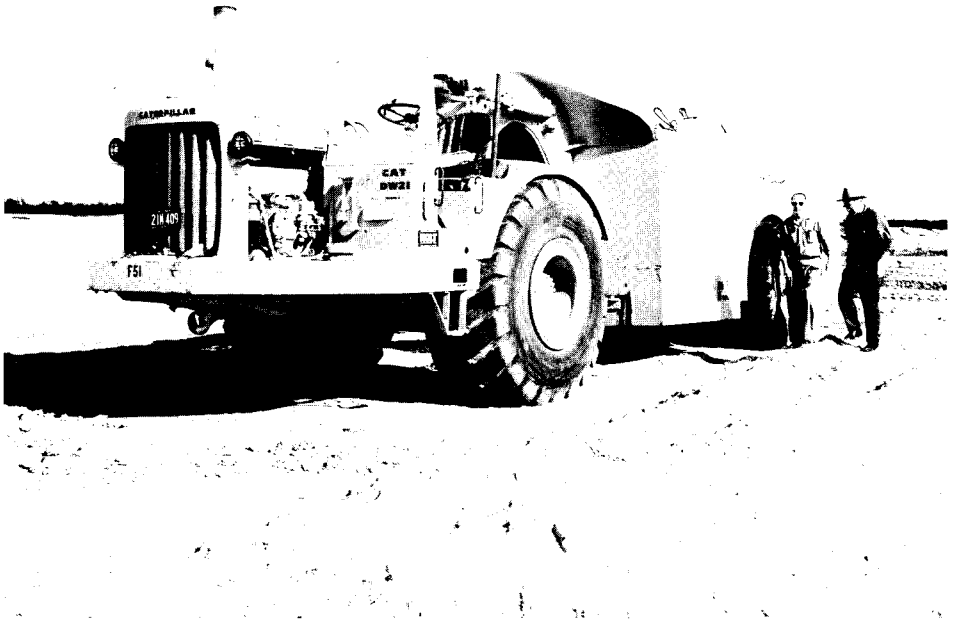
provide the minimum haul distance and to provide access to other forms of transportation for the delivery of materials and supplies. A commodious, systematic arrangement of batching facilities will promote the satisfactory control of segregation and moisture in the aggregate through the maintenance of "bermed" stockpiles. On the other hand, limited space and crowded conditions make control difficult if not impossible, promote confusion and delay and seriously curtail the production and efficiency of the entire assembly line operation.

(2) SUBGRADING and FORMING.

In this district (#12) the subgrade for concrete pavement (except for widening of existing narrow slabs) will be one of two types; either a compacted Stabilized (with lime or cement) natural soil or base material (iron ore or a sand-shell mixture), or a base material (iron ore or sand-shell mixture) compacted without a stabilizing medium such as lime or cement. Where an old narrow concrete pavement is widened by four or six feet, the natural soil usually serves for the subgrade which is "leveled-up" with an approved sandy material.

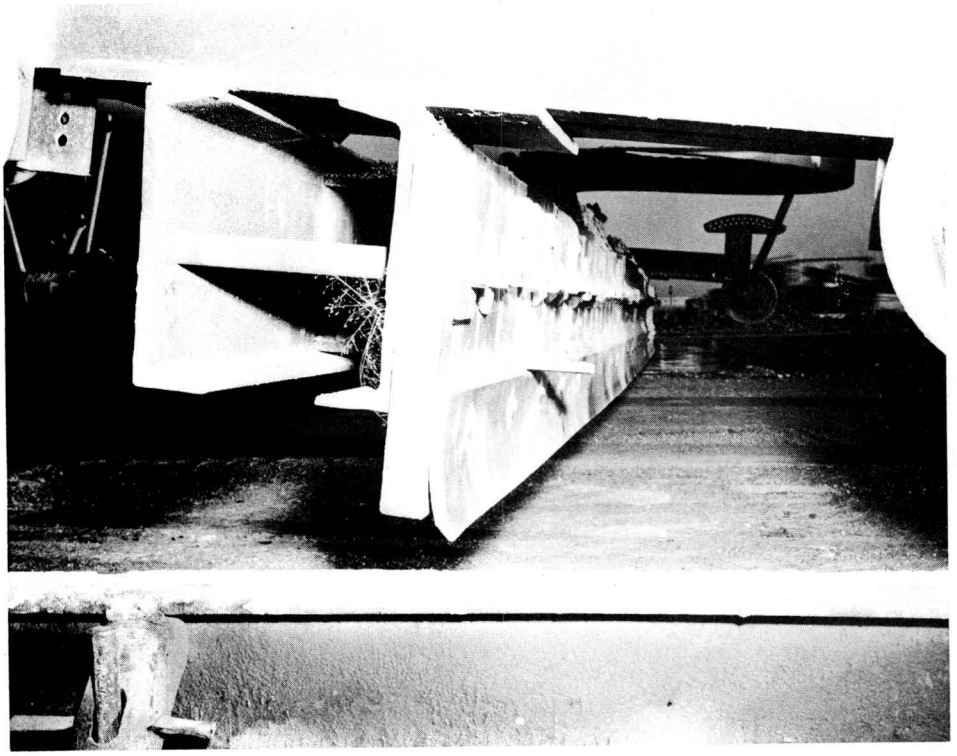
High density is desirable in pavement subgrades and bases. Even more important to the smoothness is uniform density in both longitudinal and transverse directions. Of equal importance is the continuity of the grade line and the smoothness of the finished surface in each stage of the construction. Density control is usually specified as a minimum

percentage of some standard density and governed by stated conditions of moisture-content and compactive effort. The strict, literal, enforcement of these specifications can often result in conditions that will produce rough riding pavement surfaces when no attention is given to the uniformity of the density throughout the area to be paved. After the completion of the compaction operations on the various "layers" comprising the subgrade, or base, for the pavement, the uniformity of the density can be tested by use of a heavy pneumatic roller. (Figure 2) This is generally

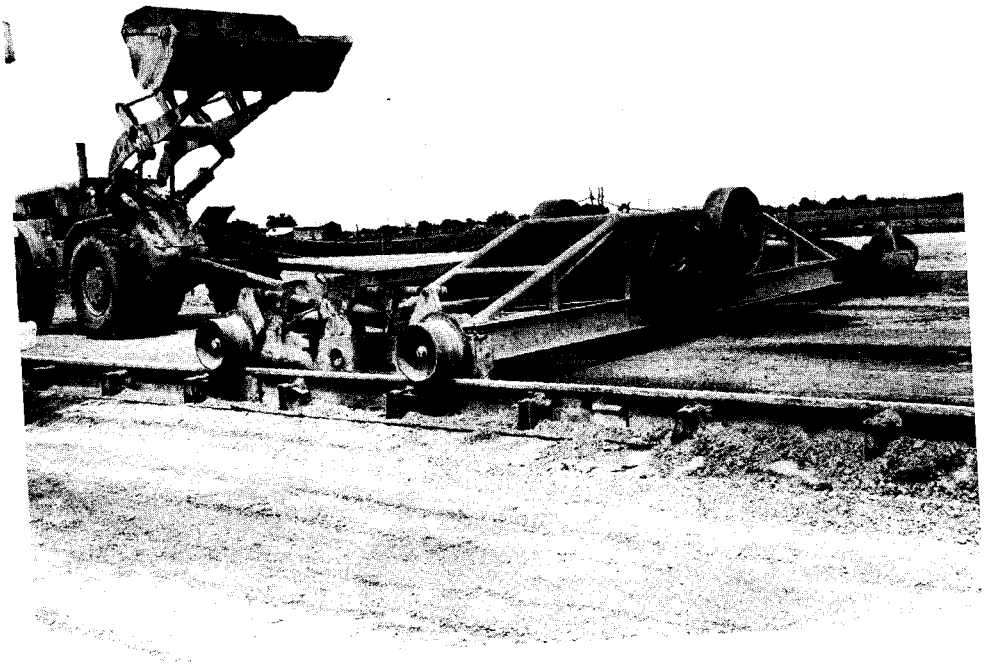


(Figure 2)

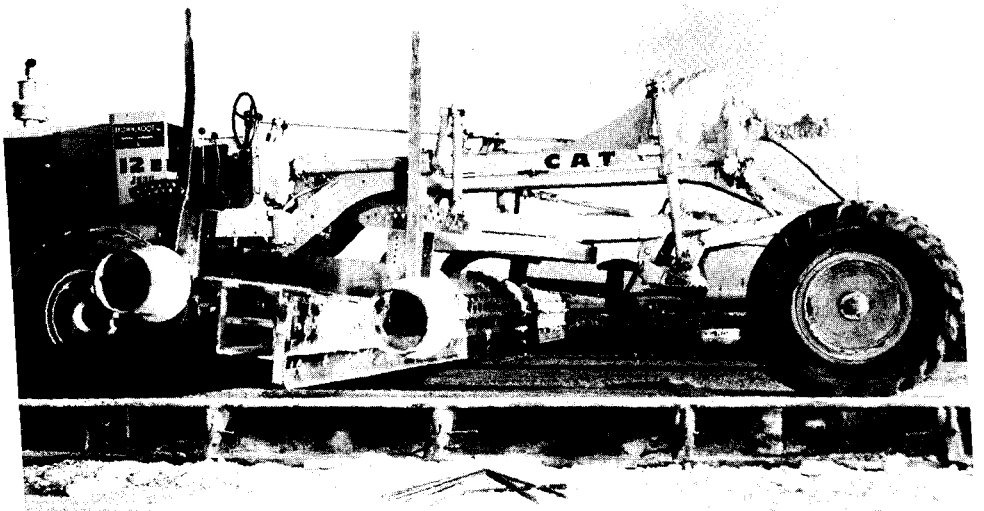
(Figure 3)



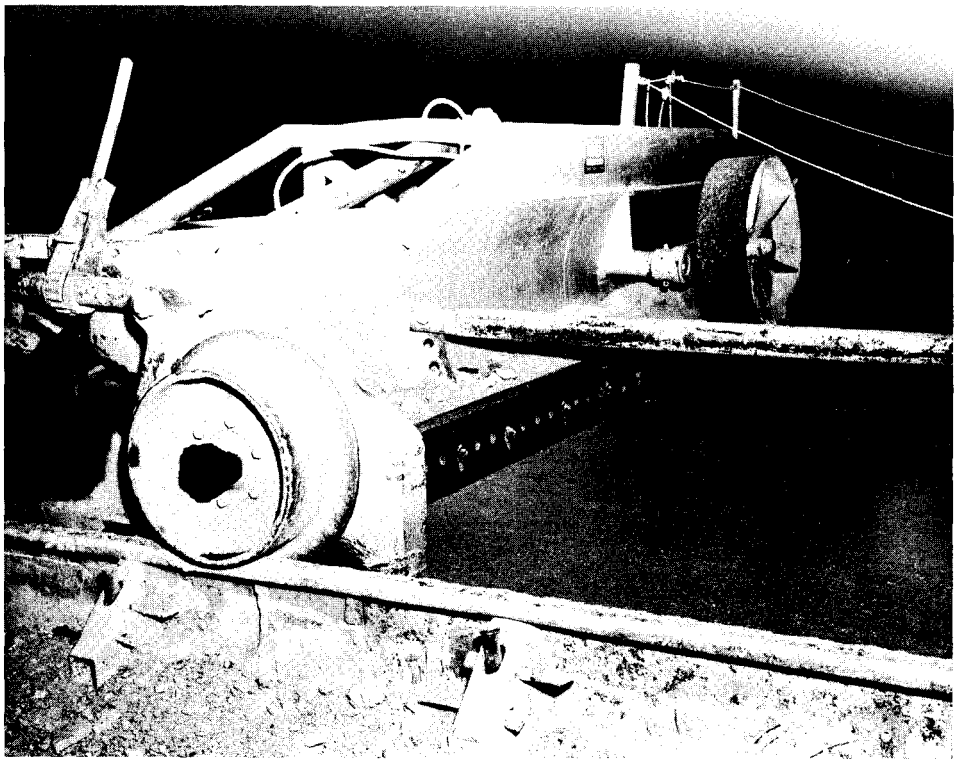
(Figure 3-A)



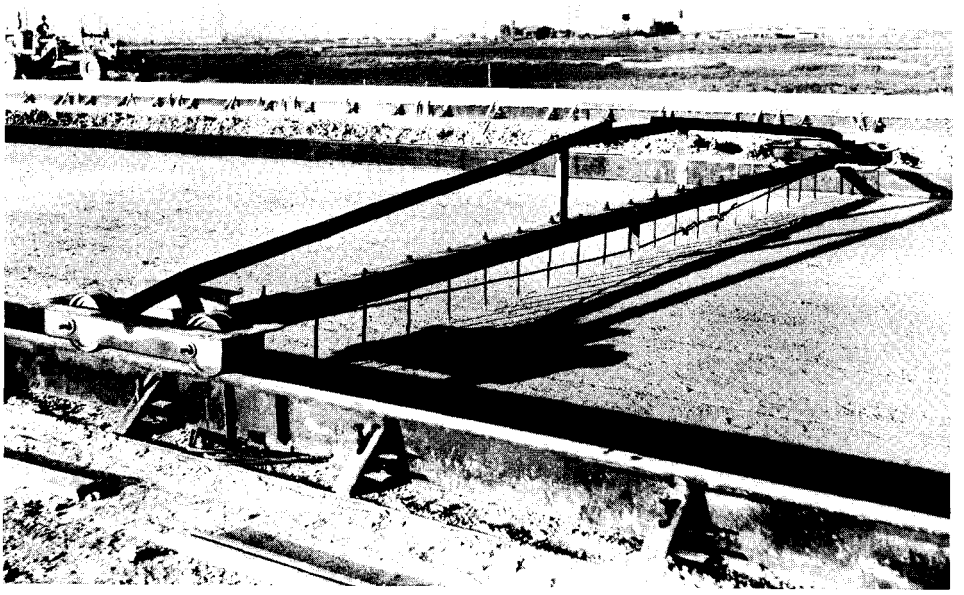
(Figure 4)



(Figure 4-A)



(Figure 4-B)

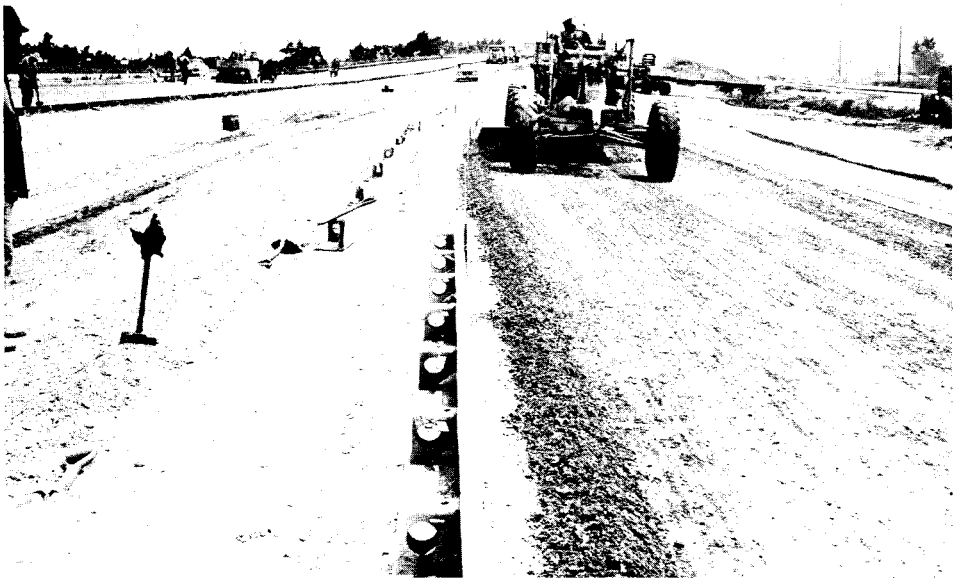


(Figure 5)

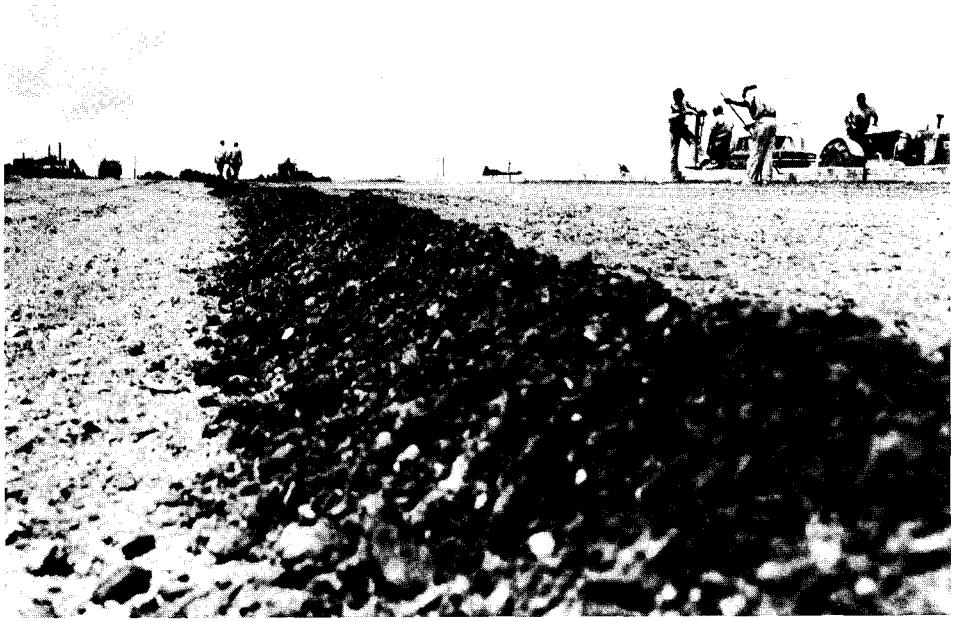
conceded to be good construction practice.

The subgrade planer and the subgrade tester (commonly called a "scratch template") are tools for shaping and checking the subgrade respectively. The planer (Figure 3 and 3-A) is a machine which rolls or glides along on the top of the line of forms (the mobile power is furnished by a tractor or some other self-propelled machine Figure 4 and 4-A) with an adjustable blade (Figure 3-A and 4-B) which is capable of cutting the subgrade to the proper cross section and elevation. The tester or scratch template (Figure 5) is a sort of guage which is pulled along on the top of the line of forms and usually mounted on wheels with adjustable pins on approximately one-foot centers set to conform to the cross section and elevation of the subgrade. As the template is moved along the pins will mark, or scratch, the subgrade when a high place is encountered, thus marking such places where the planer must make some additional cut for proper subgrade elevation. The planer is also used to strike-off the loose material used to build up low places in the subgrade. On build-ups, the "fill" material is generally the same type of freshly-stabilized material as was used to construct the subgrade. (Figure 5-A, 5-B, 5-C) In some cases, the "fill" may be an approved sandy soil, as previously mentioned.

The primary criterion by which the traveling public judges the quality of the completed paving job is the riding



(Figure 5-A)



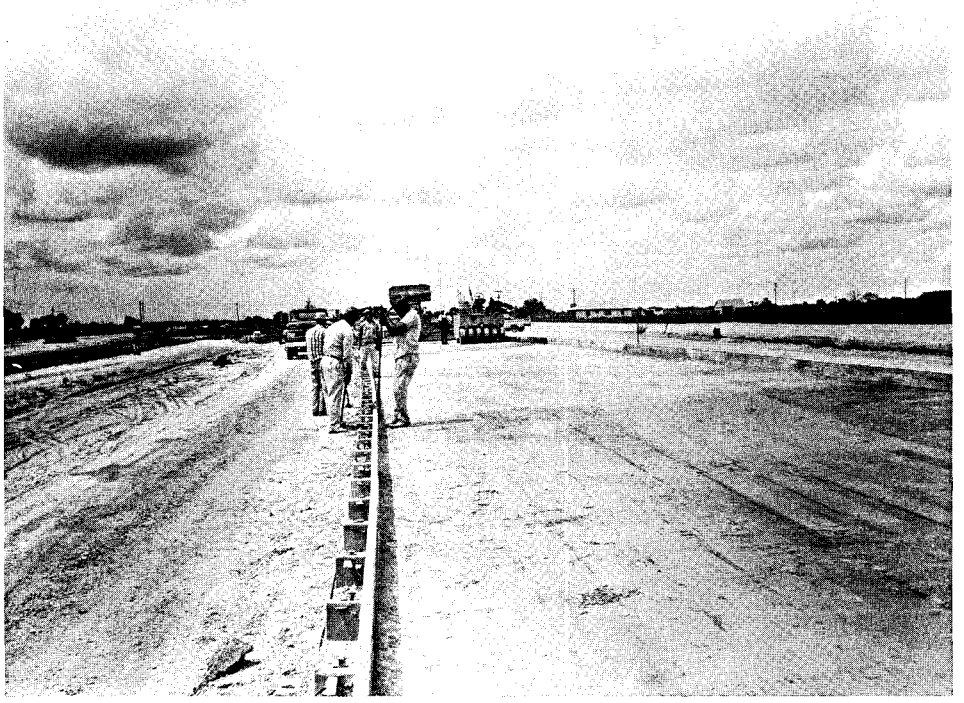
(Figure 5-B)

(Figure 5-C)

(Figure 6)

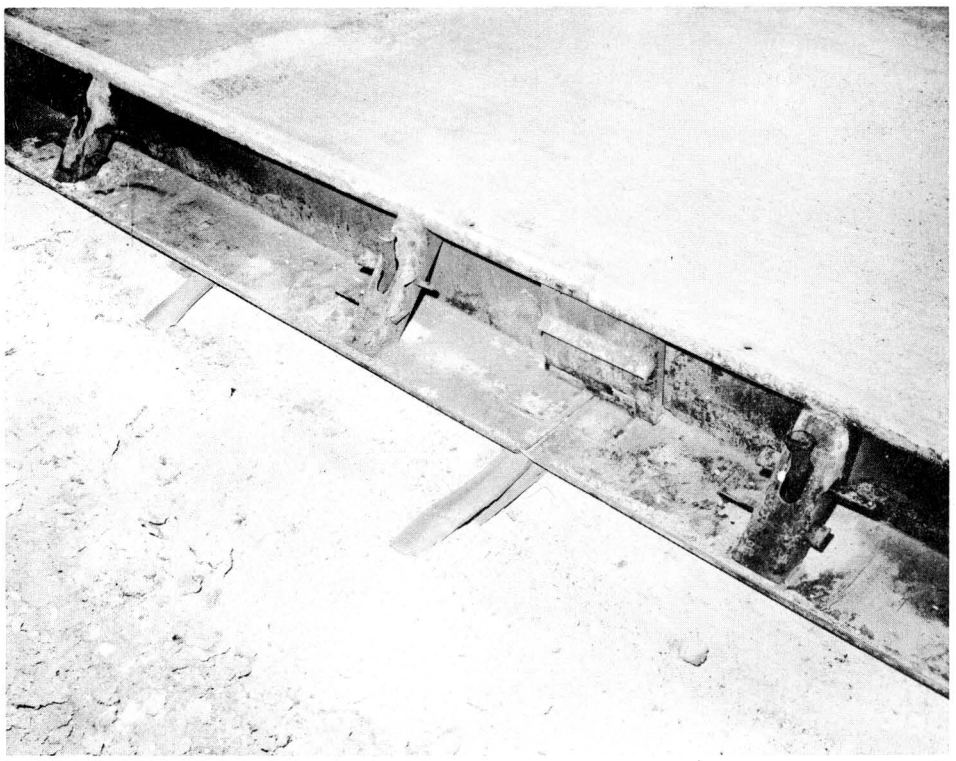
surface. Therefore, it is good basic construction practice to direct maximum effort toward the attainment of this end--a smooth riding pavement. The starting place for the exertion of this effort, then, is in the subgrading operation, and if the successful accomplishment of the objective is to be achieved, it must continue through all the others including the curing operation. Pavement roughness can be produced in the interior of the slab when imperfections in the surface of the base are present or when the density of this material is not uniform, causing a variable rate of consolidation and shrinkage in those non-uniform areas. In other words, the character of the surface of the finished subgrade or base can be of considerable influence on the smoothness of the concrete pavement slab.

Of equal or greater importance than, the subgrade, is the line of forms. These side forms are to be "set" to line (Figure 6 and 7) and grade, (Figure 8) as established by the field party's stakes, on the subgrade, or base, properly locked together (Figure 9) and pinned (Figure 10) in place. They serve four purposes: (1) they provide the gradeline template for preparing the subgrade; (2) they contain the plastic concrete in place until it "sets-up" sufficiently to hold its shape; (3) they provide the grade line to which the riding surface is to be built; and (4) they provide the travelway or "track" for, and support the spreading and finishing machinery "train".

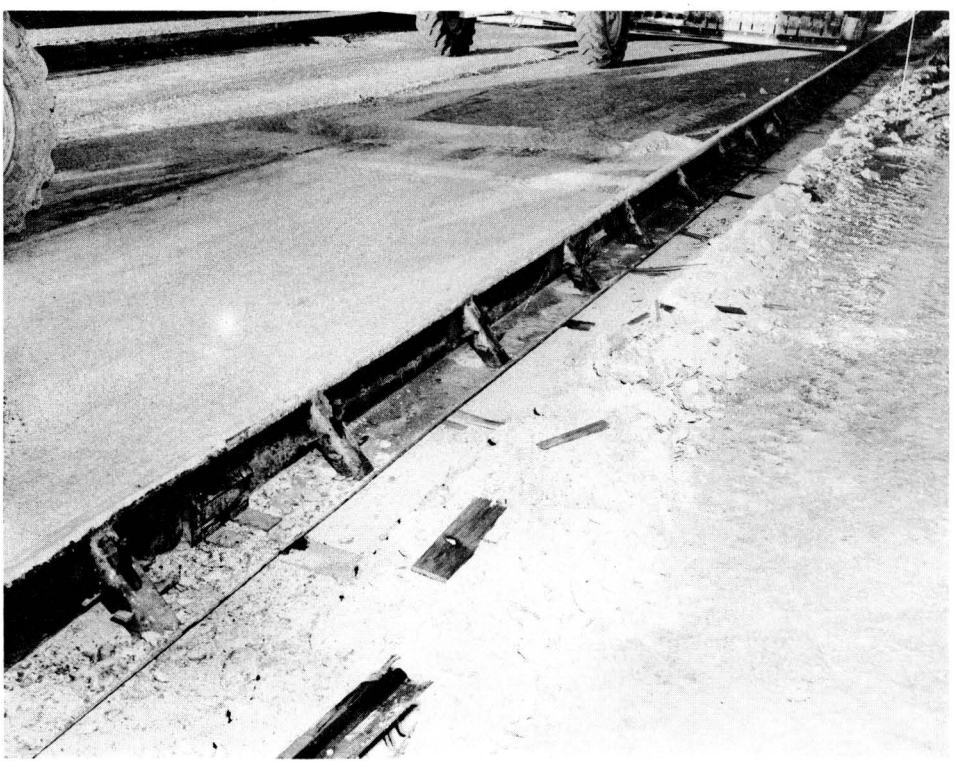


(Figure 7)

(Figure 8)



(Figure 9)



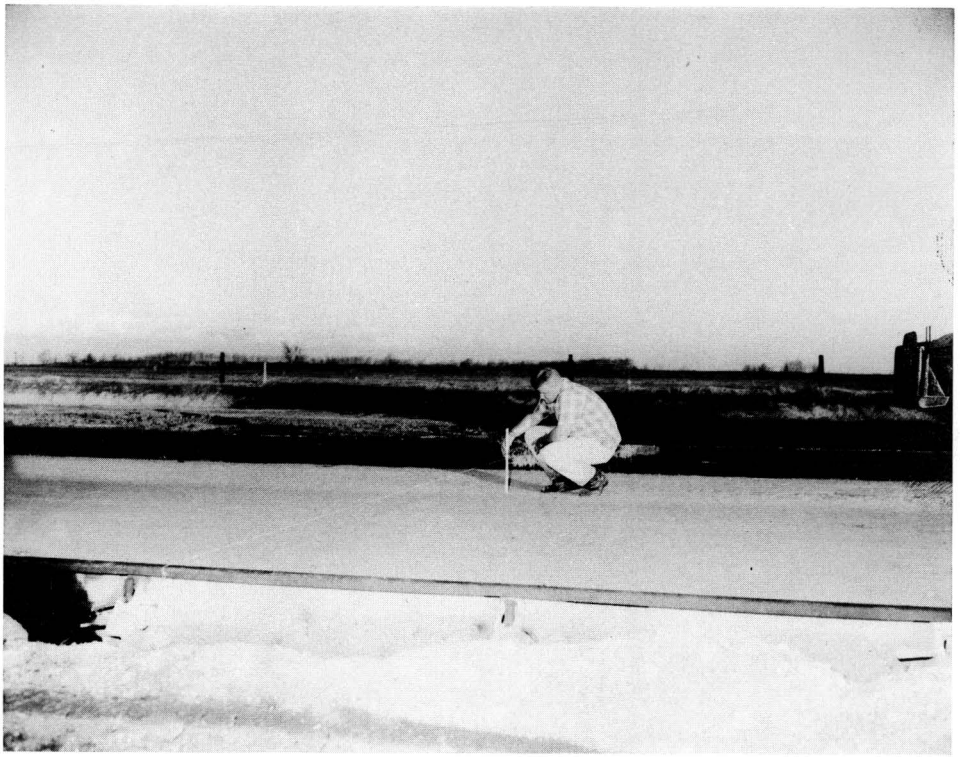
(Figure 10)

The first of these functions is a most important one---the subgrade planer is the first unit of the Contractor's machinery which will traverse this "track" in order to establish the depth, or the bottom of the "form" for the slab. If the line of forms is not maintained in a stable state during this operation, the surface of the resultant subgrade will not be horizontally uniform, and consequently, the specified thickness of the slab will not be attained. This variation of the slab thickness will directly affect the "yield" of the batch in linear feet (or in square yards) of subgrade covered. If the subgrade is lower (or deeper) than required, then the definitely-designed and carefully-controlled volume of the batch will fall short of its theoretical yield because of this extra depth of the sub-grade, and because more concrete than necessary for a slab of plan thickness will be required to fill the forms. Then, the Contractor will be complaining about his loss. On the other hand, if the subgrade is left higher than required to provide plan thickness to the slab, the same volume of concrete batch will cover more linear feet (or more square yards) and the Highway Department will be the loser (up to a point) because of deficient slab thickness. However, if the depth of the finished slab is "shy" by more than $\frac{1}{4}$ inch, the Contractor's pay for the deficient thickness will be adjusted accordingly, and if the thickness is deficient to a specified degree (Item 360.11 P. 357 of the 1962 Standard

Specifications), he gets no pay whatsoever, and further, if too thin, he will have to break it out and replace it at his own expense.

Of even more importance is the fact that the construction of a thin pavement slab fails to achieve the quality of work which was intended in the design and was provided for in the contract.

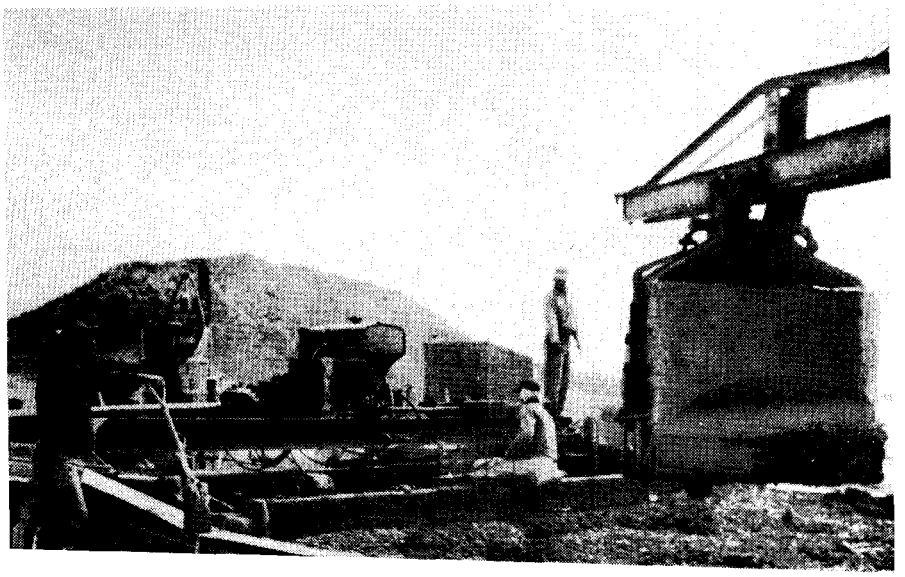
The construction of the subgrade requires almost constant observation and checking at frequent intervals, by means of a stringline drawn tightly across the top of the side forms and measuring the depth of the void to be filled with concrete. (Figure 11) Attention is here called again



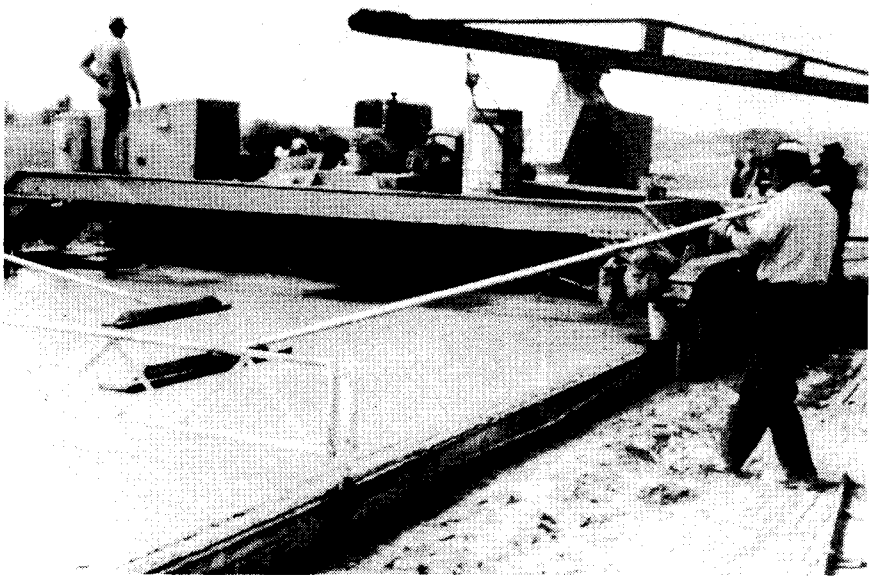
(Figure 11)

to the importance of maintaining stable lines of forms. Even though the subgrade is constructed to the precise elevation below the top of the form line, if at one or more points the forms may settle under the subsequent load of heavier machinery and the more strenuous forces to be imposed upon them, a thinner slab than anticipated will result according to the degree of settlement of the forms.

The second is the least critical function of the four. In fact, the formless-paver, (Figure I and II) which



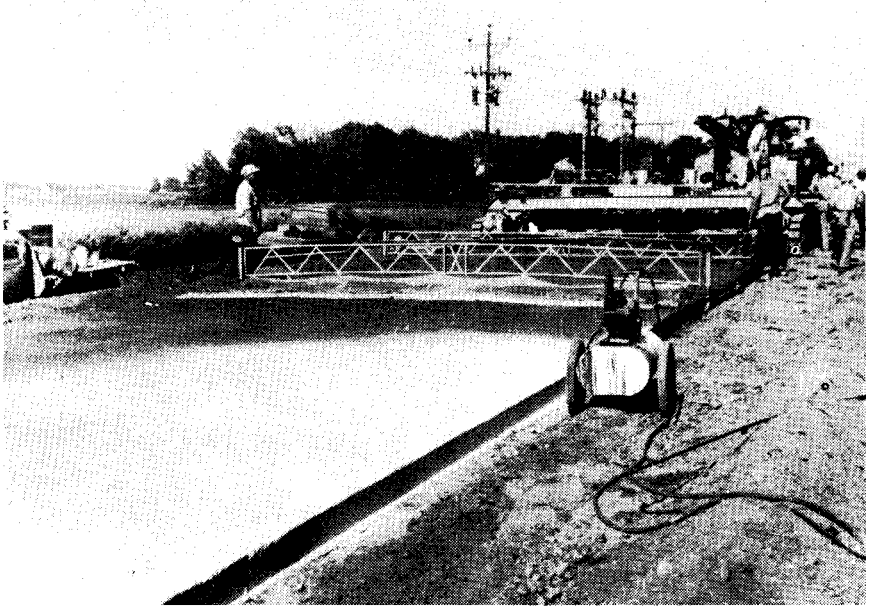
(Figure I)



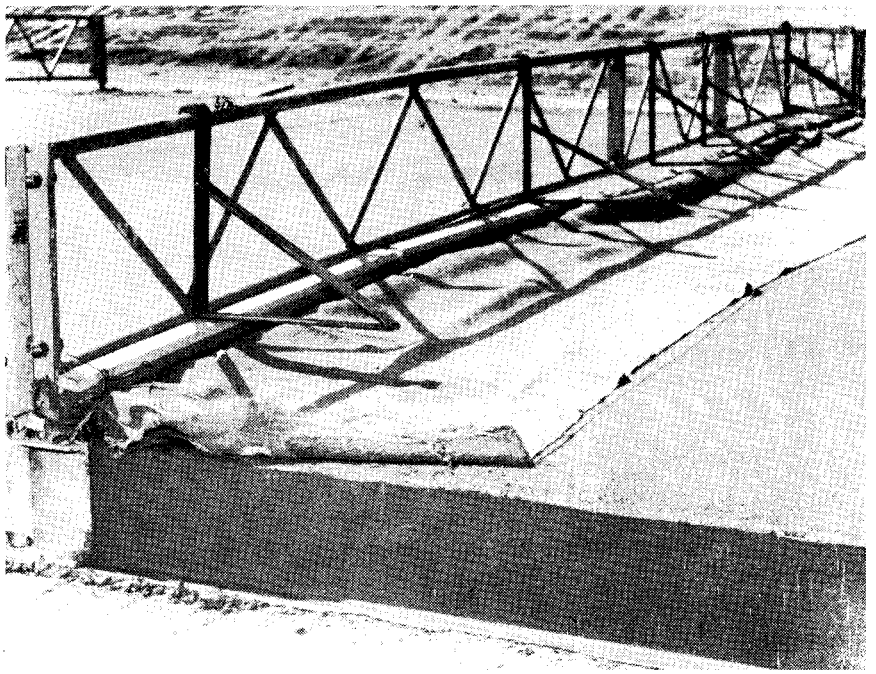
(Figure II)

is coming into more common use in present day paving, trails a short length of side forms along (Figure III) as the finishing machine moves ahead, supporting the edge of the plastic concrete for only a few minutes--about 30-- after which the edges "stand" unsupported. (Figure IV)

The third and fourth functions are so intimately related that they can hardly be separated and are of equal import with the first one. The third is the most important of all, but if the forms fail in the fourth one, they also fail in the third, so, these two will be considered as one. The individual form section (usually ten feet in length) must first of all be of adequate cross-section strength to



(Figure III)

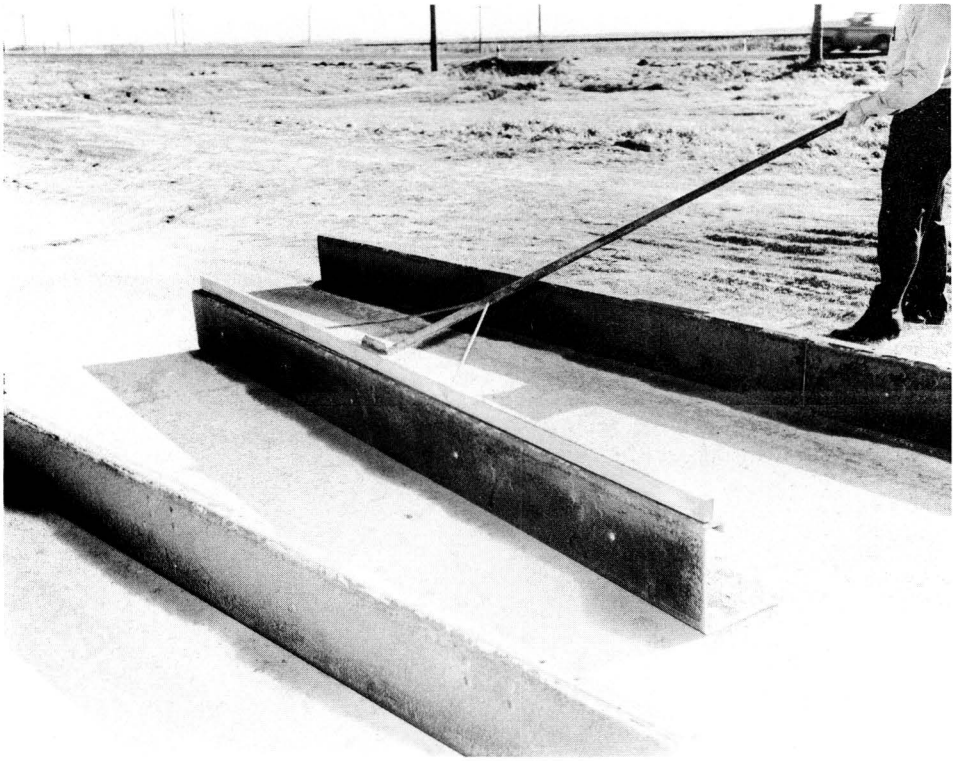


(Figure IV)

support the load to imposed upon it. Then it must be in straight alignment, not only along the "top-of-rail" line, (Figure 12), but also along the inside "face", (Figure 8)

(Figure 12)

which will form the edge of the slab. It must be free of warp, bend or kink. The individual Form alignment is to be checked by using a ten-foot straightedge (or longer--some Contractors use one which has a twelve-foot blade). (Figure 13 and 14) The straightedge must of necessity be checked for alignment before (and several times daily when in use) using it to "prove" the forms <u>or</u> the pavement surface. This is done by one person holding the straightedge by the handle (Figure 15) (or some other means, near the center of the length of the blade) and lifting the blade horizontally (with the"contact-face" down and in a horizontal



(Figure 13)

(Figure 14)

(Figure 15)

plane, up to about eye-level to the person who is to check the alignment and who will "sight" along the bottom edges of the "contact-surface" of the straightedge blade. When the blade is in proper alignment, it will "wing-down", or droop (when supported by the handle), on each end about 1/16 to 1/8" below the middle. When adjustment is necessary, it is done by laying one end of the "blade" on the forms (or some other appropriate "prop") and applying just enough pressure to the deviation to re-align the contact "face" of the "blade".

In addition to the alignment requirement, the form sections must have a positive latching device in satisfactory working condition for properly and effectively holding and locking the individual section to the one adjacent. It must also have provision, or "pockets", for at least three "pins" or stakes (Figures 6 & 10) to hold the form section in its place in the form line (Item 360.3(7), p. 333, 1962 T.H.D.

Figure 15-A

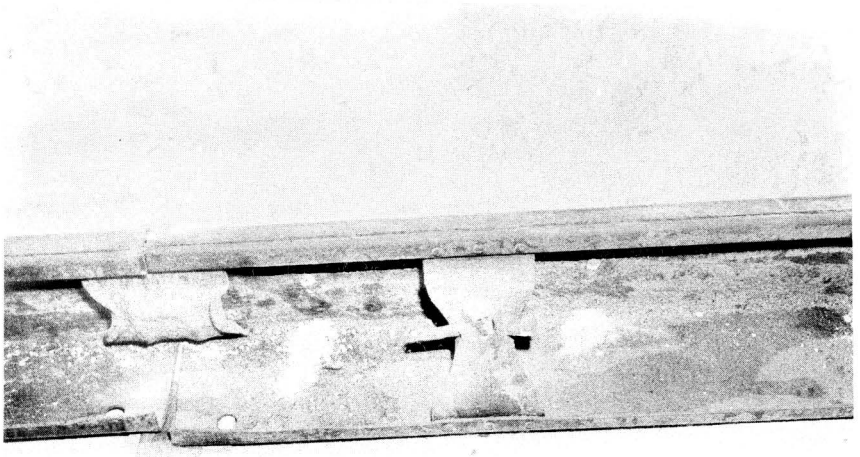


Figure 15-B

standard specifications). Two types of stake"pockets" are shown in Figures 15-a & B. The inspector should see that each pocket is at all times equipped with its designed and usable number

of wedges and pins and that the wedges are kept driven up tight in order to assure a stable form line. These wedges frequently become bent by repeated tightening and intentional loosening (when removing the forms) and when they are no longer functional, or lost, they must be straightened or replaced. Form pins should be of sufficient length to hold the forms firmly in line and to withstand the thrust of the spreading and finishing machinery. Forms should be inspected continually during the placing and finishing operations to make sure that pins do not "work" upward, that the wedges and latches are kept tight and that the form lines are maintained rigid and true.

In addition to linear stability, the line of forms must have horizontal stability and, to be stable horizontally, each form section must be supported uniformly at all points. The machinery in this "train" (Figure 1) is to move over this "track" is quite heavy and any point along the line of forms which is not capable of supporting the load imposed upon it will, of course, be deflected under this load. This deflection of the form line unless detected and corrected in time, will be directly reflected in the resulting machine-finished surface of the pavement, which will have to be corrected by hand-finishing and often results in a "shut-down" of the mixer. This one deficiency probably results in more unsatisfactory pavement riding surfaces than all other factors combined.

The extra concrete required for the longitudinal float or for the straight-edge finishers to fill in the "sag" or low area, which will results from unstable forms will have

Figure 16

to be carried back from the placing operation site manually, Figure 16 & 17, and the extra work required of the finishers to re-establish a satisfactory grade-line continuity, results in their resentment of this unnecessary work, which frequently makes it necessary to suspend the concrete placing operation

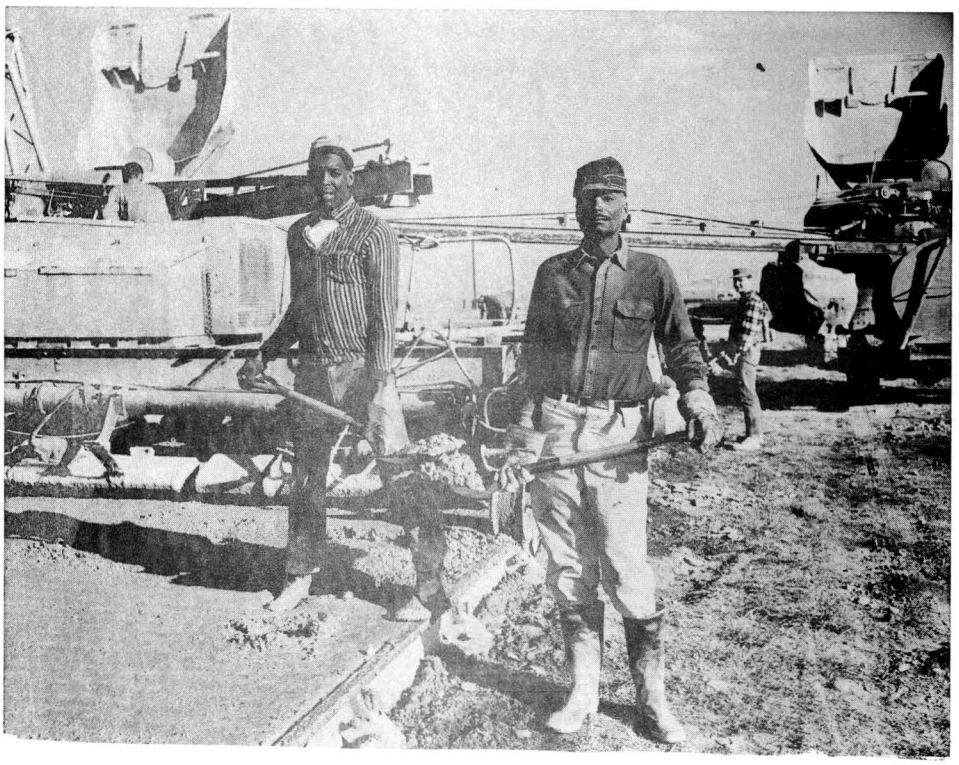
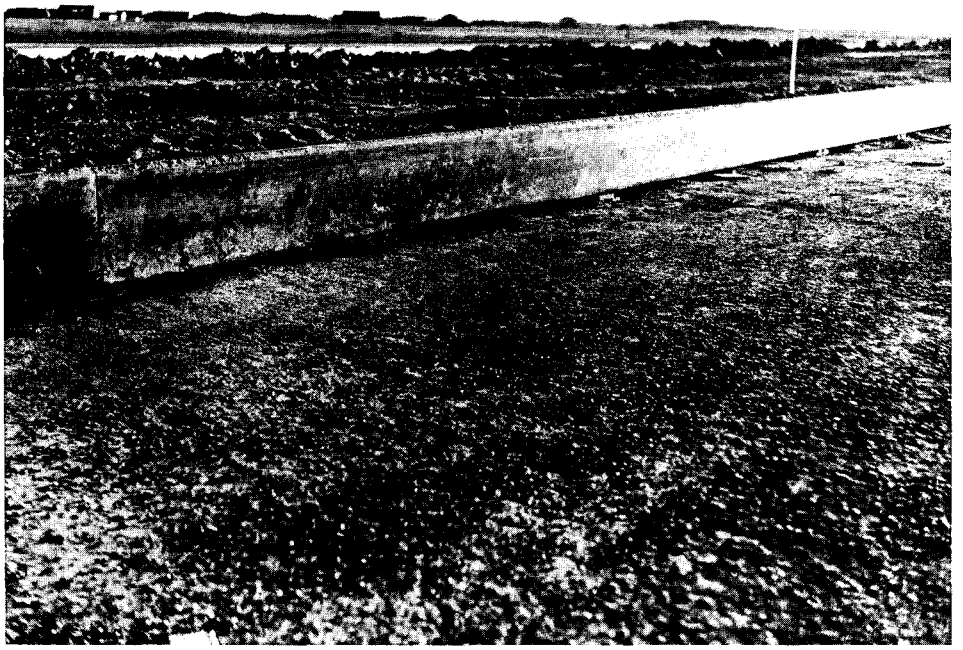


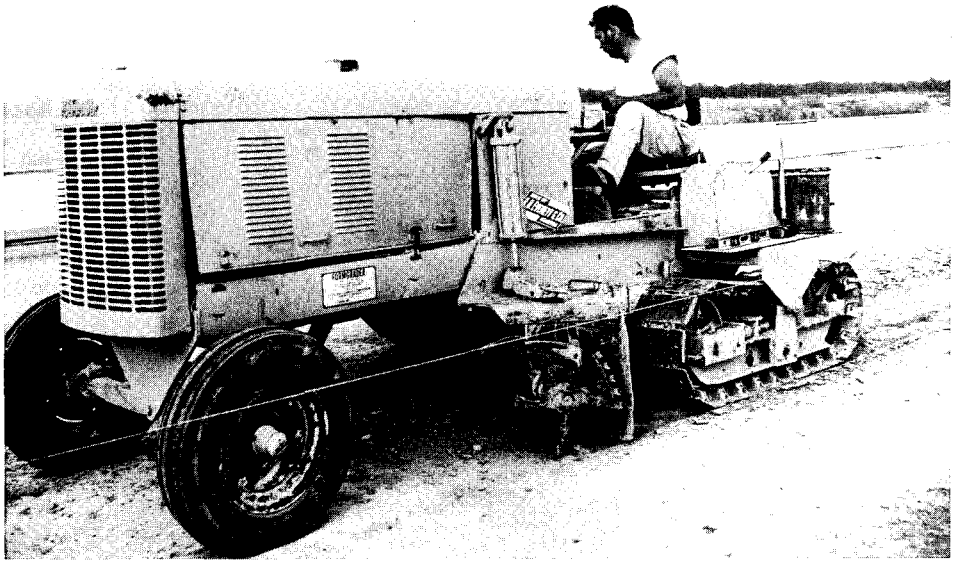
Figure 17

until the extra work is caught up. This means that production has ceased and that time as well as labor actually is being wasted. It also often means that the contractor then becomes unhappy with the inspection crew, who then resent the contractor's attitude, and the whole job goes "sour", fostering a complete breakdown of one of the most important requirements (the mutual respect and proper attitude) for the attainment of our main objective - a smooth riding surface - all because the form line would not support the load of the finishing machinery.

Thus the importance of providing adequate support for the forms is paramount, and it becomes one of the first and foremost duties of the inspection crew to see that this is done. It is true that we permit the forms to be shimmed-up with wooden shingles (Figure 9 & 18), and/or various thickness of other wooden shims, when forms are set on a cement stabilized subgrade because of the practical impossibility of cutting a smooth, continuous grade in this type of material for the base of the forms to be set on. (Figure 18-A) But this does not preclude nor eliminate the need for a continuous and firm foundation for the forms. In addition to providing continuous support, the filling of the void areas spanned by the form base (Figure 18) is necessary in order to prevent the loss of mortar from the edge of the slab by the required vibration of the concrete, thereby creating "honey-combed" areas against the forms. The specifications require that "honey-comb", where it exists, be corrected immediately upon removal of the forms /Item 360.5(2), p. 340/. This continuous support can be attained by tamping suitable material from the shoulder of the road, or from some other satis-



(Figure 18)



(Figure 18-A)

factory source, firmly under the forms (Figures 5-B & 19) for the entire form-base width and length. The development of this con continuous support, which is essential, will require the constant attention of an inspector. For some unknown reason, some contractors are reluctant to assume this responsibility.

(Figure 19)

One easy way to check form settlement is to drive a stake in the shoulder at some convenient distance from the form line (sufficient to permit the machinery to pass without disturbing the stake) to the same elevation as the top of the clean form rail (check with spirit level). After the machinery has all passed this point on the form rail, place the spirit level on the same place on the clean form rail (as was used when setting the stake) and on the stake. If the bubble indicates form settlement, the machine-finished surface will likely need correction, dependent upon the amount of settlement (Item 360.5, P.399 of 1962 Standard Specifications. T.H.D.) When settlement of the forms is detected or suspected, immediate attention should be directed to the situation, and the cause contributing to the settlement determined. If the condition is at all "general", steps should be taken at once to correct it, but if it exists in only one localized spot, then all that need be done is to bring fresh concrete back to the low place, fill it in, and have the finishers correct the riding surface.

(3) MIXING and PLACING

On a modern paving project, the operations of mixing and placing are probably the easiest of any to accomplish, physically. At the same time though, they are most important to the job because their rate of production governs the capacity required of all the others. The production-rate represents the profit-making-rate, thereby creating a strong tendency on the contractor's part to keep the mixer running regardless of the affect on the quality

of the other phases of the work, particularly the finishing and the curing. But this production-rate must be synchronized with the capacity of the slowest machine in the train and, therefore, could possibly be penalized thereby. If the contractor has provided himself with ample, adequate facilities, he should be able to operate at the maximum rate provided by the specifications. This mixing and placing should be almost entirely a machine operation and is fairly simple once the machines have been properly adjusted and are operated by competent operators.

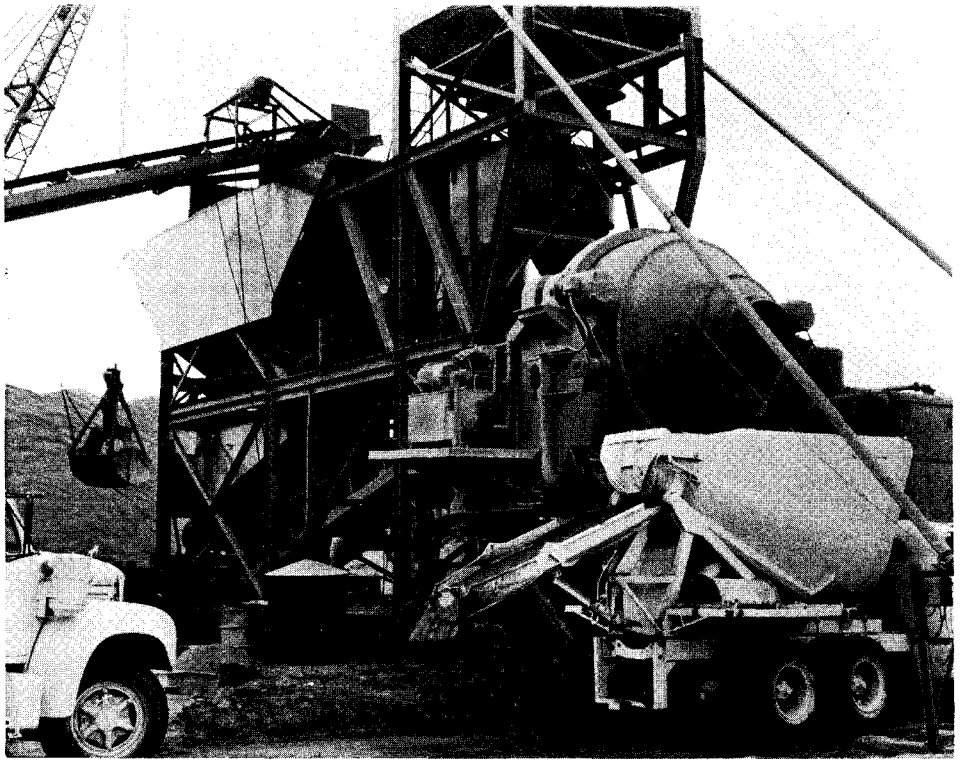
All the adjustments and calibrations should be made and checked prior to the start of the work in order to avoid as much confustion as possible on the first day. It is poor practice to leave the supervision of these adjustments and calibrations to the contractor's personnel and then find that too many subsequent re-adjustments are required. However, correct adjustments should be maintained, of course, as the work progresses.[1]

In starting a project, a leisurely pace the first day will permit the crew to familiarize themselves with their duties without the pressure of trying to achieve normal production at once. It will also allow time for making some final adjustments to the equipment without having the finishing operations fall too far behind.[2]

The current (1964) conventional method of mixing structural concrete used in District 12, is by transit-mix truck/1962 Standard Specifications, P. 705, Item 502.3(3)

and P. 706, Item 502.6(2)/ and that for paving concrete is by a mixer of sufficient capacity/ P. 331, Item 360.3(4)/ which travels along beside the form line, mixes the batch and deposits it on the prepared subgrade.

The central mixing plant, (Figure 20) like the



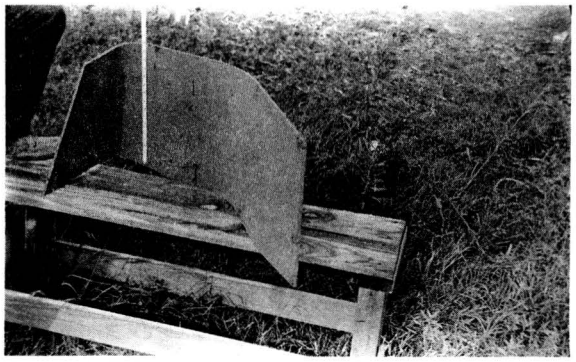
(Figure 20)

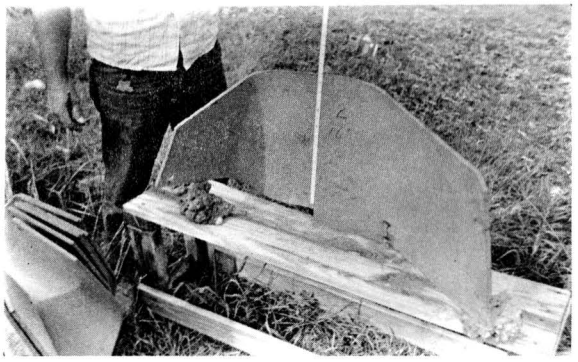
formless paver, is beginning to make its appearance in our area, but to date it is an exception enough to be a curiosity. The details of its operation will have to be learned later when some contractor with this equipment gets a contract in our district. Except where an enormous quantity of structural concrete would be involved, the application of this type plant would likely be confined to paving or to airport construction contracts.

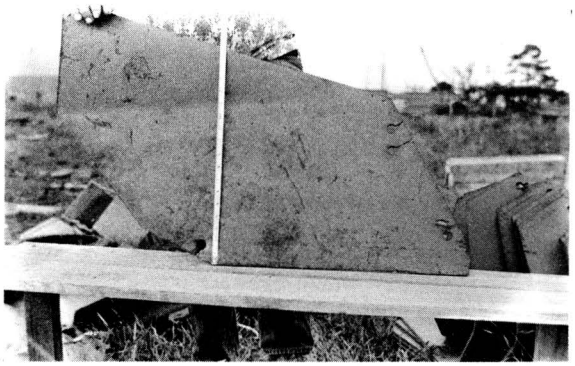
For concrete paving, this discussion will be confined to the "conventional" type mixers. (Figures 21 & 21-A) The mixer size disignation (27-E: 34-E, etc.) denotes the capacity of the "drum," or the mixing compartment, expressed in cubic feet, i.e.--a 34-E mixer has the rated (by the manufacturer) mixing capacity of 34 cubic feet of concrete per batch. The drum must rotate within the specified minimum and maximum number of revolutions per minute for adequately mixing the batch and must have an adjustable, automatic timing device to regulate the mixing time to that specified, (Item 360.6 (2), P.340). Remember that the drum revolution speed may be slightly slower when loaded than when empty. The "mixing blades" in the drum (Figure 20-A) must be in good condition and without excessive wear, Item 360.3 (4), P. 331, The mixer must also have a water measuring device which will accurately measure the required water to be added to each batch (P.331), within 1 per cent and it must all be introduced into the drum within a specified time interval (P. 340).

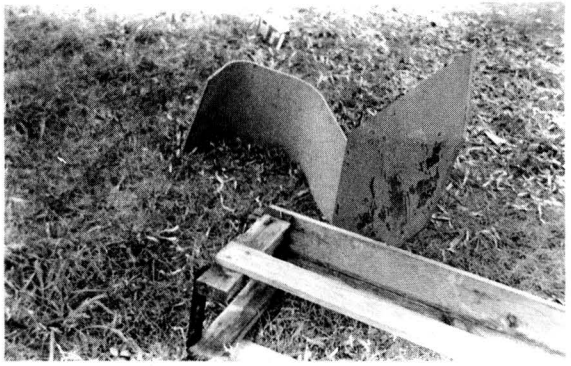
A multiple-drum mixer is one with the mixing hold divided into two or more compartments, effectively separated from each other, with provision for the speedy and complete transfer of the batch from one compartment to the next successive one. Multiple drum mixers are permitted, (P.331). The "dual drum" is the type most commonly used on concrete paving projects in this area. (Figure 21)

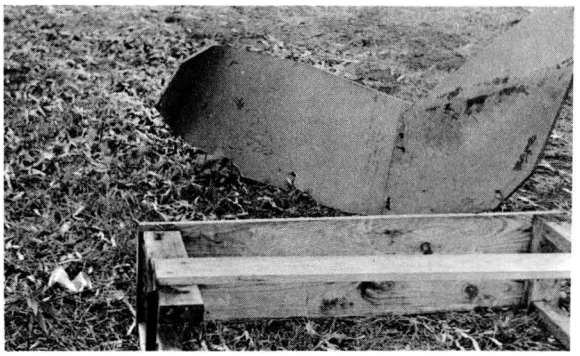
All of the specific requirements for the mixer have to be checked, and often times adjusted, to assure their











MIXER BLADES

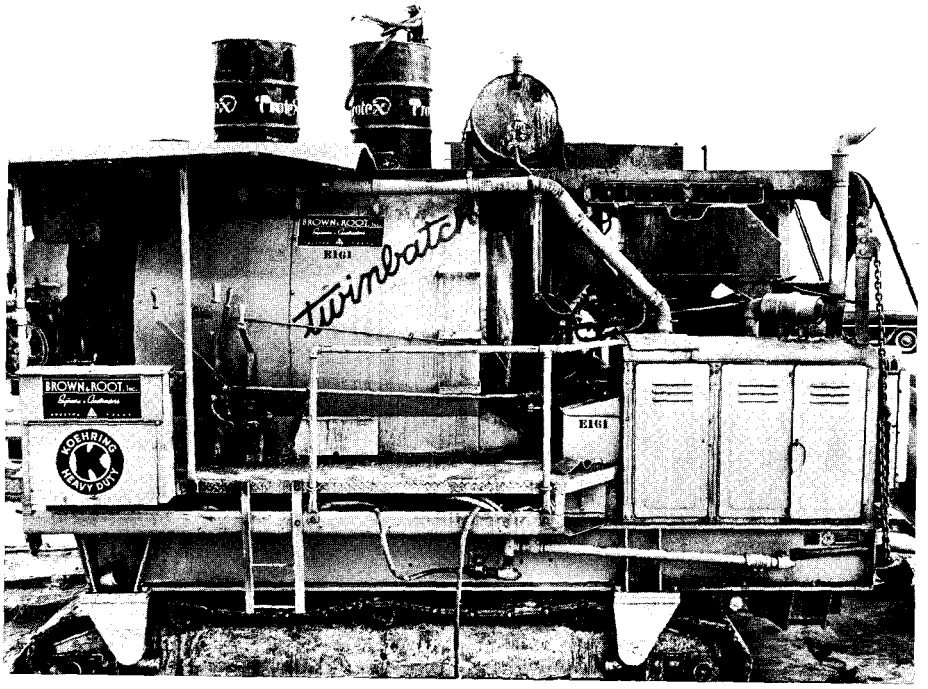


Figure 21

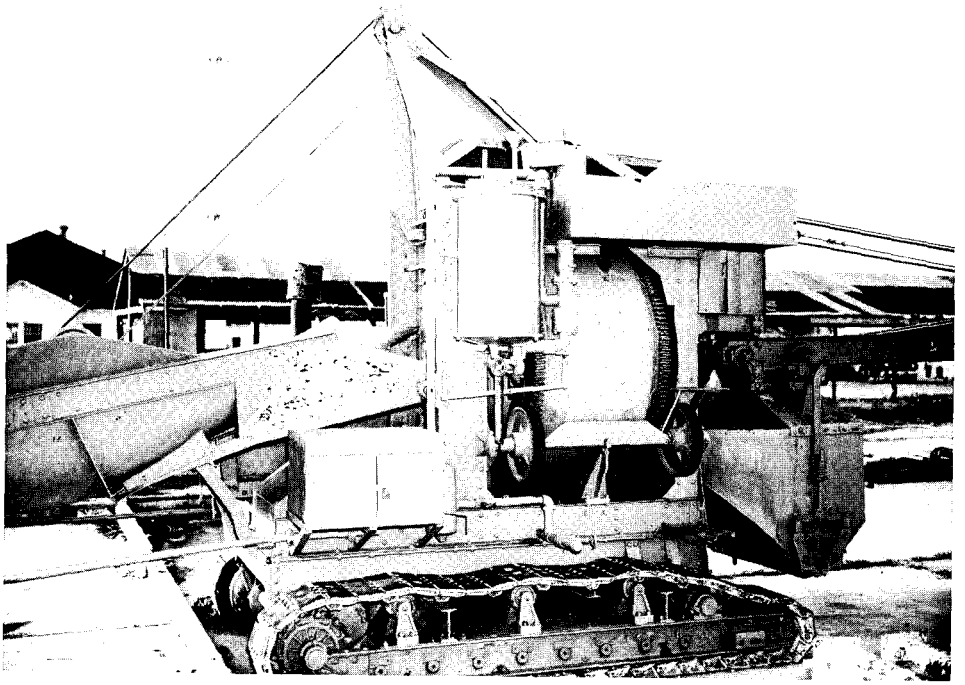
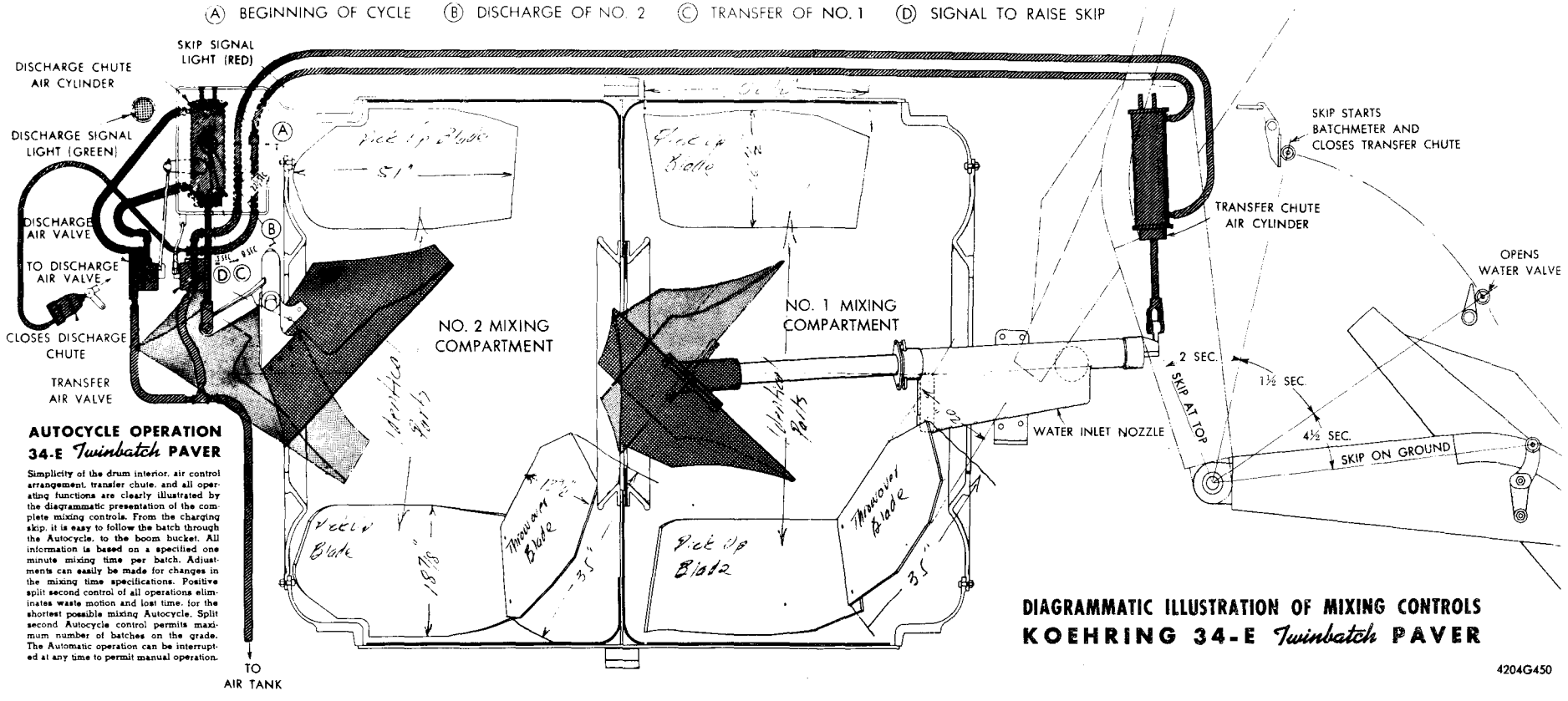


Figure 21-A

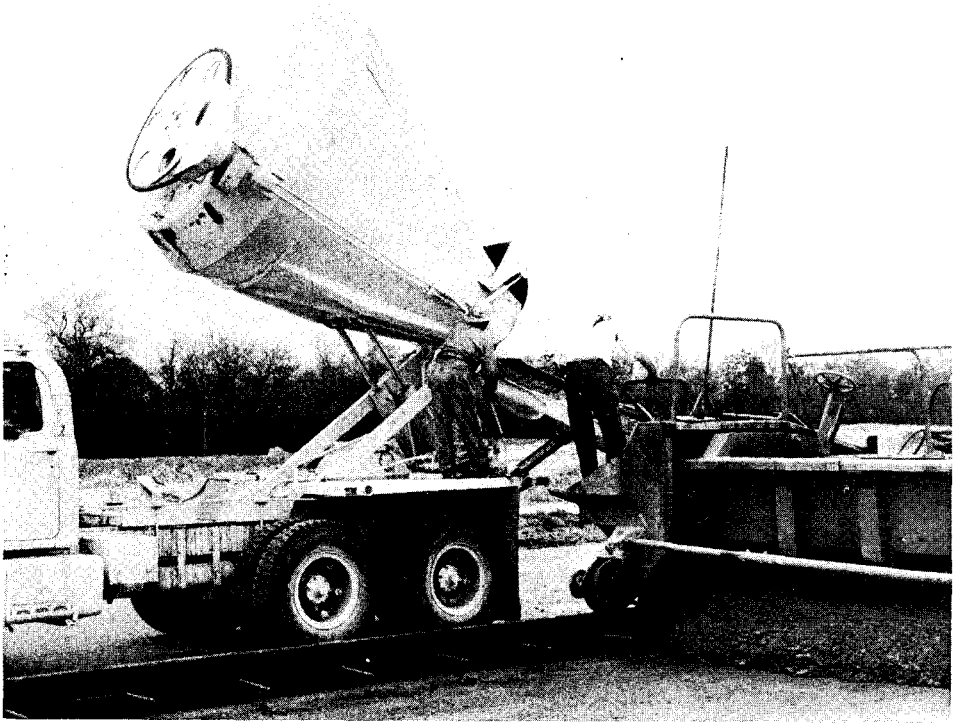


AUTOCYCLE OPERATION
34-E *Twinbatch* PAVER

Simplicity of the drum interior, air control arrangement, transfer chute, and all operating functions are clearly illustrated by the diagrammatic presentation of the complete mixing controls. From the charging skip, it is easy to follow the batch through the Autocycle, to the boom bucket. All information is based on a specified one minute mixing time per batch. Adjustments can easily be made for changes in the mixing time specifications. Positive split second control of all operations eliminates waste motion and lost time, for the shortest possible mixing Autocycle. Split second Autocycle control permits maximum number of batches on the grade. The Automatic operation can be interrupted at any time to permit manual operation.

DIAGRAMMATIC ILLUSTRATION OF MIXING CONTROLS
KOEHRING 34-E *Twinbatch* PAVER

4204G450



AGITATOR TRUCKS HAUL MIXED BATCH FROM CENTRAL MIXING PLANT

Figure 21.B

compliance with the specifications for the particular project. The timing device for measuring the mixing cycle is to be checked with a stop-watch.

The water measuring device should be checked by at least ten successive trials on each regulator "setting" used in the series for the check. Continuous operation, batch after batch, all day long, demands dependable and accurate measuring of the water to be mixed with each batch. If the water measuring device will operate within the specified tolerance for ten successive trials, then more confidence can be placed in the probable continued satisfactory repetition of this operation than if it had been checked by only two or three successive measurements. The series of trial-measurements should always begin with that regulator setting at which it is fixed when encountered for the check, and should

comprise at least that range between 25 and 45 gallons, (both inclusive), by 5 gallon increments. The dispensed water can be checked for accuracy either by measuring it in a proved-volume container, or by weight. When the check is to be made by weight, (Figure 22) the accuracy of the scales must be established first. This is accomplished by check-weighing

(Figure 22)

50-lb. test weights, sufficient in number to equal the largest amount of water to be checked.

Later, on the job, when alternate too-wet and too-dry batches may be discharged from the mixer, the failure of the water measuring mechanism to supply the "selected" volume

of water to the batch can be the cause of this difficulty. Even though a thorough and satisfactory check, as set out above, has been made recently (within the past week) and the inspector may have justifiable confidence in the accuracy of the volume of mixing water being added, rust and scale fragments from water pipes or water tanks, or sand grains (even as large as small pebbles) and other foreign particles can gradually or instantaneously get into the water system to prevent valves from closing or gaskets from sealing completely and thereby be the cause of the failure of the system to function properly.

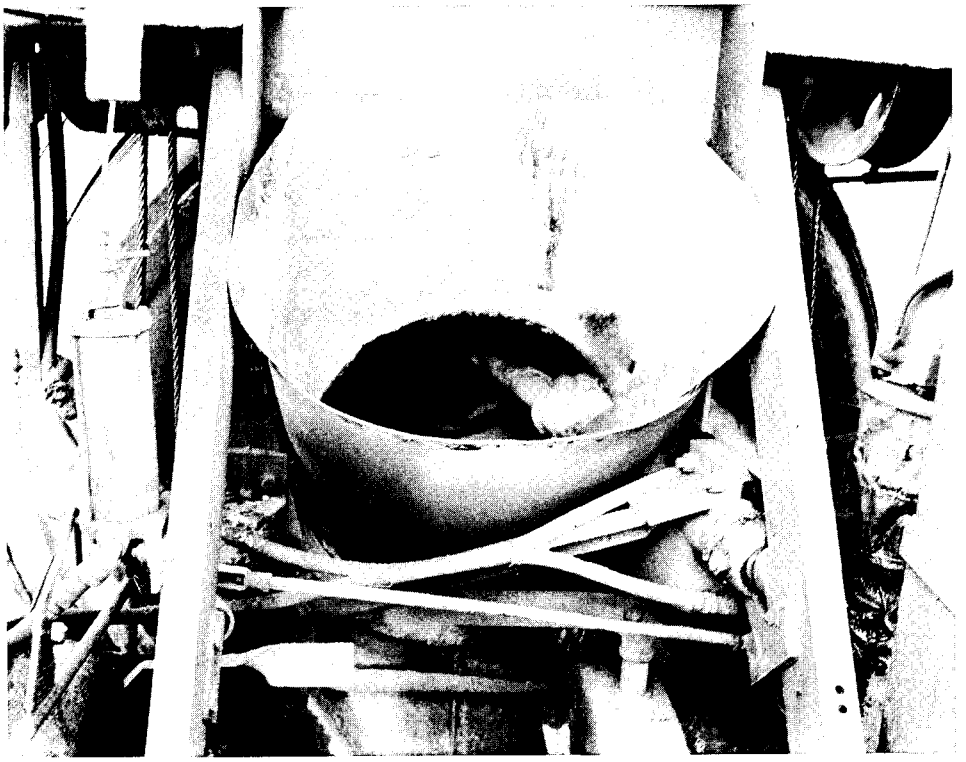
There are also other conditions which may exist and which can, and often do, contribute to, or directly cause, this fluctuation in consistency They should also be considered and looked into, at least, before reaching a definite conclusion that the water measuring mechanism is "off". Some of these averse conditions are:

1. Batch truck compartments too small to adequately contain the batch-or improperly loaded - so that a portion of one or more batches spills over into the one being dumped into the "skip".
2. Failure of the entire batch to "shed" out of the truck bed.
3. Failure of the entire batch to get into the mixer "skip" because of negligence or because of conditions under which the trucks are forced to operate.

4. Failure of the entire batch to "shed" out of, or be emptied from the "skip" into the mixer drum.
5. Mixing "cycle" regulator mechanism not allowing sufficient time interval to permit the discharge of all the selected volume of water.
6. Crane operator at the batching plant handling the materials in a careless or negligent manner - spilling one material into the other's bin or contamination by some other means.
7. Improper handling of the Stock pile, causing Segregation and resulting change in characteristics of materials.
8. Aggregate portions of the batch not being proportioned properly; scales out of adjustment by accident or intent, trucks carelessly "spotted" for loading.
9. Dumping rejected or "left-over" batches on the Coarse aggregate stockpile and attempting to incorporate them with the stockpile.
10. Cement portion of the batch not uniform - scales not operating - or operated - properly.

Since the use of entrained air is now permitted,

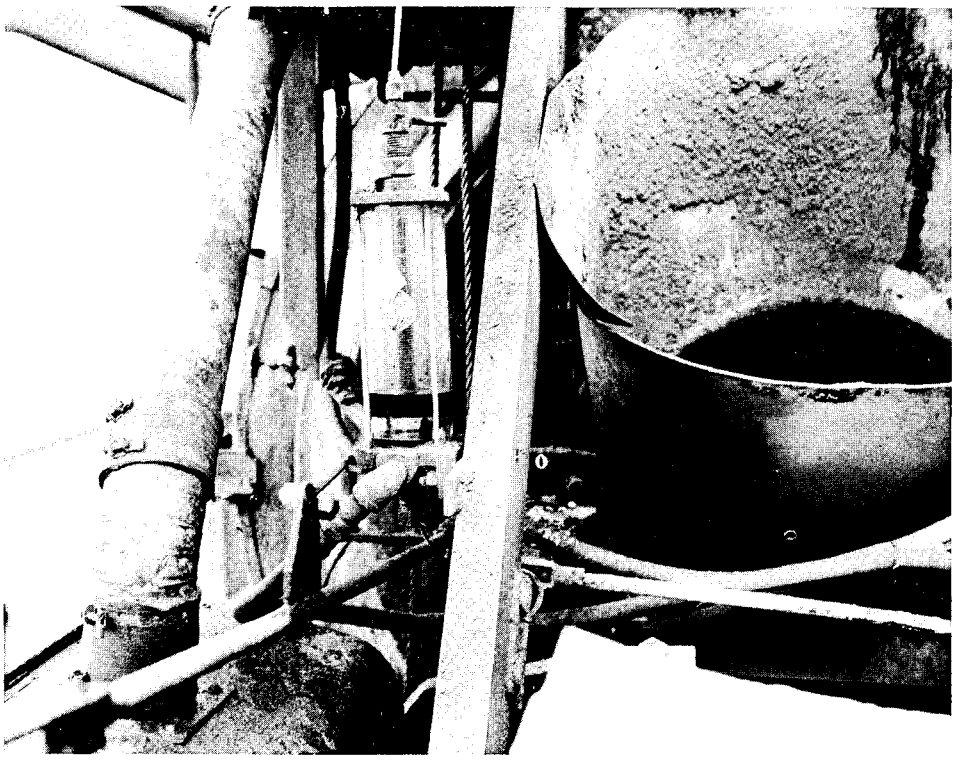
where it is needed, and is specified in some instances, most contractors have mounted dispensers for the air-entraining agents on their mixers. (Figure 23)



(Figure 23)

When this equipment is to be used, it must be checked for accurate measurement of the additive and for positive introduction into the batch, perferably along with the "charge" of mixing water. It has been customary to check the accuracy of measurement by discharging the increment measured by the dispenser, into a baby's milk-feeding bottle which is graduated in liquid ounces. For positive delivery to the batch, the lines, or tubes, connecting the dispenser to the mixer drum or to the water chute will have

to be checked frequently for clear passage. Accuracy of the measurement should be checked at 3 or 4 different "settings" before use. Because of the natural inclination of the liquid air-entraining agent to "gum-up", causing a consequent, progressive, lowering of the amount discharged, the system must be watched very closely to assure that it is operating satisfactorily. It must be cleaned-off (Figure 24) often enough that the inspector can determine visually, through the day, that the liquid is being measured and dispensed properly.



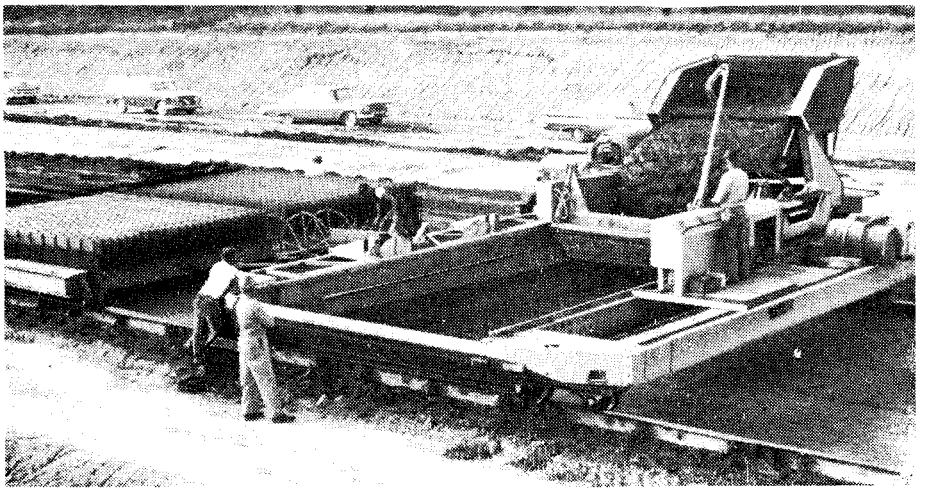
(Figure 24)

Placing: Concrete should be deposited on the subgrade in such a manner that it requires a minimum of

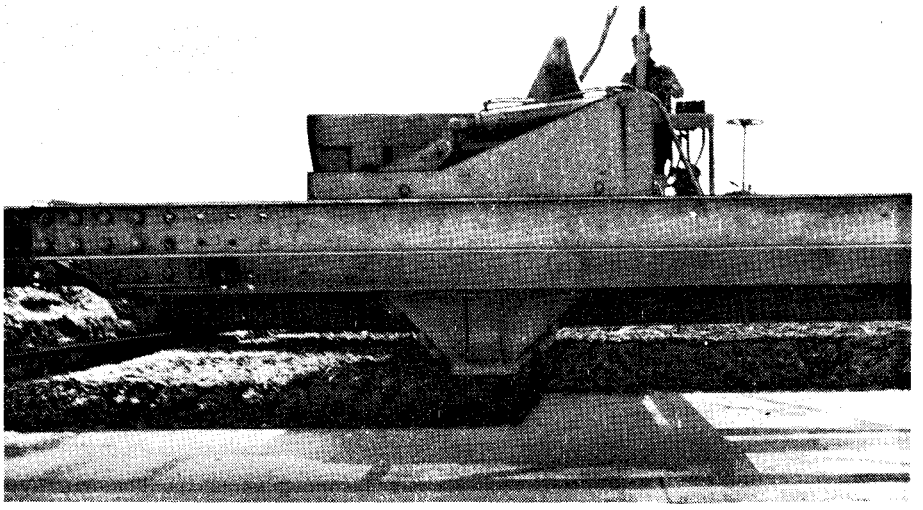
redistribution. The even distribution of concrete on the grade, or on each course, is a very important step toward a smooth-riding job. The most even distribution in the initial placing will result in a minimum variation in final settlement of the surface. If concrete is deposited in "piles or windows," unequal consolidation is likely to take place. This may never be overcome throughout the entire finishing procedure and can be the cause of unequal settlement and rough surfaces developing later, after the finishing has been completed.[3]

Mechanical concrete spreaders are of at least three different types. One is made to receive the entire batch, at or near the form line, in a box or hopper, (Figure V) and to spread the concrete as the hopper travels laterally across to the other form line. (Figure VI) This type is used with the central-mix type of "set-up" and will likely be a thing of the not-too-distant future for most of us. The other two, the "auger-type" (sometimes called the "screw-type") (Figure 25) and the "paddle-type" (sometimes called the "plow-type") (Figure 26) are fairly common, especially on projects where wire-mesh reinforcing is used.

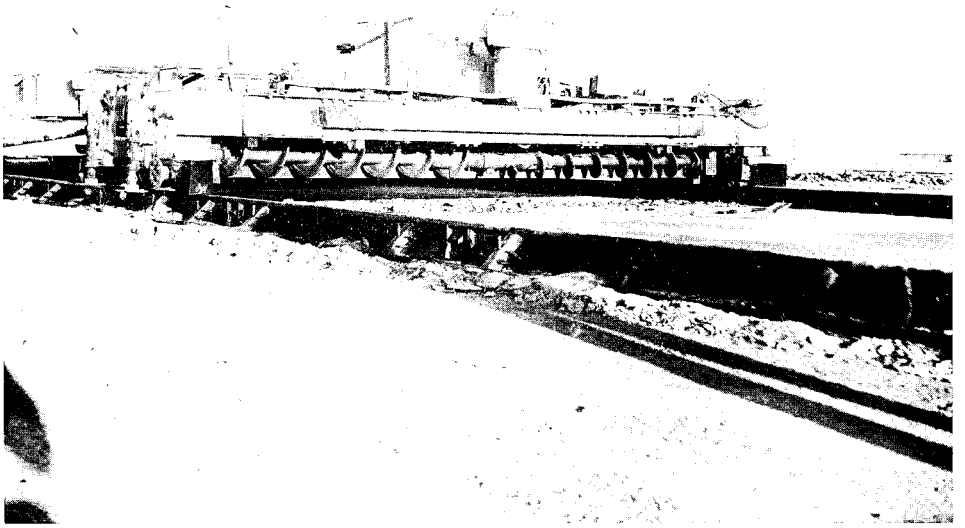
The auger type is the more versatile of the two in that it can spread either toward the forms or away from them, or from either side to the other. It can be set to strike-off at one level when making the first "pass" and to strike-off at a higher (selective) level on a subsequent



(Figure V)



(Figure VI)



(Figure 25)

INSTALLING $\frac{1}{2}$" TIE-BARS IN LONGITUDINAL "CENTER" JOINT

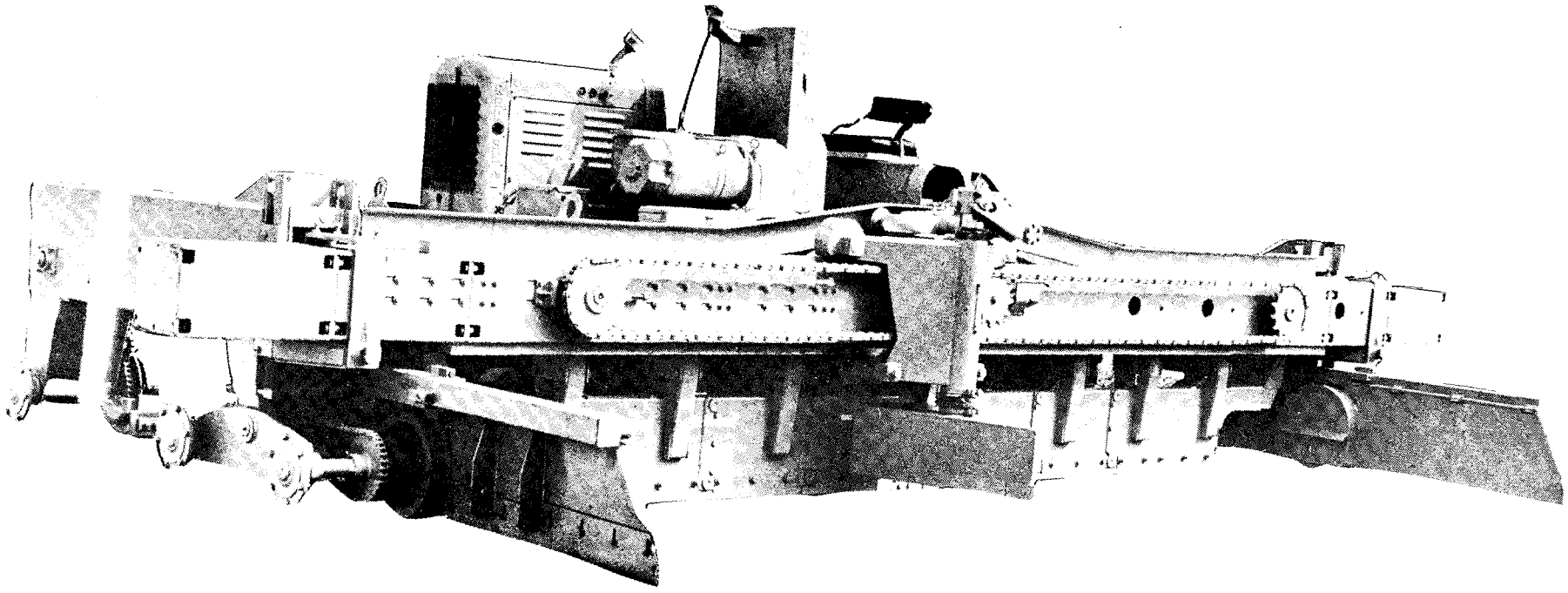
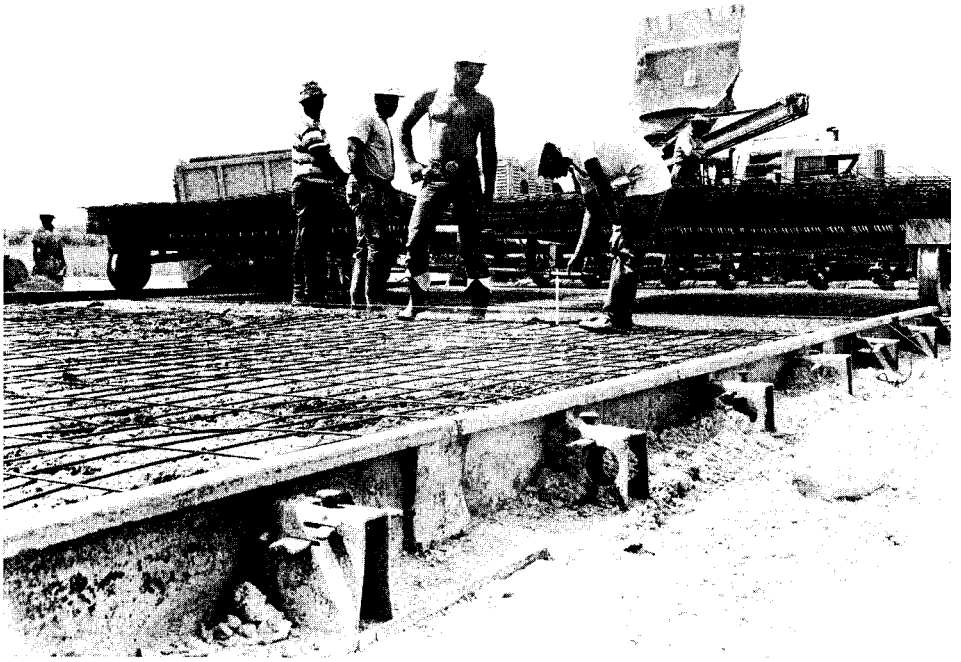


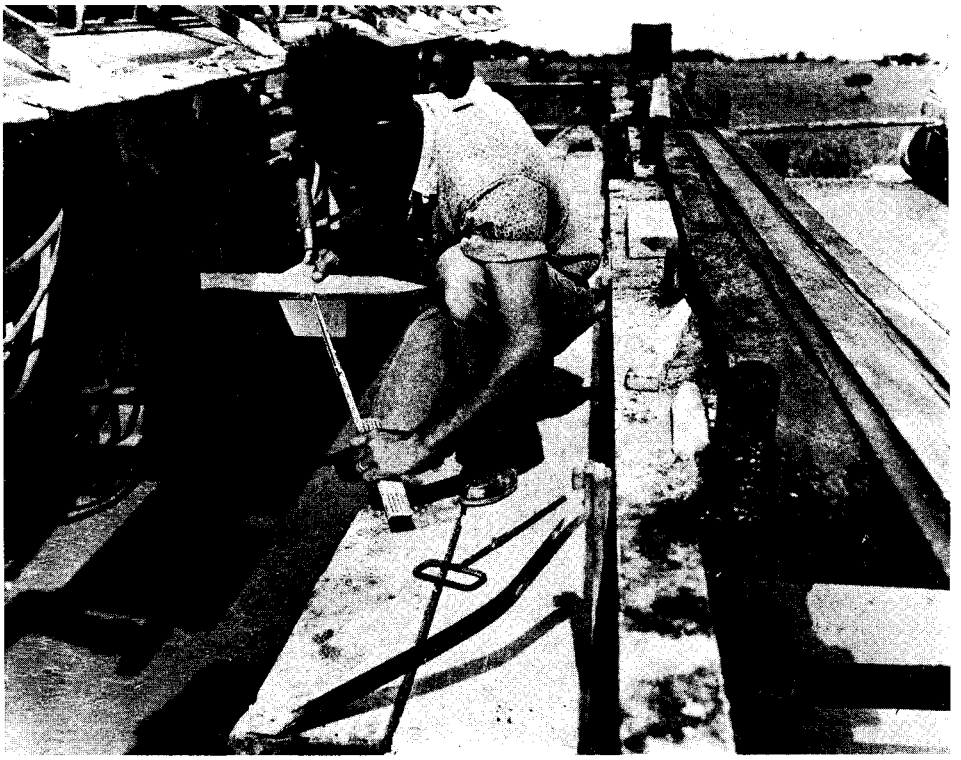
Figure 26

pass. It exerts no "thrust" on the forms; instead there is more of a steady push outward, or pull inward depending on whether the concrete is being moved toward or away from the form line. In the case of the installation of wire-mesh, this type spreader can strike-off the concrete at the proper elevation for the installation of the mesh, (Figure 27 & 27-A)

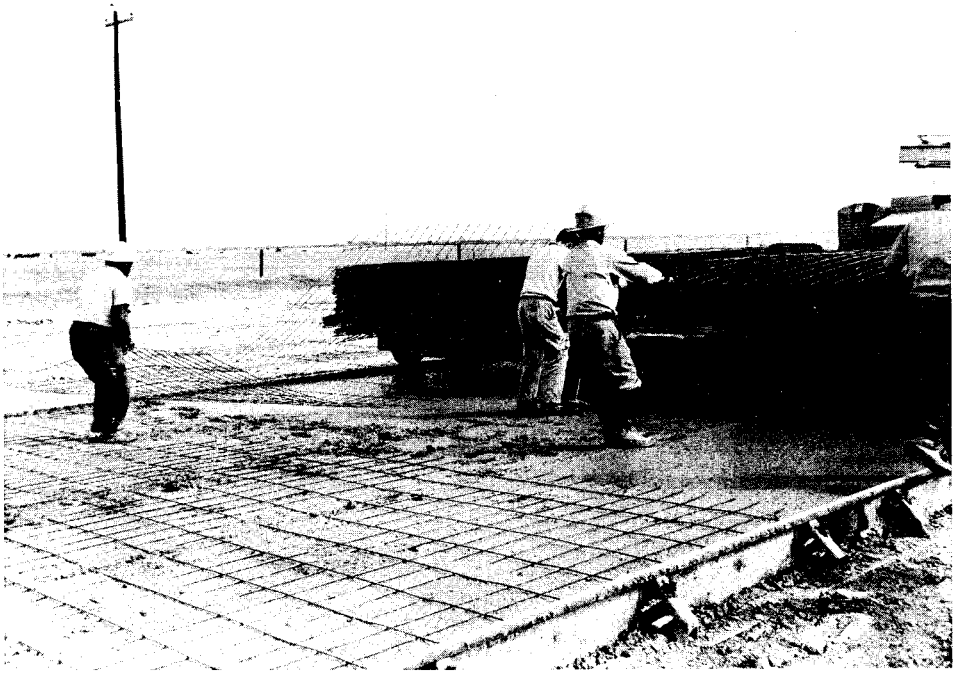


(Figure 27)

and then can be backed-up and strike-off the top layer at the proper elevation for the finishing machine to operate efficiently. However, if the spreader pulls a conveyance for carrying the wire-mesh mats, (Figures 27 & 28) then this feature is nullified somewhat because in this case, it cannot be moved backward without some difficulty.



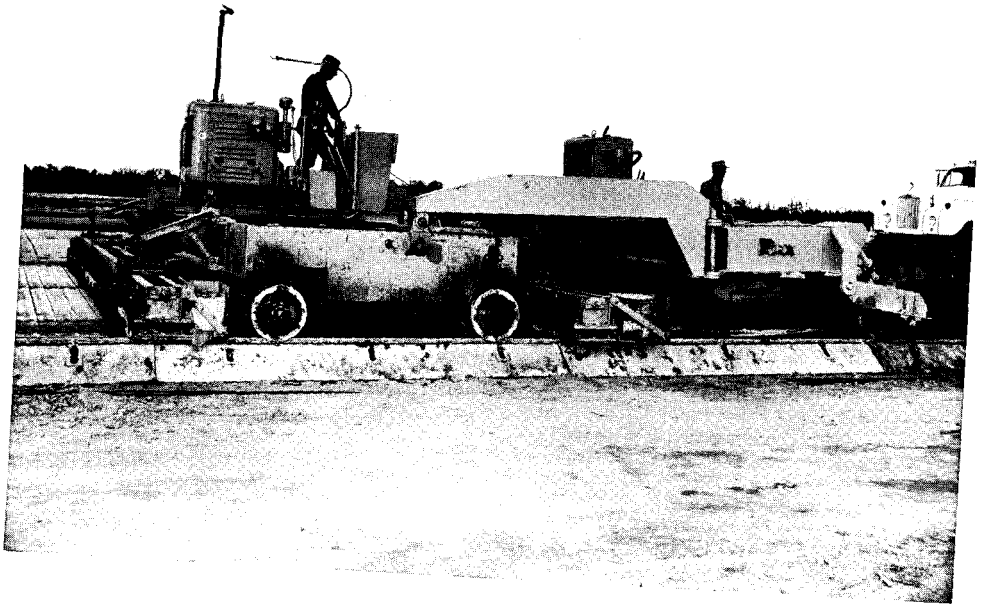
(Figure 27-A)

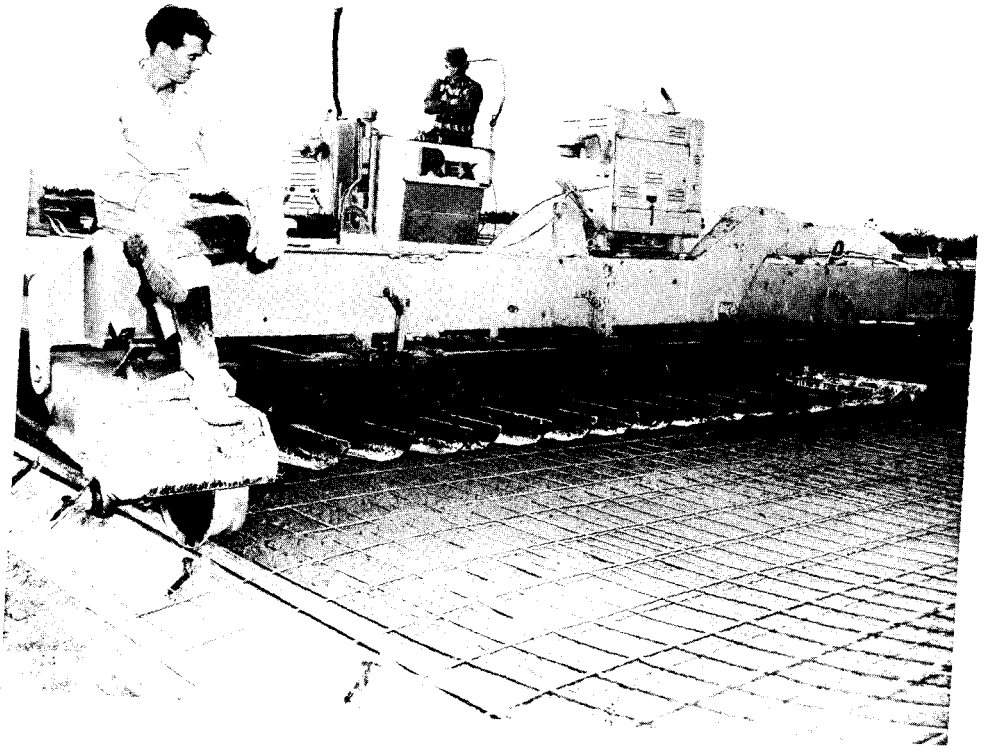


(Figure 28)

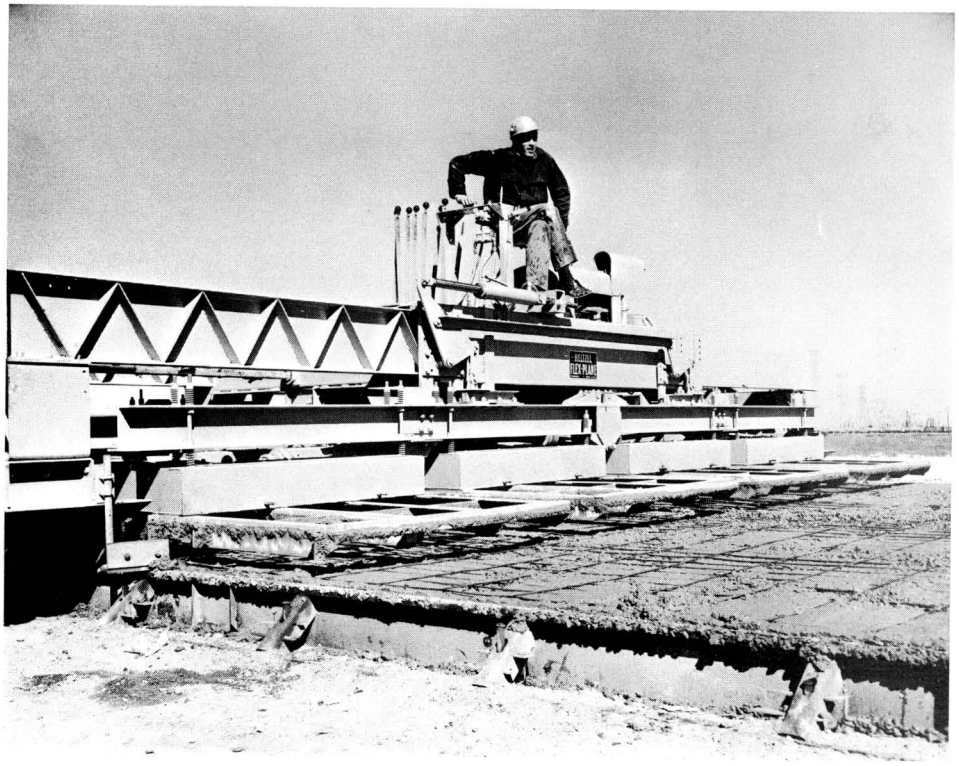
Currently making its appearance on some of our projects, is a machine (Figure 29,29-A,29-B and 29-C) which will install this wire-mesh without the necessity of placing the concrete in two "passes", as has been the custom so far. The advantages of such an installation are quite obvious and such a machine is more than likely to become standard equipment for wire-mesh installation at an early date.(Figures 29-D & E)

The paddle type can also be used to strike-off two different "levels", or elevations, but will only spread the concrete in the wake of the paddle while it moves traversely from one form line to the other as the machine moves forward. The "thrust" of this machine is very strenuous on the form line and considerably more attention has to be directed to the maintenance of the form line where this type spreader is used. Dry, or low-slump concrete increases this strain on the forms and this is one more reason why it is important to maintain a constant batch-consistency. If the mixer operator will distribute the concrete with some semblance of uniformity over the subgrade ahead of the spreader, the resultant consolidation of the concrete throughout the entire slab will be more nearly uniform and a substantial contribution will be made toward the achievement of the smooth riding surface being sought. In addition the form line will be relieved of unnecessary strain and the construction team will be relieved of all the related complications. Concrete should be deposited on the subgrade in such a manner that it requires a minimum of redistribution. Simply because the spreader is a big and

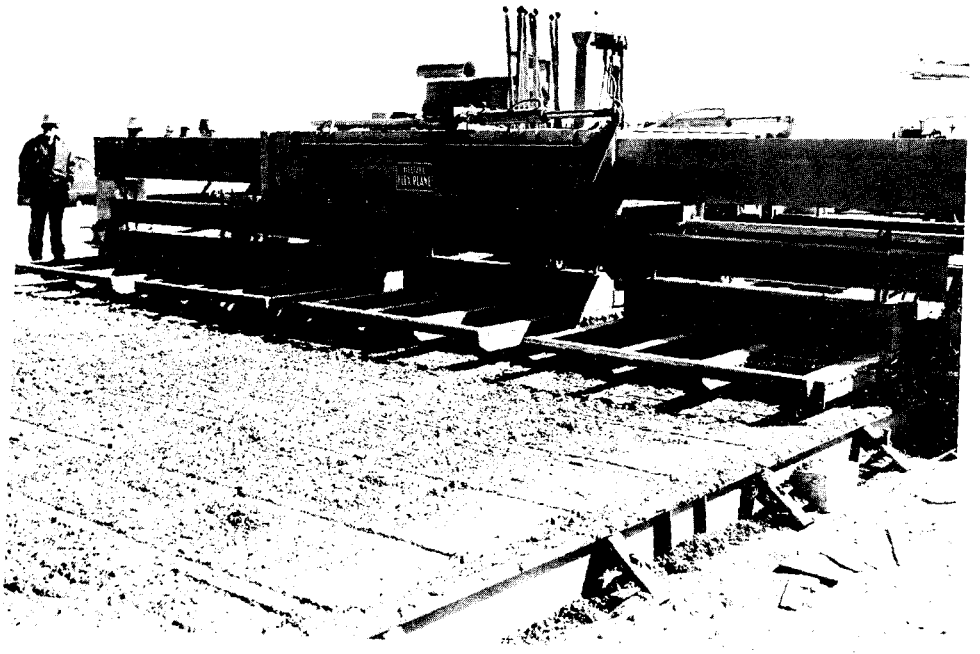



REX

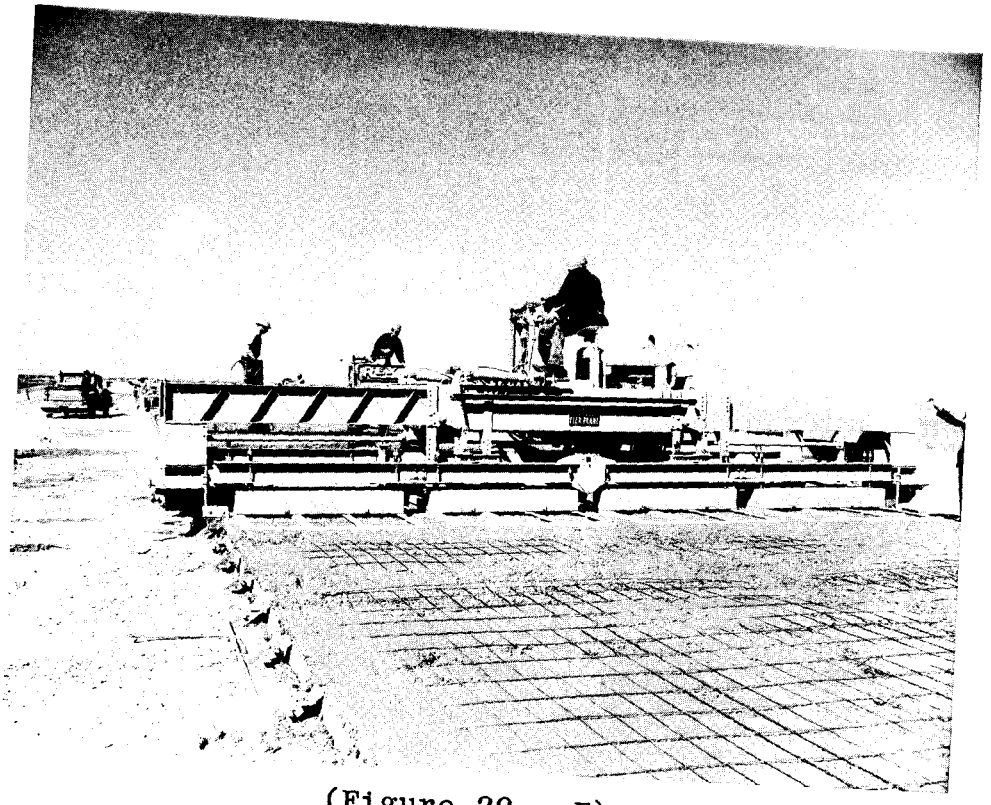
(Figure 29-B)



(Figure 29-C)



(Figure 29 - D)



(Figure 29 - E)

powerful piece of the equipment which will handle heavy accumulations of concrete is no reason to permit improper distribution by the mixer operator. Where a large mass of concrete is pushed and rolled along, segregation is invited and most probably will occur.[3] Uniformity in the placing of the concrete cannot be over-emphasized.

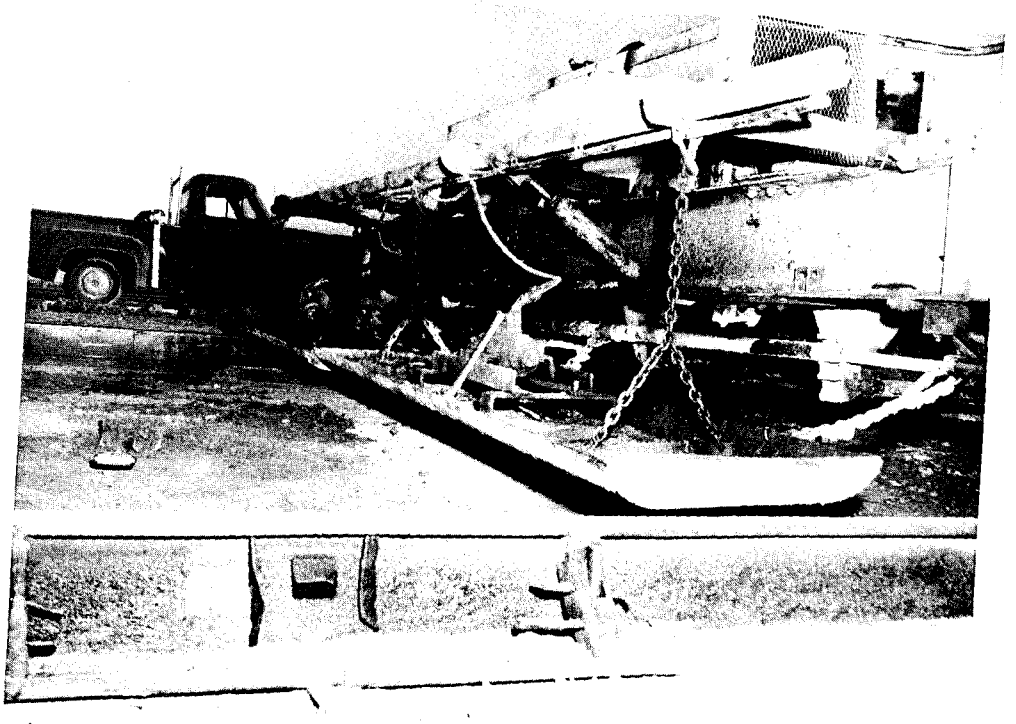
Just behind the screw or plow-distributor, the spreader is equipped with a "strike-off". The height of both the distributor and the strike-off is adjustable, and, before starting a project, the strike-off should be positioned with the ends level with the top of the forms to check the gauge reading. At this elevation, it should read "0" (zero). If it does not, the gauge should be adjusted so that it does.[2] The strike-off and the distributor have separate controls. The distributor should be set about one inch higher than the strike-off. The ease and success of the finishing operations are dependent to a considerable extent on the uniformity in the amount of concrete left behind the spreader. This, in turn, is largely dependent on the skill of the spreader operator and his judgment of the strike-off elevation necessary to satisfy the requirements of the subsequent placing and finishing operations. The purpose of the spreader is to leave the proper amount of concrete for the subsequent finishing operation uniformly distributed for the full form width of the placement.

If the mix is harsh and stiff, it will be inclined to "pull" and "tear", and, under this condition, the strike-

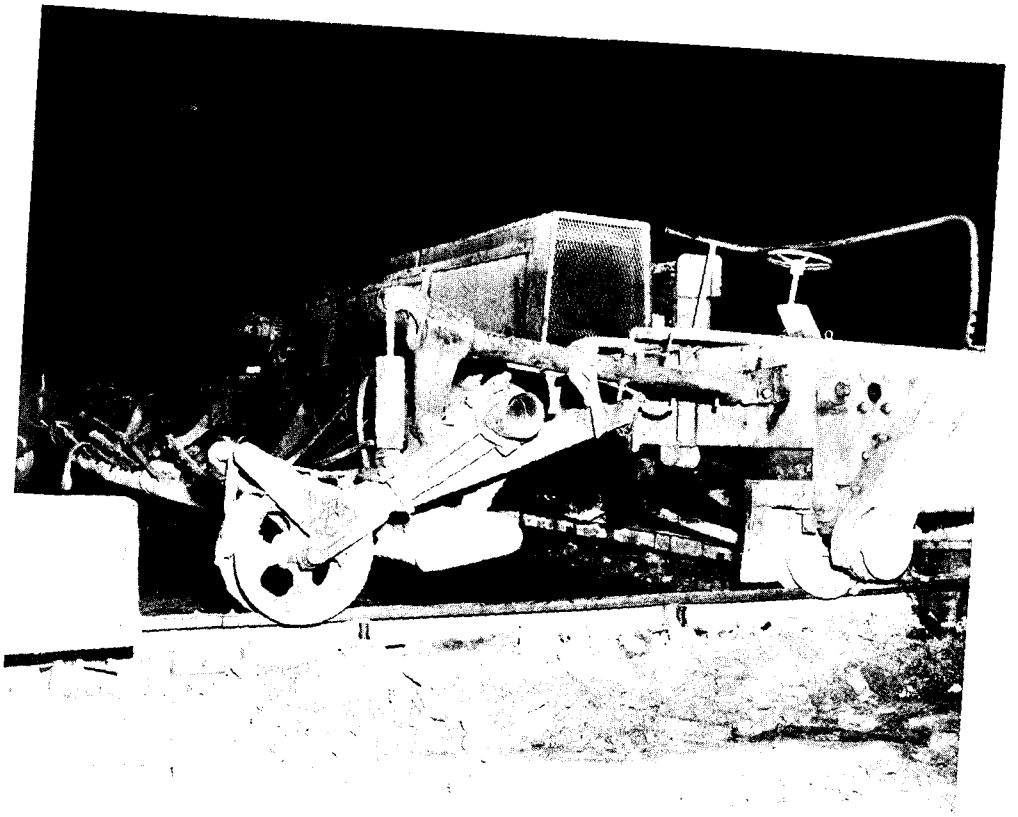
off should be set higher than for a more fluid or sandy mix which tends to "surge" under the strike-off.

Attached to the spreader and behind the strike-off, a vibrator is mounted. In District 12, pan-type vibrators (Figures 30 and 30-A) are preferred. One is also mounted behind the rear screed of the finishing machine. It is important that the vibrators be operated only when the attached machine is in forward motion. An automatic cut-off to insure this effect is recommended. Concrete should not be spread over dowel-bar joint-assemblies by either the mixer bucket or the mechanical spreader, but should be placed around the dowel bars by hand, with shovels, and vibrated carefully and sparingly with a probe-type vibrator, to insure the installation of the dowels in correct horizontal and linear alignment and with the elimination of "honey-comb". The probe vibrator should be inserted only momentarily and vertically between each dowel and positively without touching the dowel bar.

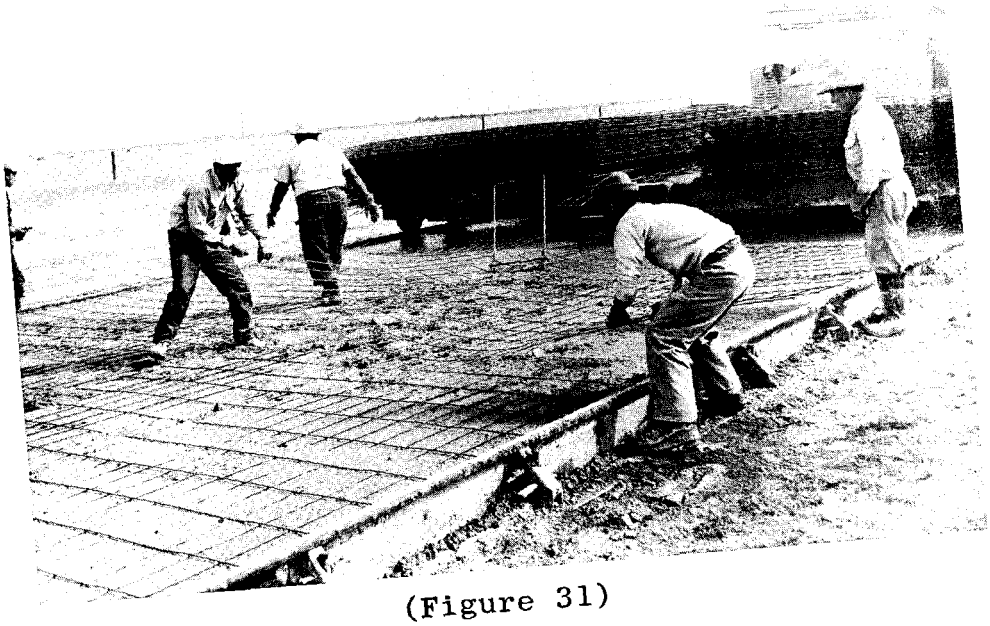
Where wire mesh reinforcing is used, the concrete is now being placed in two courses, or layers, and two mixers are generally required. The mesh is installed by hand on top of the bottom course, behind the spreader. (Figure 31) The top course, or layer, is usually spread by the mixer operator, using the "bucket" on the "boom" at the rear of the mixer. (Figure 32) In this instance, the concrete placing is completed in front of the finishing machine by hand labor. These laborers are commonly called "mud-cutters:"



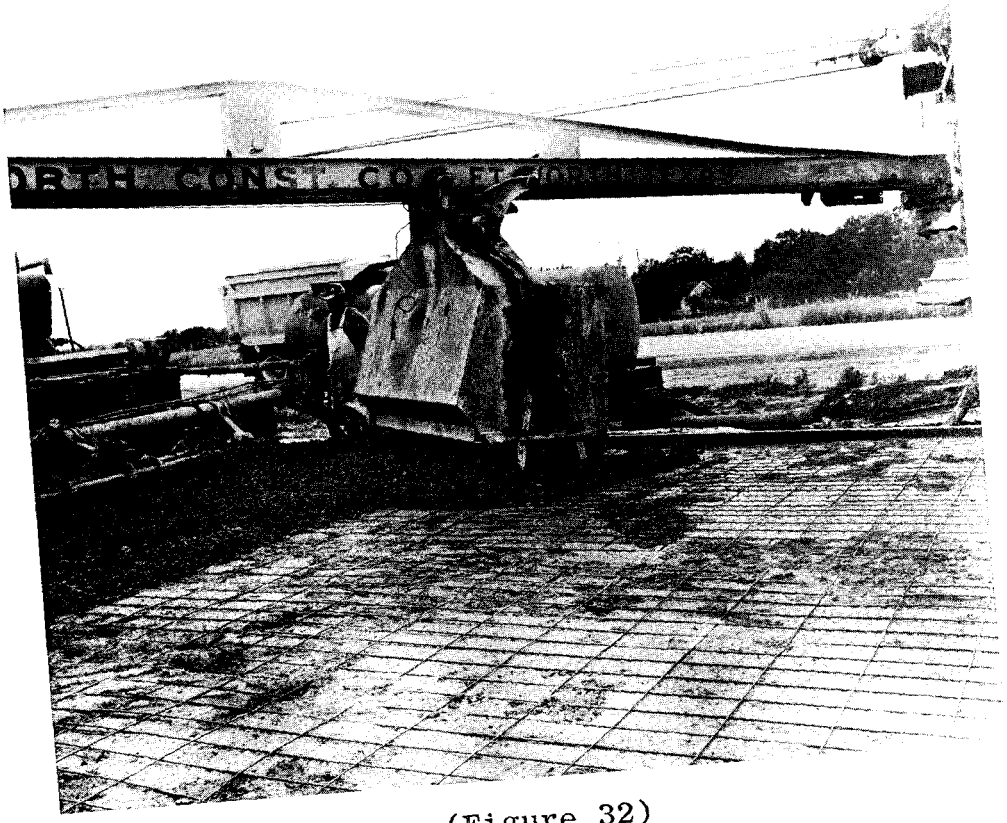
(Figure 30)



(Figure 30-A)



(Figure 31)

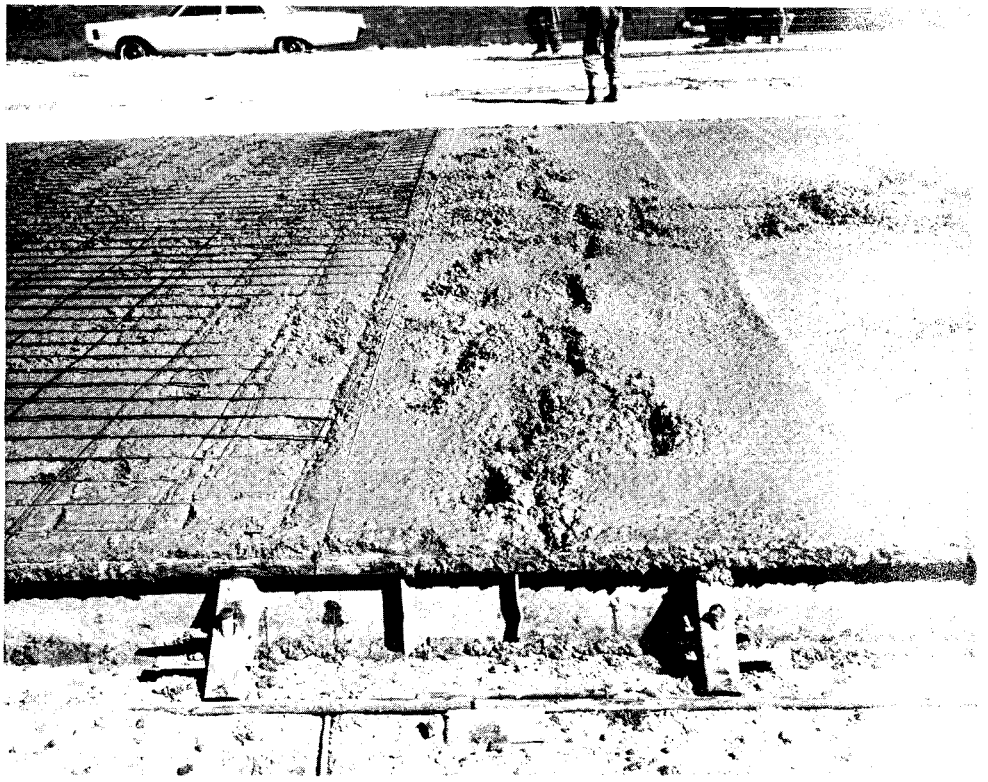


(Figure 32)

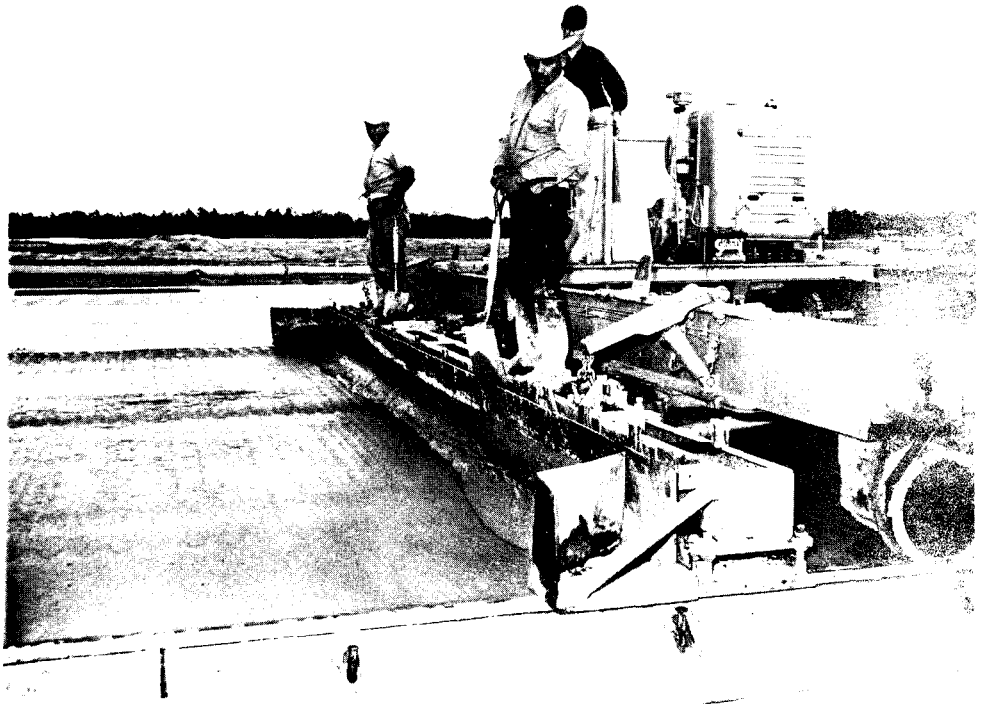
and they perform the work on the top layer that the mechanical spreader did on the bottom (which was about twice the thickness of the top one). Considerable attention, patience and training is required to "break-in" a new man on this job. Far more than merely shoveling concrete is involved. Skill and ability in this operation is also important in accomplishing the ultimate objective. Enough care should be exercised to assure that reinforcing steel is not misplaced. After the concrete has once been spread, walking through it should be discouraged and kept to a minimum. Every effort should be made to eliminate any condition or to preclude so far as possible, any situation which creates, or in any way contributes to this objectionable practice. However, there is often present some condition or method of operation that makes such practice seem unavoidable. In such cases, the "tracks" (Figure 33) are not to be filled with "slush" nor mortar skimmed off the top of the slab (Figure 33-A), but with "whole", well-graded concrete.

When the placing of concrete is stopped, whether intentionally or not, a bulkhead, commonly referred to as a "header", is installed to form a neat end to the placement. /Item 360.6 (5)/ Although no minimum distance is specified, it has become common practice, and is considered good engineering, to place the header at least ten feet away from the nearest contraction joint, so that no "slab" will be less than ten feet long.

The header is "set" using a tight string line as a guide, perpendicular to the centerline of the placement, vertical to the subgrade, and with its top slightly (about 1/8") below the line of the surface of the pavement to prevent displacement by the screeds. As the longitudinal float approaches the header, stop



(Figure 33)



(Figure 33-A)

the forward movement of the machine with the screed just-short-of the header, and operate the screed "straight-across" the slab. Then, pick up the screed, move the machine forward until about $\frac{1}{4}$ the screed length extends beyond the header. Lower the screed and again operate it straight-across without forward motion. Finishing machine screeds should also be stopped just-short-of the header and leave the final finishing to the straight edges. (Figure 33-B). Take special care to keep the dowels in proper horizontal and linear alignment.

(Figure 33-B)

4. FINISHING AND CURING:

The finishing and curing operations are in some respects the most difficult of all to accomplish. They are radically affected by the following variables, at least:

1. - The weather

2. - The density and smoothness of the base

3. - The mix design

4. - The uniformity of the batch

5. - The production-rate (when not synchronized with the capacity of the slowest machine of the "train").

For these reasons it is practically impossible to insure good construction practice by referring to specifications and instruction manuals alone. The construction team must rely on their experience and their knowledge of the presence - and the effect - of these variables, to direct the operations in a manner that will produce the desired results. The objective of these operations is to consolidate the plastic concrete into a slab of uniformly high density without segregation, with the surface smoothed true to line, grade and cross-section, properly jointed, and with a continuity of horizontal line that will produce the desired riding surface. [I]

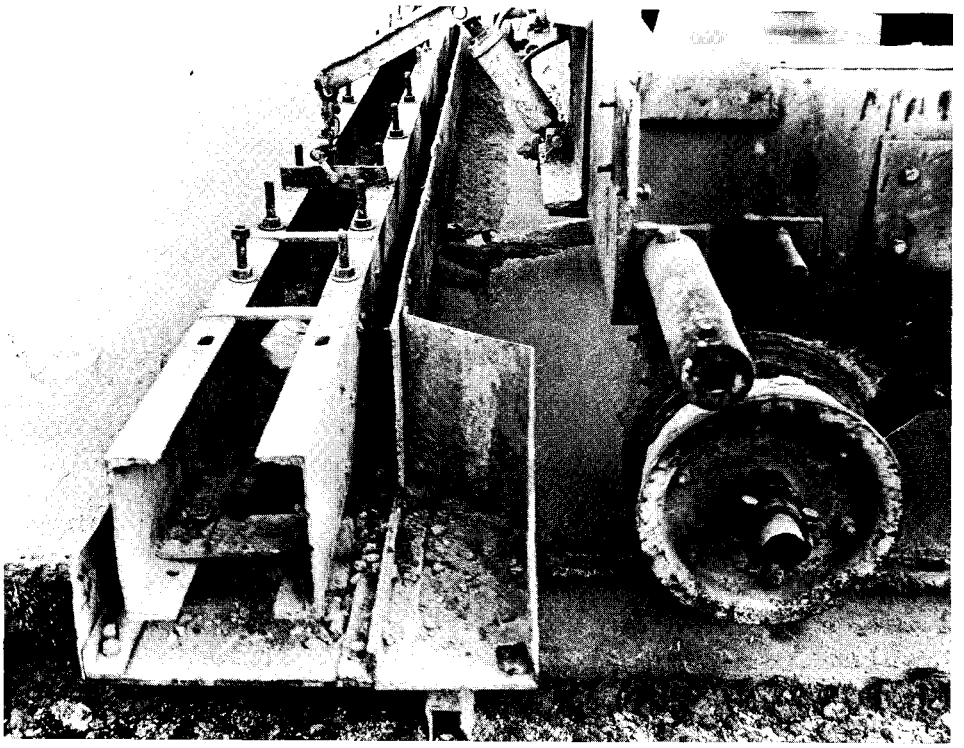
The finishing machine is the next piece of equipment in the train of machinery. Its purpose and function is to consolidate the plastic concrete and give it the proper shape by transverse screeding or "striking-off". When properly performed, this operation will leave the surface close to the final grade and with the specified cross-section, or "crown surface".

The finishing machine is equipped with two adjustable screeds (one front and one rear) which have an opposing, laterally reciprocating movement as the machine itself moves forward on the forms. As mentioned above, a pan-type vibrator

attached behind the rear screed. Before paving operations are begun, the alignment of the bottom of these screeds must be checked and set to conform to the specified shape of the surface of the slab. There are three types of screeds.

(1). Having a single row of adjusting studs, uniformly spaced along the middle and for the length of the screed "beam."

(2). Having two rows of adjusting studs uniformly spaced one along the front and one along the back edge of the screed beam, opposite each other in pairs, for the length of the screed "beam". (Figures34) Some of these have two pairs of adjusting studs over the "shoes" and some of them have only one pair. Two pairs afford better control and the second pair should be added to screeds that are not so equipped.



(Figure 34)

(3). The "quick-crown-change" type on later model machines also has two rows of

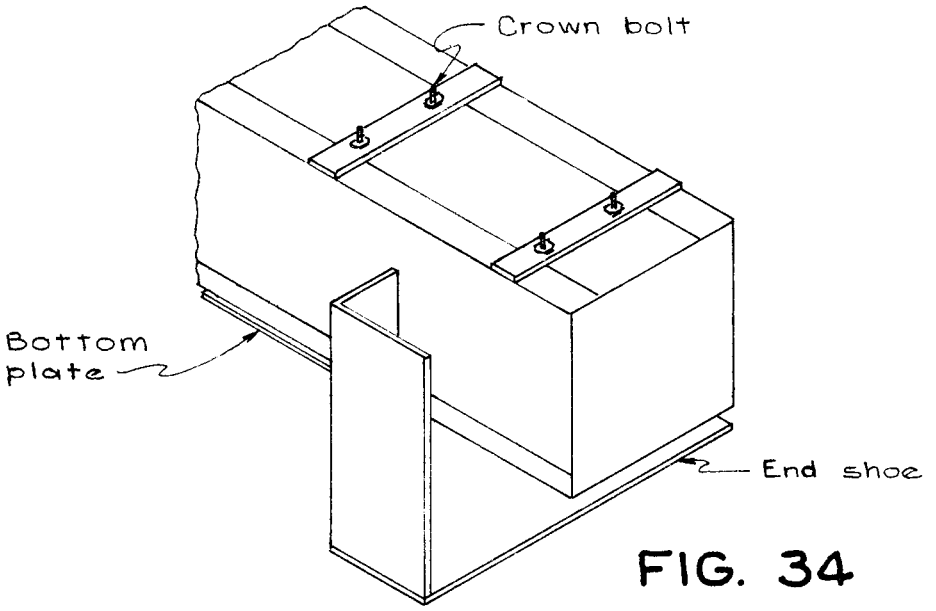


FIG. 34

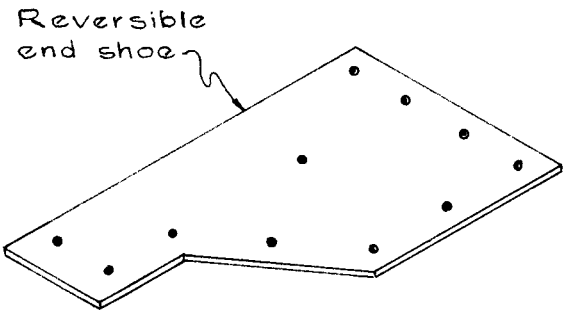


FIG. 34-A

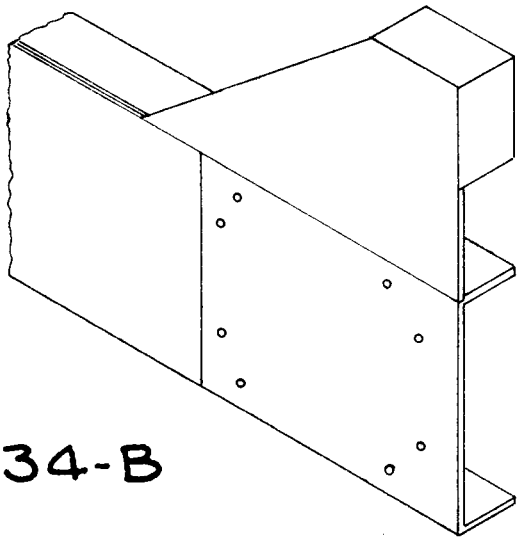
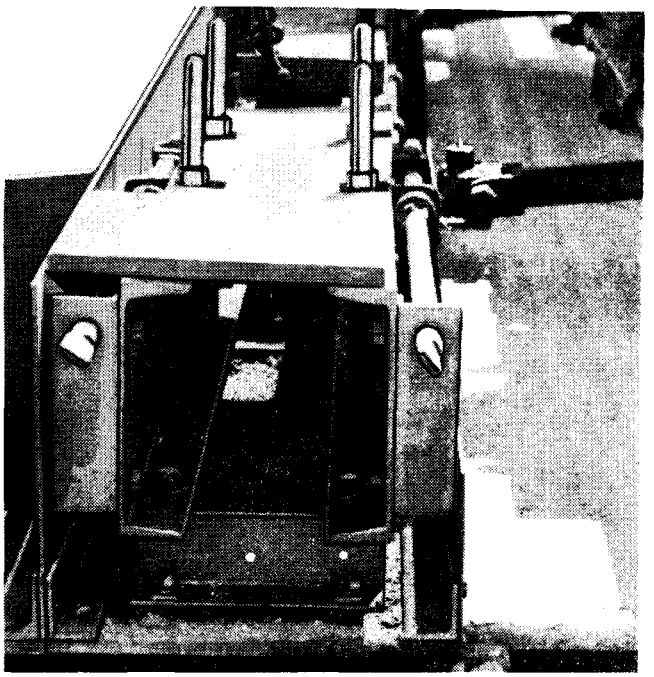


FIG. 34-B

adjusting studs as in (2), above.(Figure 35)



(Figure 35)

In addition it has a single adjustment controlled from one end of the screed (Figure 36) which is designed to change the shape of the entire length of the screed bottom uniformly and simultaneously. (Figure 36-A)This quick change feature is especially advantageous in the transition from crowned section to flat or straight-slope and vice versa.

Generally, the front edge of the front screed, at least, should be tilted slightly upward. The requirement for tilt varies with the grade-line, whether paving up-hill or down-hill, and with the consistency of the batch, and will be discussed more in detail a little farther on.

All screeds have a reversible and replacable bottom

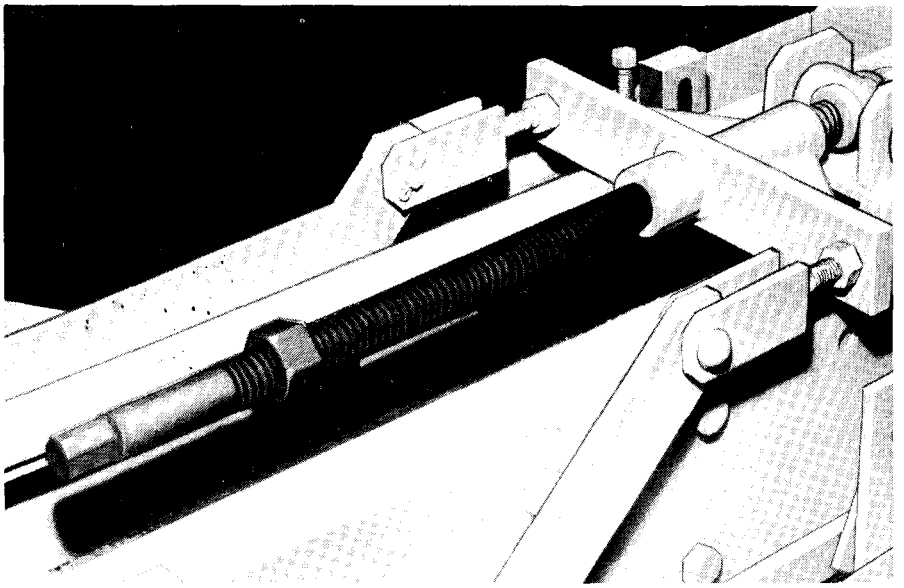


Figure 36

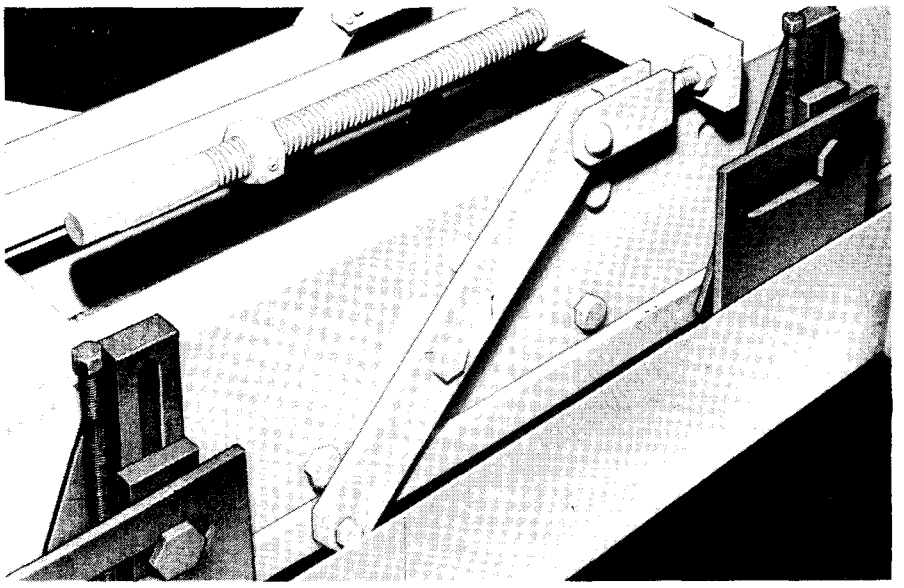
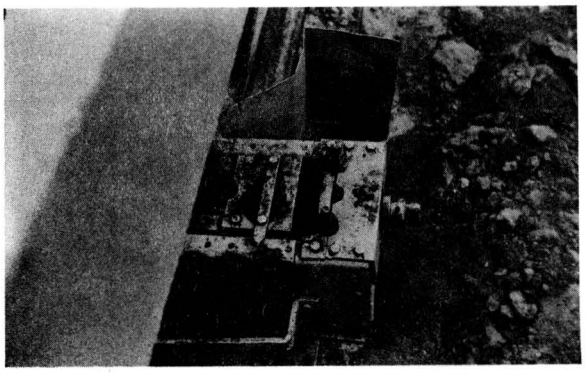
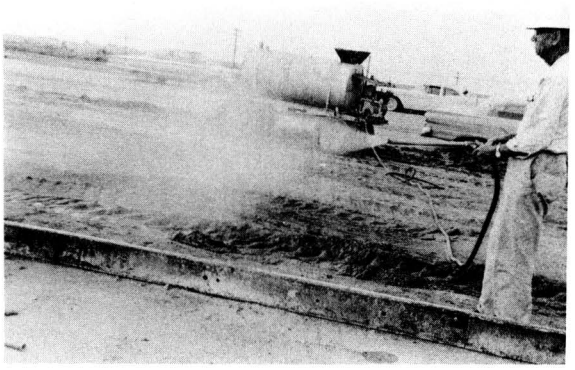


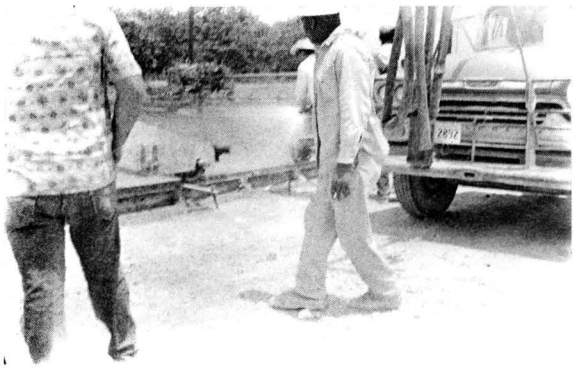
Figure 36-A

CHECKING ACCURACY OF AIR-ENTRAINING DISPENSER (p. 40)

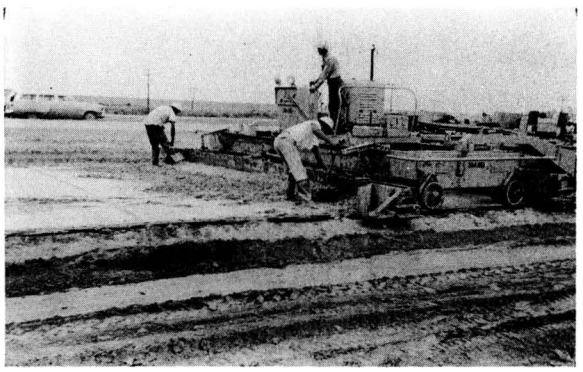


ONE OF THE QUICK-set SCREED CONTROLS (p. 61)

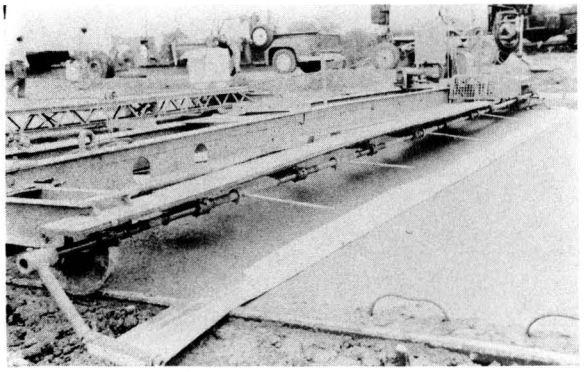




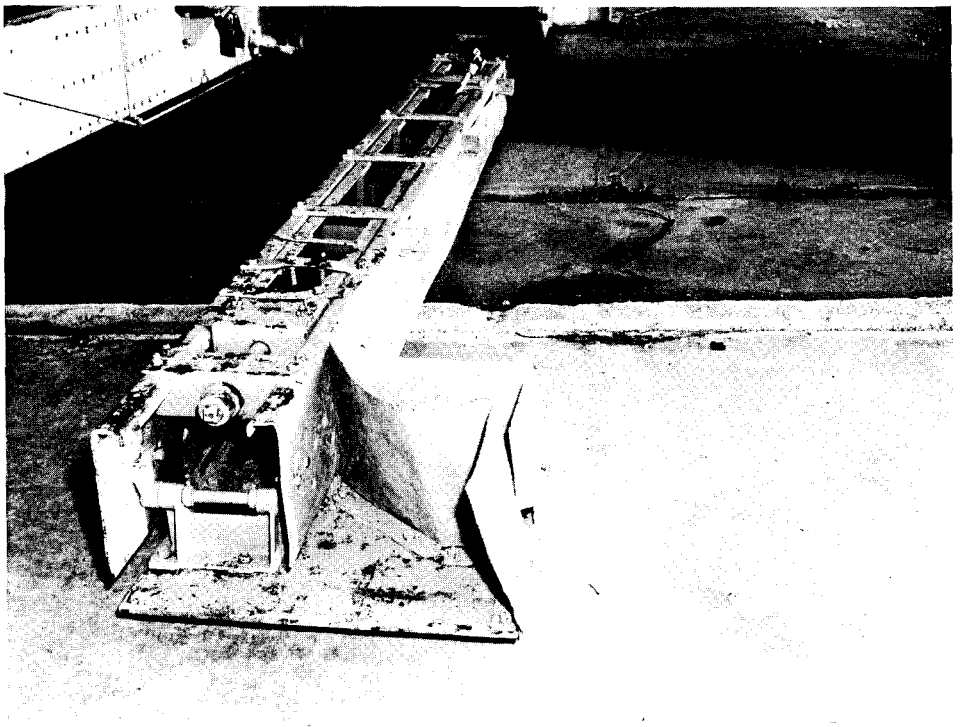
APPLY ANY ADDITIONAL WATER NECESSARY FOR FINISHING BY SPRAYING (p. 100)



PROPER ATTENTION TO SCREED ENDS AT FORM LINES (p. 74)



MECHANICAL BELTING MACHINE (p. 117 & 118)



(Figure 36-B)

end-section which is commonly called a "shoe" or wear plate. (Figure 34-A and 34-B) These "shoes", when turned bottom-side-up will fit on the opposite end of the screed.

Adjustments: The function of the adjusting studs mentioned above, is to move the contact surface (bottom) of the screed, up or down, at the stud, so that the shape of the screed bottom can be made to conform to the shape of the pavement surface specified for the particular slab.

The position of the screed bottom governs its performance. A flat screed "cuts" while a tilted screed "irons" or tends to "float". Keeping this in mind, the necessary adjustments can be made to accomplish the desired effect in almost any machine-finishing situation likely to be encountered. Remember also that greater compaction is attained with a tilted screed.

Before paving operations begin - and oftentimes during the progress of the job - when changes, major adjustments or checks are necessary - the screed's shape must be "set" (or changed) to conform to the specified surface-shape or cross-section of the pavement. In addition, adjustments must be made in tilt and screed height to allow the machine to give the concrete the desired finish as well as shape.

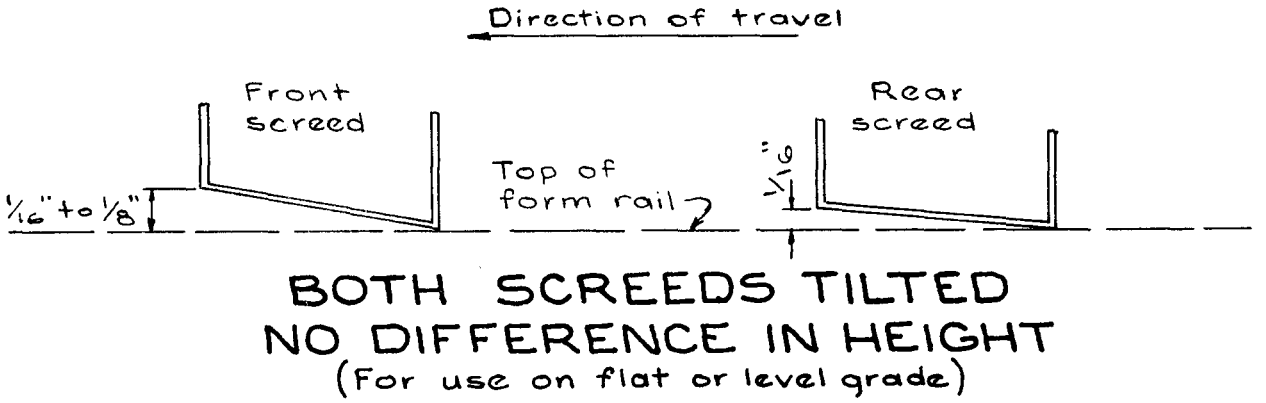
First, see that the wheels of the finishing machine are free of any hardened concrete, mud, or other "build-up", that the top of the rail is clean and true, and that the forms upon which it is setting have been satisfactorily lined, tamped, latched and keyed. Next, center the screed as to its lateral movement over the form lines and avoid positioning it over a joint in the forms.

The next step is to "balance the shoes" (or wear plates). If they have been used and are "hollowed-out" or worn down, where they have been rubbing on the forms, as much as one-eighth of an inch they are to be reversed, as previously mentioned. If both sides of the shoe are worn as much as 1/8", the shoes are to be replaced with new ones. To "balance the shoes", they must be adjusted so that the shoe sets flat on the rail when the screed is let down and allowed to rest freely on the rails. As mentioned above, some screeds have two pairs (four) of adjusting studs and some have only one pair over the wear plates. By means of these adjusting studs, set the shoes (or wear plates) so that they do set flat on the rail and are aligned to correspond

to their respective section of the crown, or slope of the specified surface, of the slab. Using an ordinary grade-stake (or something similar) as a "prybar" against the top of the rail, "feel" of the "load" on each of the four corners of the screed to determine if approximately the same resistance is detected at all four points. If the resistance does not seem to be equal, move that corner of the screed which seems light, or loose, down, by means of the corresponding adjusting stud and then check again making any necessary adjustments to equalize the load on all four corners.

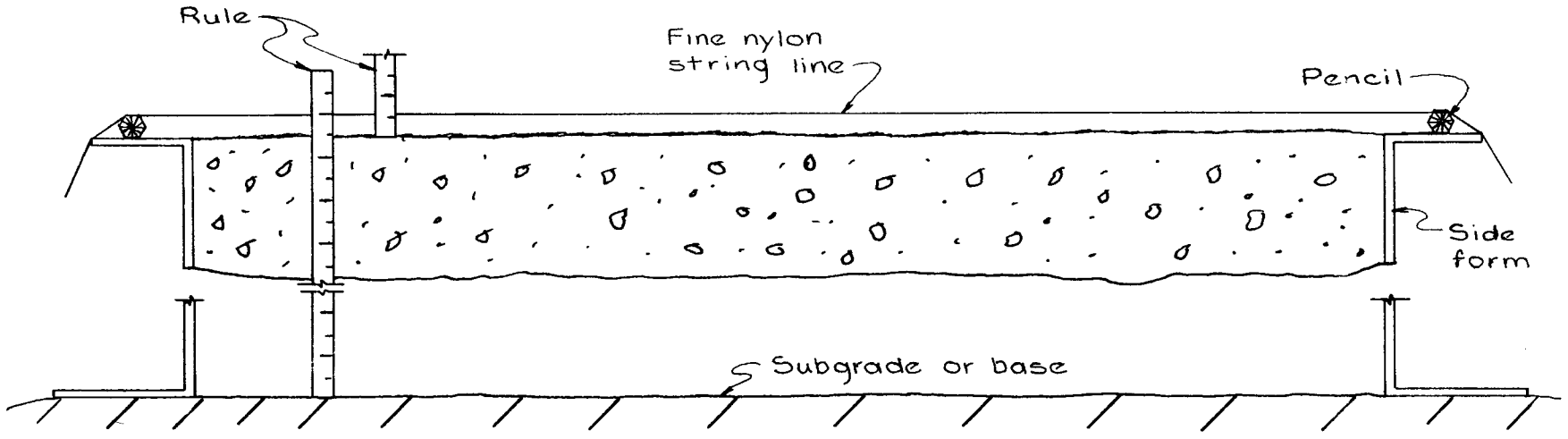
Next, lift the screed off the forms and stretch two lines (one just under the front edge and one just under the rear edge) of fine, nylon fishing cord, taut under the screed and across the tops of the form rails. Tie the cord to any convenient obtrusion on the forms, or to a stake driven outside of, and with the top leaning away from, the form line. Make sure it is stretched tight! Check again to see that the top of the rail is clean and smooth, and if so, place an engineer's stake (approximately 1" x 2" x 15") under each end of the screed, on the strings on top of the forms. Gently lower the screed onto the stakes so as not to cut the nylon cord, and make sure that the screed weight is resting freely on the stakes. Then by means of the intermediate adjusting studs, and checking the distance between the nylon lines and the screed bottom, with a ruler graduated in 1/16ths of an inch, and taking cognizance of the thickness of the two stakes (which must be equal), make the screed bottom conform to the

specified shape of the surface of the slab. These intermediate studs are to be set (or adjusted) in pairs. That is, set both the front and the back edges of the screed at each point before proceeding to set the next point. To assist in the concrete consolidation process, the front of the screed should be slightly tilted upward. (Figure 37) One-sixteenth of an

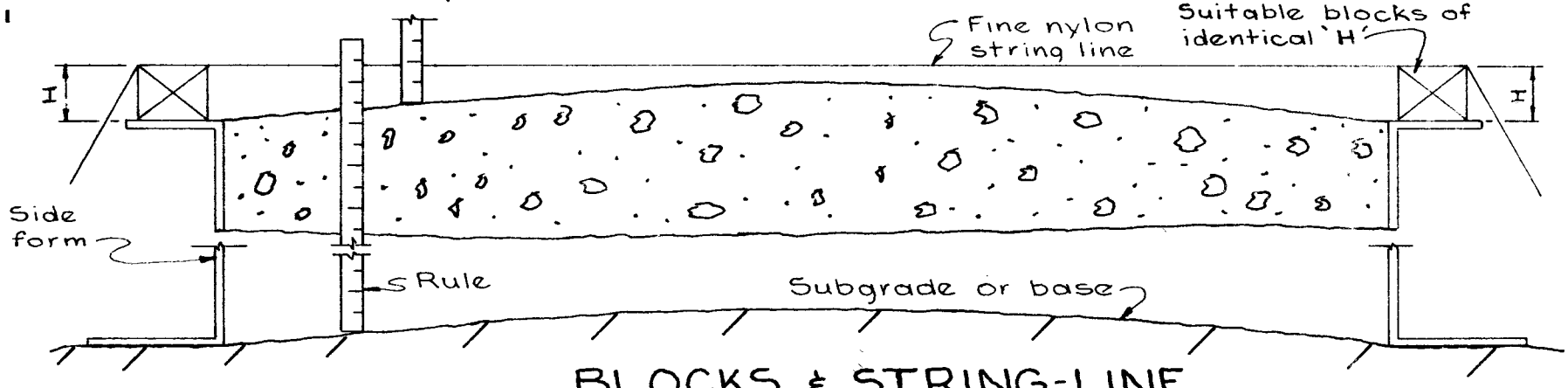


(Figure 37)

inch tilt is recommended as a usual beginning setting for both screeds. Only the intermediate points are given the tilt. The shoes are set flat and are to ride flat on the form rail. When it is considered necessary, or desirable, to change the tilt the first thing to do is to determine (by means of a fine nylon fishing cord stretched taut over a pencil or other suitable "spacers", placed on the clean top of each form line- Figure 38) whether the surface of the



PENCILS & STRING-LINE
SURFACE HEIGHT AND SUBGRADE DEPTH CHECK
(For flat or uniform-slope surface)



BLOCKS & STRING-LINE
SURFACE HEIGHT AND SUBGRADE DEPTH CHECK
(For circular & parabolic crown surface)

FIG. 38

slab is being left at the desired height or not.

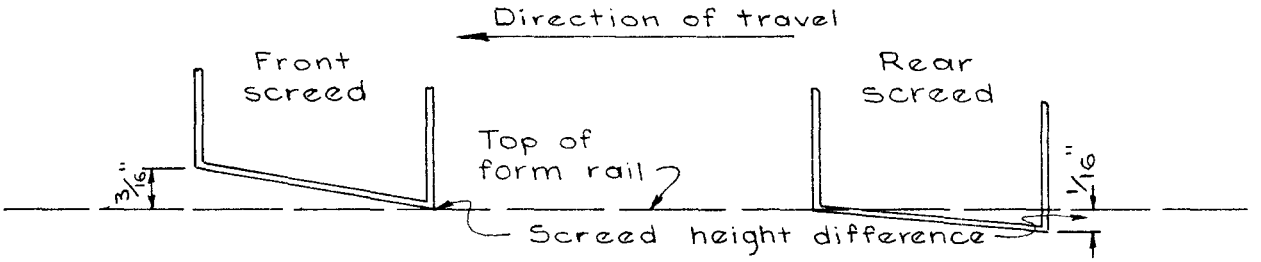
If the surface of the pavement needs to be raised slightly, and the concrete is finishing satisfactorily, lift the entire screed, maintaining the same tilt, by adjusting the shoe studs only. (So as to push the shoe down). It may be that the desired lift can be obtained by means of the end pair of studs only on screeds which have two pairs of studs over the shoes, or it may be that both pairs will have to be used. One complete turn (360°) plus a half turn (180°) of the nut on the adjusting studs will ordinarily raise or lower the screed about 1/16".

If the surface of the pavement needs to be lowered slightly, reverse the operation described in the paragraph above, lowering the entire screed (pull the shoe up) while maintaining the tilt.

When raising or lowering the entire screed and if the existing tilt is to maintained, identically the same degree of change should be made in the corresponding adjusting studs at opposite ends of the screed.

If the surface elevation is satisfactory but the surface is being left "ragged" or "pulled", give a little more tilt to the screeds. Increase the tilt of the rear screed by lowering the rear edge of that screed. This adjustment will tend to "bury" the coarse aggragate and leave a "surge" of mortar on top for the subsequent finishing operations.(Figure 39)

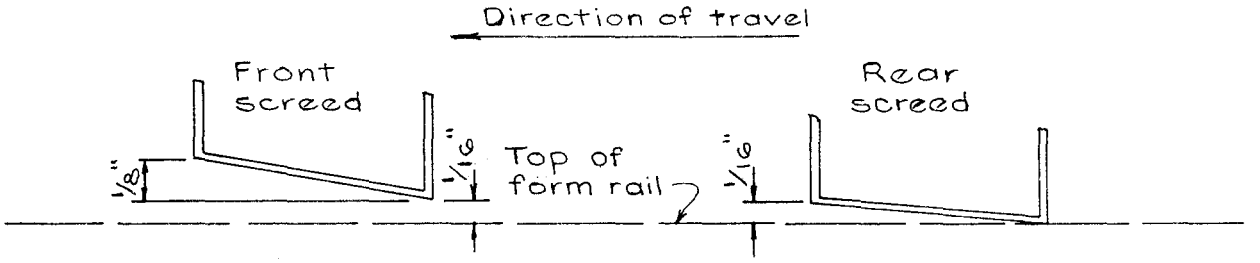
For paving down-hill, the natural tendency of the plastic concrete to slump downhill (ahead) is countered by



LOWERED REAR EDGE OF REAR SCREED

For rocky, harsh batch, deficient in mortar
Can also be used paving down-hill

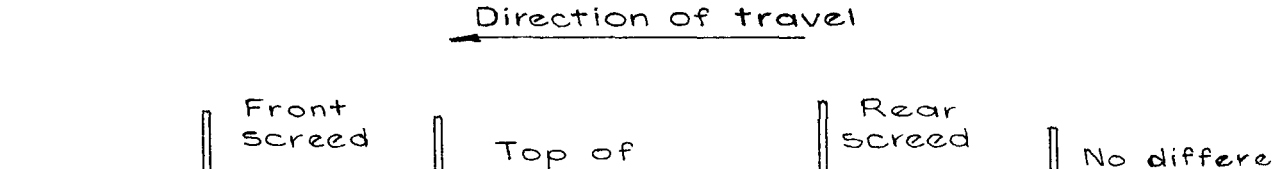
FIG. 39



BOTH SCREEDS TILTED FRONT SCREED HIGHER THAN REAR SCREED REAR SCREED AT FORM LINE HEIGHT

(For use on down-hill grade — good workability)

FIG. 40



FLAT FLAT

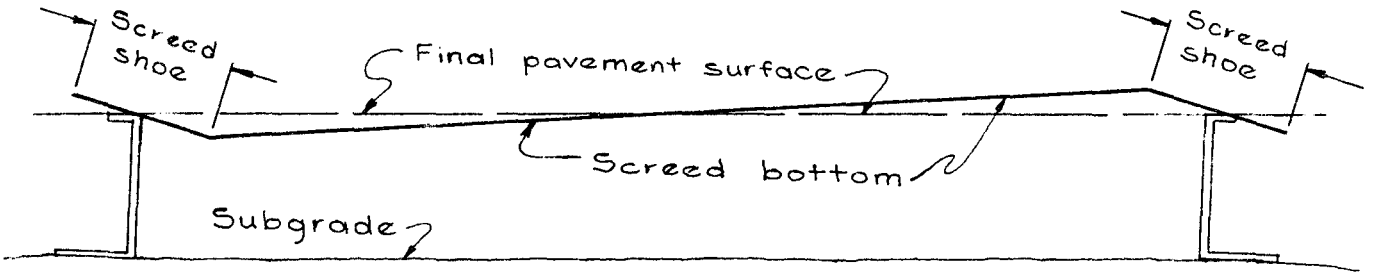
(For use on up-hill grade)

FIG. 41

positioning (tilting) the screeds to induce both compaction and surge. The front screed should be slightly higher, than the rear one and should also have a little bit more tilt. (Figure 40) More than the minimum number of "passes" of the finishing machine is ordinarily required and with the screeds carrying the proper "roll" of concrete for satisfactory operation (P. 78 1st paragraph) on every "pass". Normally, the rear edge of the rear screed should be at the top-of-form height.

For paving up-hill, the natural tendency of the plastic concrete to slump downhill (backward) is countered by positioning the screeds (flat) (Figure 41) to cut off the "bulge" and carry it forward. Normally, both screeds should be flat and at the same (top-of-form) elevation and should not require any concrete to be brought back to them for establishing the proper "roll" as is the need when paving down-hill. One similarity to down-hill paving exists, and that is that numerous "passes" of the finishing machines will most likely be required for both conditions.

Another screed adjustment that is advantageous to the preservation of yield and finishing uniformity is the intentional horizontal warping of the end two or three feet of the screed when the grade of either form line is sufficiently high above the other to cause the plastic mass of concrete to slump to the lower side. (Figure 42) The lower end of the screed is adjusted so as to leave a slightly concave surface (the exact degree of the "warp" required will vary with the consistency of the batch and



INTENTIONAL HORIZONTAL WARPING OF THE SCREED ENDS

(For use on superelevated curves and at other places where the difference in form line elevation is sufficient to warrant)

(Figure 42)

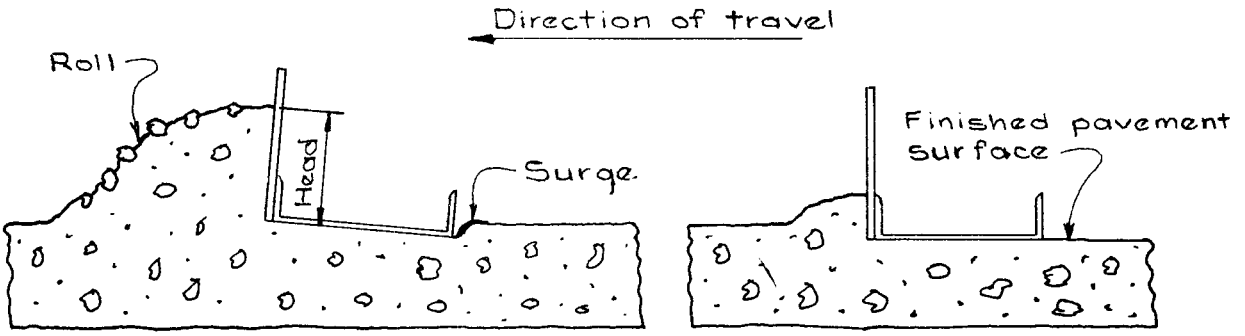
with the variation in the form line elevations) on the slab for about 2 or 3 feet adjacent to the lower form line, while the upper end is adjusted so as to leave a slightly convex surface on the slab for 2 or 3 feet adjacent to the higher form line. Theoretically, at least, this adjustment of the screeds will leave some extra concrete on the high side of the placement for slumping to the low side which was intentionally "scooped-out" to provide some space to accommodate this inevitable slump. Even with this adjustment - and most certainly without it, (and to a much greater extent), - some concrete will likely need to be carried back from the placement area and added to the high side of the pavement during the subsequent finishing operations. (Figure 16 & 17)

Specific instructions for screed settings to cope with all situations is not practical. As stated earlier, remember that a tilted-screed is used to "iron-over" or

"smooth out" with a tendency to "ride" along over the surface, and that a flat-screed is necessary for any "cutting" action. (Figure 43) Combine these positions to make the finishing machine perform to the prevalent requirements or conditions. When making adjustments for up-hill, down-hill or for any changes in grade, make those adjustments gradually and in keeping with the grade-change, so that when the point of maximum change of grade has been reached, the maximum adjustments to the machinery will have been made. A "string-line-and pencils" check (Figure 38) of the surface should be made in conjunction with same-station subgrade-depth measurements * (conventional "depth-tests," Bulletin C-11 P.94. (Figures 44 & 45) are not satisfactory for this check) after changes have been made to the screeds. This requires some advance planning as to the exact station at which the screed changes and check-measurements will be made. Subgrade-depth should be measured and recorded so that the "string-line-and-pencils" check, later, will be meaningful.

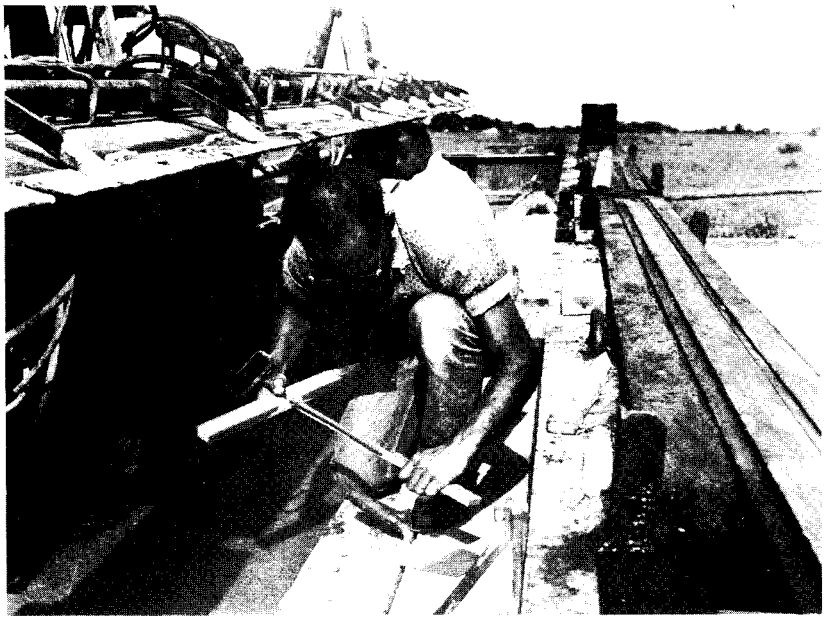
Harsh or dry mixes will "tear" and "pull" under a flat screed and will not leave enough mortar for the satisfactory accomplishment of the subsequent finishing operations. Up to $\frac{1}{4}$" tilt may be required when this condition exists. However, on more fluid and/or sandy mixes considerably less tilt (1/8" or possibly less) will be mandatory if control of the yield is to be exercised. With this sandy or soft type batch, an excessive amount of the mix would "surge" out from under the back of the screed if it had too much

* Figure 11

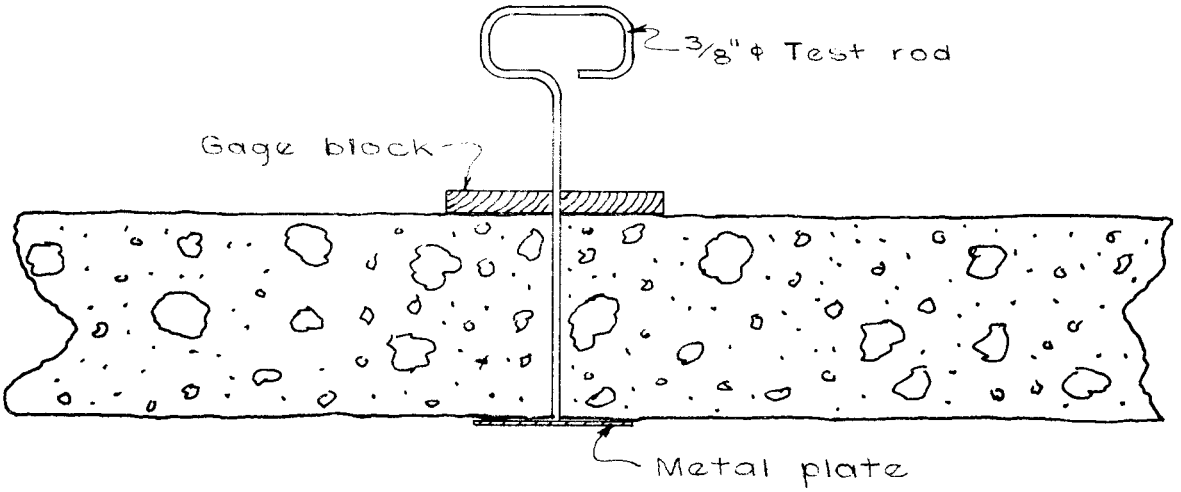


TO "IRON" TO CUT

FIG. 43



(Figure 44)

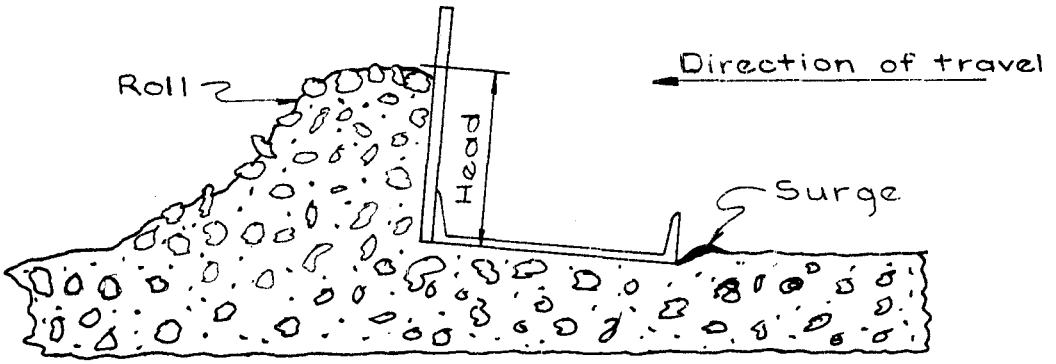


DEPTH TEST

FIG. 45

tilt. (Figure 46-A) This tilt will account for some loss or gain in yield, if not controlled. By leaving the slab a little more than plan-thickness, concrete will be "lost" in one of two ways or, by leaving it a little thin, an increase in yield will result. If the finishing operations that follow do not cut it off to the specified thickness, then it is "lost" in the extra depth of the slab; but if it is cut off, then it can still be lost, over the side of the forms, in waste. It can be pushed ahead and saved by proper screed adjustment and attention to the screed ends at the form line.

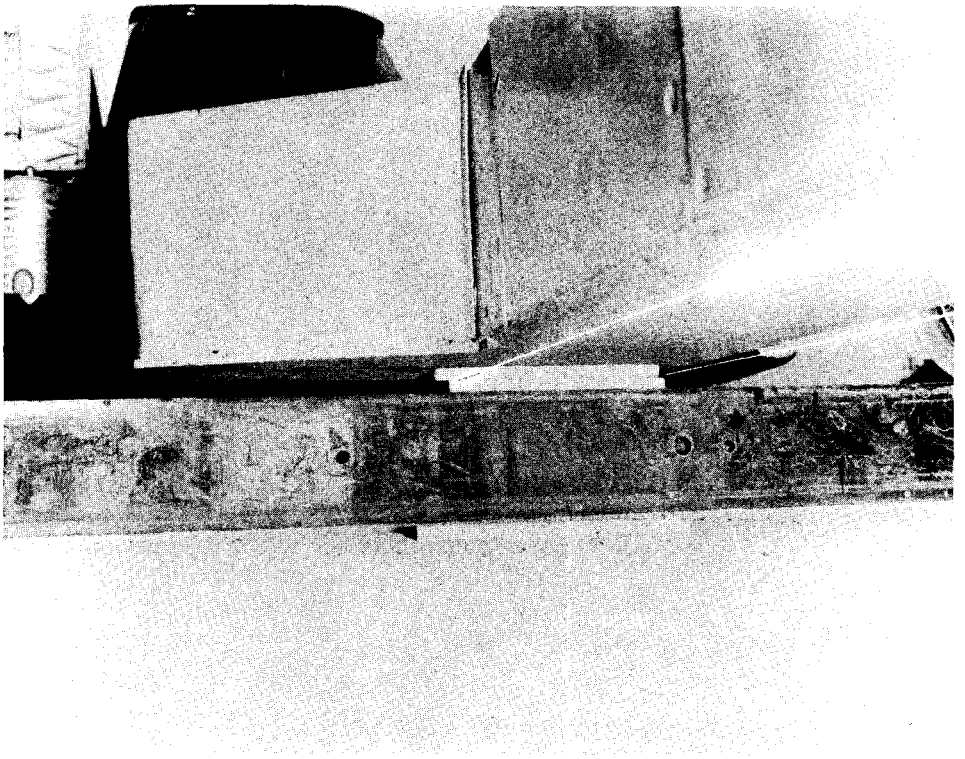
If the pavement thickness is 8" (according to plans), then each 1/8" of thickness is approximately 1.6% of the volume of the concrete. Assume that 1500 linear feet of this "8-inch" pavement was placed during a day's work, and assume that the average actual thickness of the pavement placed was 8 1/8". This extra 1/8" of depth, or thickness, then is lost or wasted so far as the contractor is concerned because it would have paved an additional 1.6% of the 1500 linear feet (or 24 additional linear feet) for the same cost to him. Concrete pavement is currently being paid for by the square yard. Assuming that this pavement was 24' wide, then an additional $\frac{24 \times 24}{9}$ or 64 sq. yds. would have been placed. Assume that the bid price for this concrete was $5.25 per sq. yd. and you can see that this additional 1/8" thickness for this one day has cost this contractor $336.00. This is no astounding sum, but it



TILTED SCREED

(A tilted screed smoothes or irons, with a tendency to float, leaving a surge of mortar behind)

(Figure 46-A)



"SET-UP" FOR CHECKING SCREED SETTINGS

is of sufficient consequence to merit at least some effort to preserve the specified yield.

Operation: Properly timing the sequence of operations from the initial compaction of the concrete to the final surface-finish, cannot be established by specification or regualtion in advance of the work, but must be continually supervised and regulated by the inspectors and the contractor. This continuous supervision includes all the inter-dependent adjustments and changes necessary to cope with the existing, governing, conditions of the mix, of the weather and of the production-rate. The initial compacting and screeding operation should follow the mixer as closely as possible: all subsequent operations should be delayed as long as feasible but allowing time for completion of all operations before the concrete becomes unworkable.[1]

Manual finishing operations are generally required to correct the mistakes or inadequacies of machine finishing due to improper adjustments and/or timing sequence. If the machines are properly adjusted and efficiently operated in properly timed sequence, then manual corrective finishing would be almost unnecessary. Unfortunately, the value of a properly conceived timing sequence of finishing equipment, in terms of the quality of the finished pavement, is often not recognized. Too often, this timing sequence is adversely regulated by attempts to develop the maximum production from the mixer with inadequate finishing equipment, and by the fear of a costly shut-down due to either a mechanical failure of some piece of equipment, or to unfavorable weather conditions.[1]

This objectionable practice can be minimized with

1. - Adequate finishing equipment for an established production rate

2. - A small, on-the-job stock of a few commonly expendable repair parts to shorten break-down delays.

3. - An efficient maintenance program

4. - Alert supervision

   a. able to anticipate adverse weather conditions

   b. willing and able to take necessary precautionary action

According to the specifications, the finishing machine shall be operated over all areas as many times and at such intervals as is directed and at least two passes will be required, with the last one having a continuous run of not less than 40 feet. (Item 360 8(1), P. 349). All finishing machines are equipped with a suitable transmissions for varying both the forward and backward travel speed of the machine, as well as the frequency of the screed "strokes", or oscillations, and with adjustable eccentrics for changing the length of the screed stroke.

For harsh, stiff mixes, the screeds should make rapid, lengthy strokes conbined with slow forward movement of the machine. This will assist in "working-up" mortar to the surface which is needed for satisfactory finishing.

For the more-workable mixes the stroke of the screed should be shorter and less frequent, combined with faster forward movement of the machine.

Both screeds should always carry a "roll" of concrete. This accumulation, ahead of the screeds, provides a working supply for filling the low places as the machine moves along. The "roll" on the front screed should always be as much as 4 inches high (Figure 46) but should not be allowed

(Figure 46)

to "build-up" higher than 8 or 10 inches and must be continuous for the full width of the pavement. (Figure 47) This "head" of concrete (or height of the "roll") has a direct affect (combined with the screed tilt) on the amount of "surge" past the screed, (Fig. 46-A) for a given mix, and every effort should be made to maintain the head at a uniform height for this reason. If the "roll" is allowed to build up, then too much excess will be left for the following operations. Where it becomes deficient or non-existant, (Figure 48) a low place will develop. Thus, it should be obvious that, if the "head" continually varies, then

Figure 47

a wavy, rough surface will be left behind.[3] At the start of the day and on "passes" of the finishing machine, subsequent to the first, an initial "accumulation" in front of the screed should be provided. (Figures 16, 17 & 48-A)

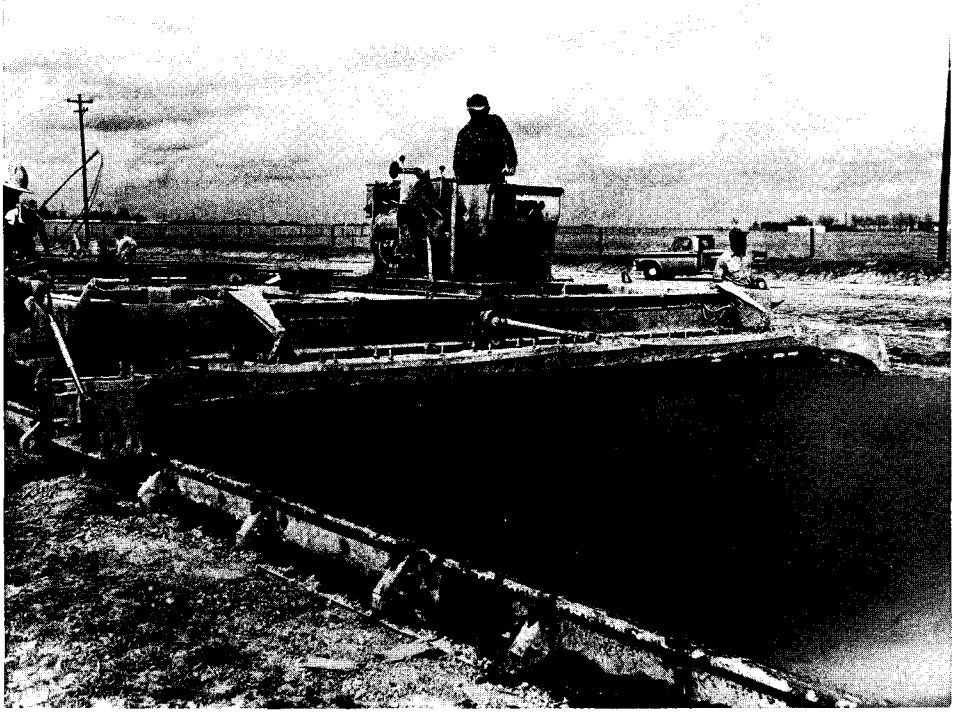


Figure 48

Figure 48-A

The placing, as well as the distribution, of the concrete and the transverse screeding must be co-ordinated if uniform, acceptable finishing results are to be obtained.

On screeds which are equipped with "lift chains", Figure 49, the chains must be long enough to remain slack at the ends of the screed strokes. If they are short enough that they tighten-up at the end of the stroke, the screed will be lifted off the forms momentarily at this point, leaving a slight hump or ridge (depending on how short the chain is, as to how high the screed is lifted) of mortar at every oscillation of the screed. These cumulative ridges, which actually amount to extra concrete, if worked into the slab by subsequent finishing operations, will add their volume to the pavement thickness. If cut off, this volume will be wasted outside the forms. Either way, it is the contractor's loss and will have its affect on the yield, on the subsequent finishing operations, and quite possibly on the resultant riding surface itself.

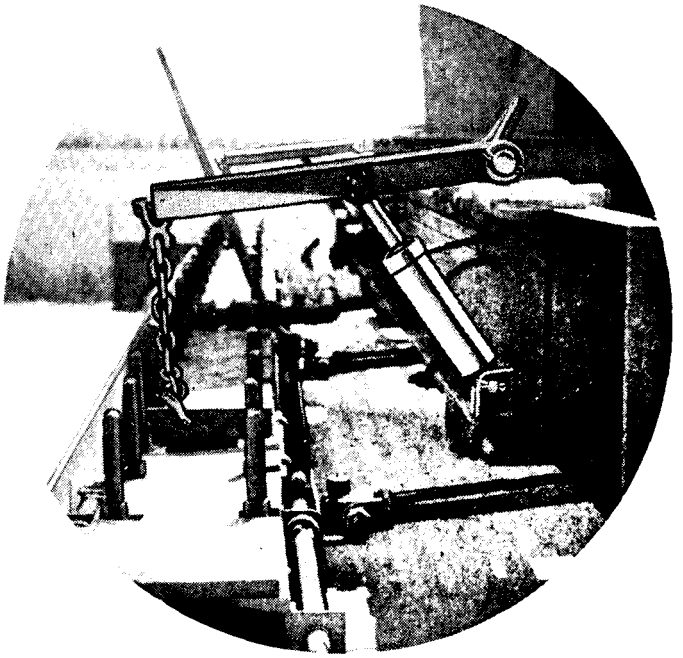


Figure 49

The machinery wheels should be equipped with scrapers to prevent the accumulation of concrete on the wheels. Figure 50. The top of the forms (rail) should be kept free of rocks and fresh concrete or other "build-up". Figure 51. Any accumulation

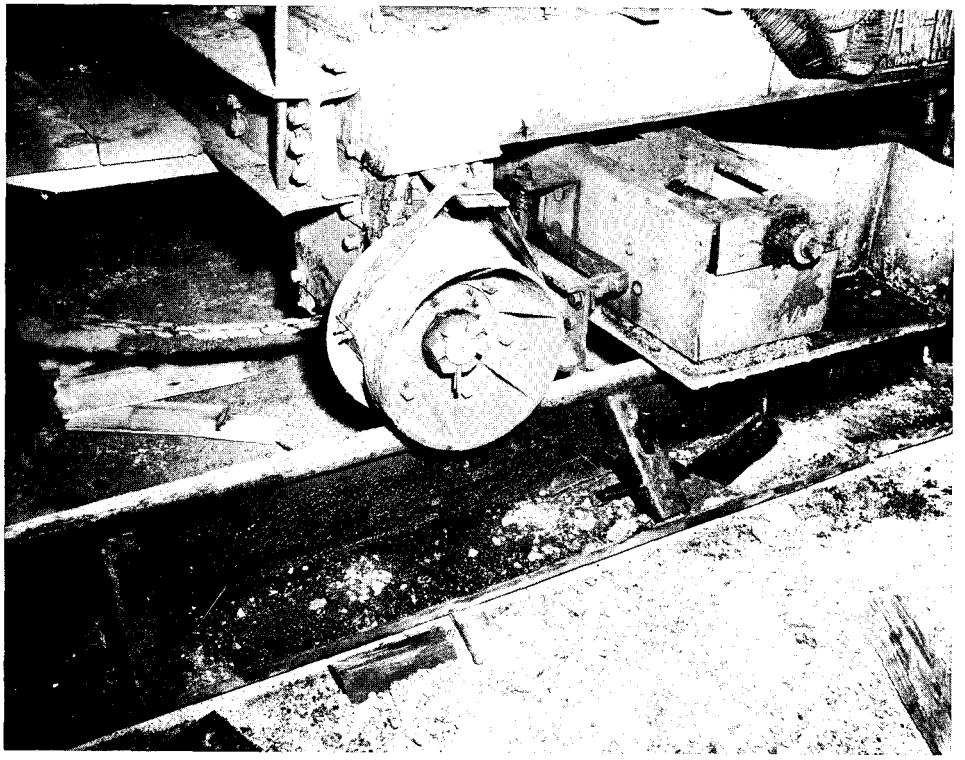


Figure 50

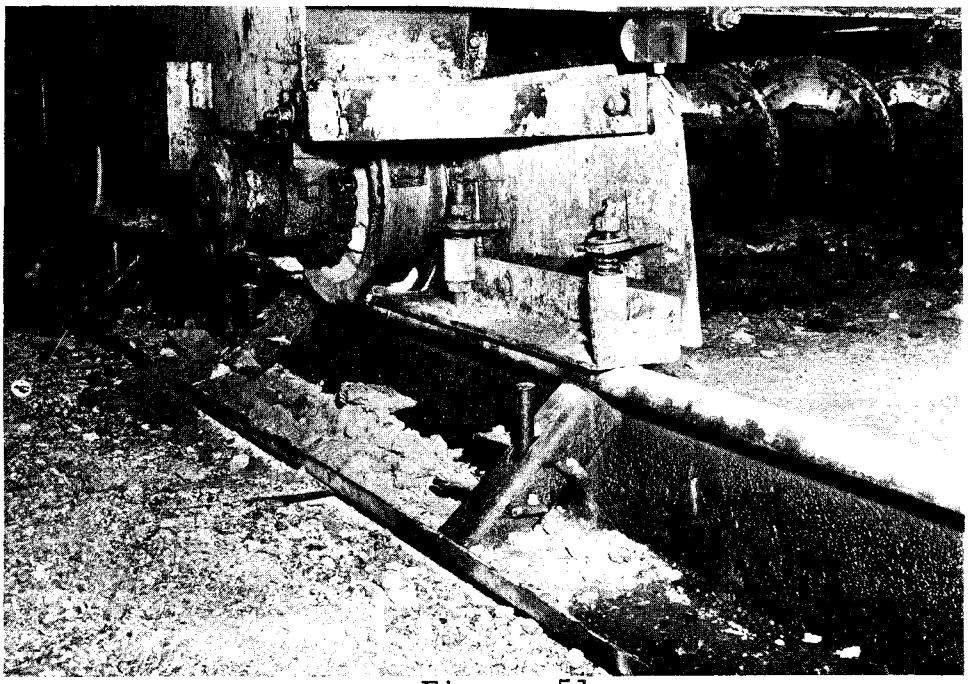


Figure 51

on the rail-top has the same effect as a shim of equal thickness under the screeds, since the entire machine is raised above the rails by whatever the thickness of the "build-up" is. This is still another condition which can adversely affect the "yield"

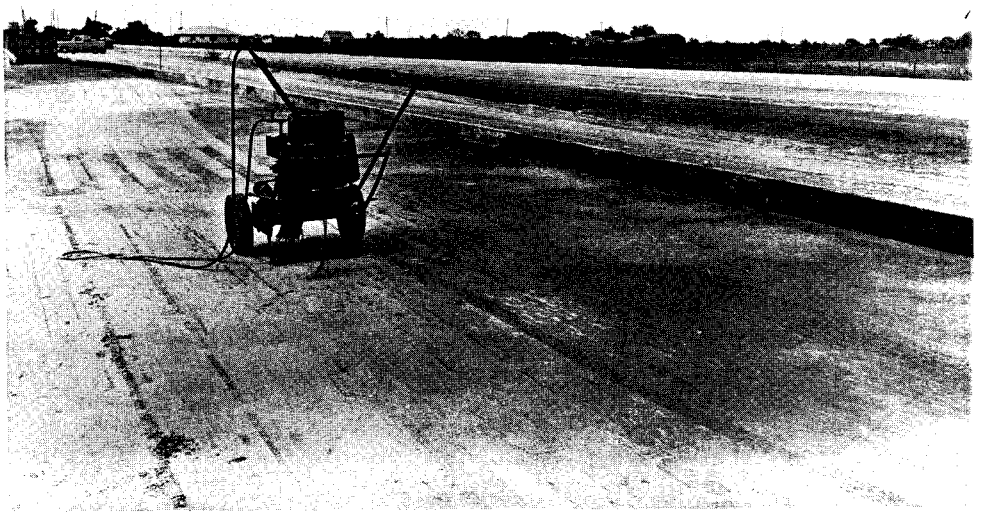


Figure 51-A

All forms should be thoroughly cleaned before setting, and oiled before paving against them. /Item 360.5(2), p 339. Figure 51 - A.

The timing sequence for any set of finishing equipment is variable and quite likely to require frequent revision. Changes in the timing sequence are affected by the innumerable circumstances, situations and conditions that arise and are encountered daily. Generally, though, the initial compacting and screeding operation should follow the "placing" as closely as possible. All subsequent operations should be delayed as long as feasible, but with each allowing time for the completion of those succeeding, before the concretebecomes unworkable. This intentional delay will give time for all the normal consolidation, due to the effects of the initial working and to the weight of the mass itself, to occur. Working with concrete under these conditions will minimize shrinkage cracking and surface irregularities due to subsidence. A finishing-operation time-sequence based on these principles will materially aid to produce a durable pavement with desirable riding qualities.[1]

The longitudinal float. This operation constitutes the last mechanically-controlled finishing operation. Good work by the longitudinal finishing machine should leave the surface in a condition which is practically satisfactory "as-is", and requiring of the straight edges, only to remove the screed marks and very few, very minor surface irregularities. Actually, the longitudinal float itself, should have only minor surface irregularities to contend with. The preceeding operations have not been properly performed if this machine finds much more to do than to eliminate the screed marks left by the transverse finishing machine. Where the preceeding operations have been properly performed, and a where a longitudinal float not in proper adjustment is permitted to continue to

operate in that unsatisfactory condition, it will absolutely ruin the good surface, so-far prepared. There will be times when, due to irregular forms, or to lack of uniformity in proportioning the batch, or changes in vertical or horizontal alignment (all of which the construction team should be constantly striving to prevent), surfaces will develop that will have to be corrected, largely by the longtitudinal finishing machine, and proper adjustment is essential for these corrections.

Where this piece of finishing equipment is used, it follows the transverse finishing machine or machines (sometimes two finishing machines are used). During the past 5 or 6 years a combination float finisher (Figure 52 and 52-A) has been introduced to the industry and used to some extent in the place of the longitudinal float. However, in this (District 12) area the "bull-float", or longitudinal float, (Figure 53) is still the preferred equipment for attaining a satisfactory riding surface.

Adjustments: Adjustment details may vary among manufacturers, but in principle, they are similar. The purpose of the adjustments is to make it possible to maintain the "float" or screed, parallel to the top of the forms and at the proper elevation at each and every point in its travel. All machines suspend the float from transverse tracks at the front and at the rear of the machine. To maintain proper adjustment, the support for the tracks must be stiff enough to resist deflection as the float moves across the surface of the pavement.[2]

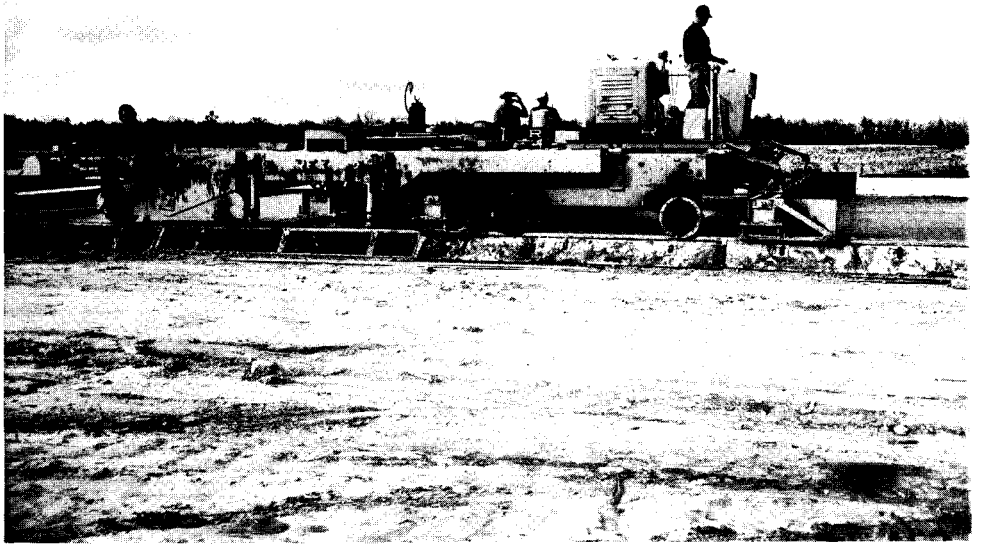


Figure 52

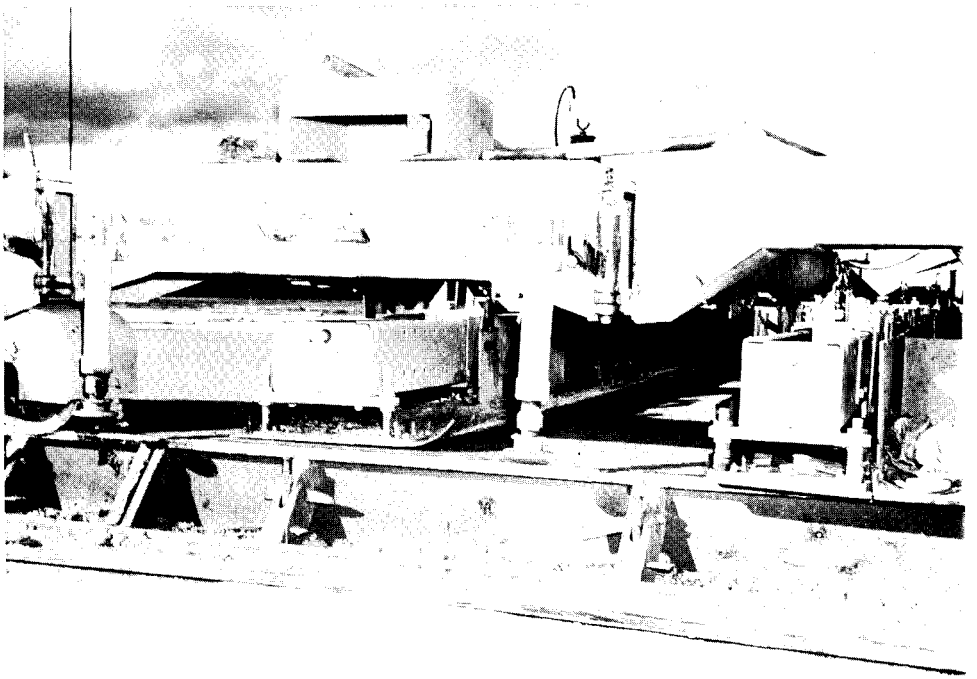


Figure 52-A

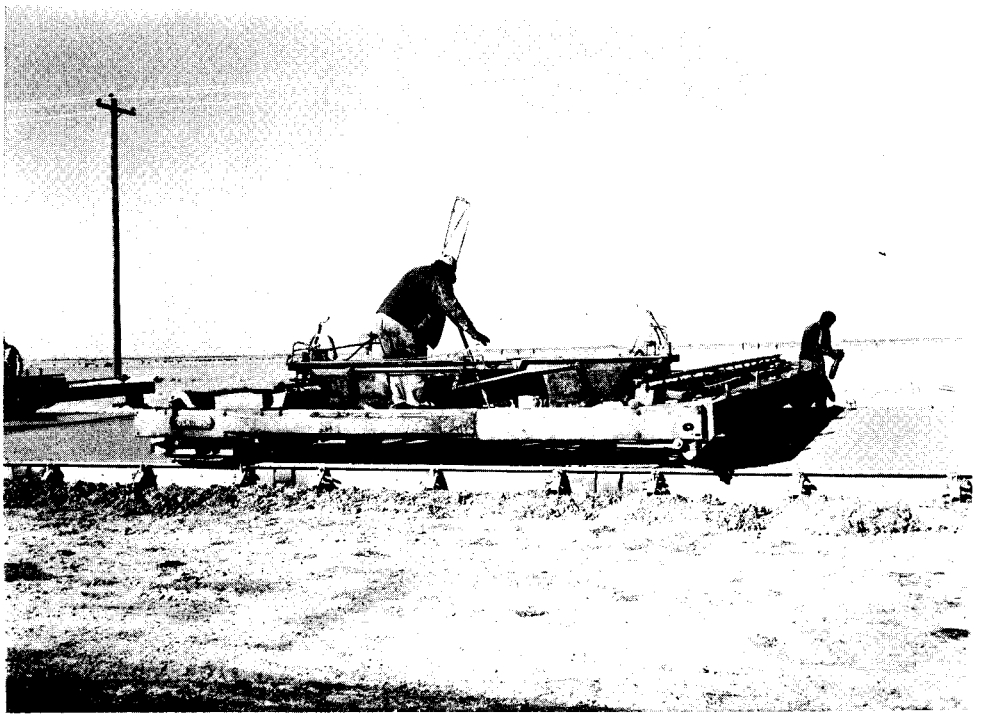


Figure 53

There are five adjustments to check and to keep in proper operating condition:

1. - Height of the crown-rails above the form-rails for the basic definition of the plane of the pavement surface.

2. - Alignment of crown-rail, and/or track, to control the plane of the pavement surface.

3. - Alignment of the screed "pan" to assure its "straight-edge" qualities.

4. - Screed adjustments:
   A. - To avert "twist" in the contact surface.
   B. - To control the heighth of the strike-off plane.

The heighth of the crown-rails (or tracks), upon which the screed assembly is conveyed from either sideof the pavement to the other, should be checked, and, if need be, adjusted so that they are <u>exactly</u> the same distance above

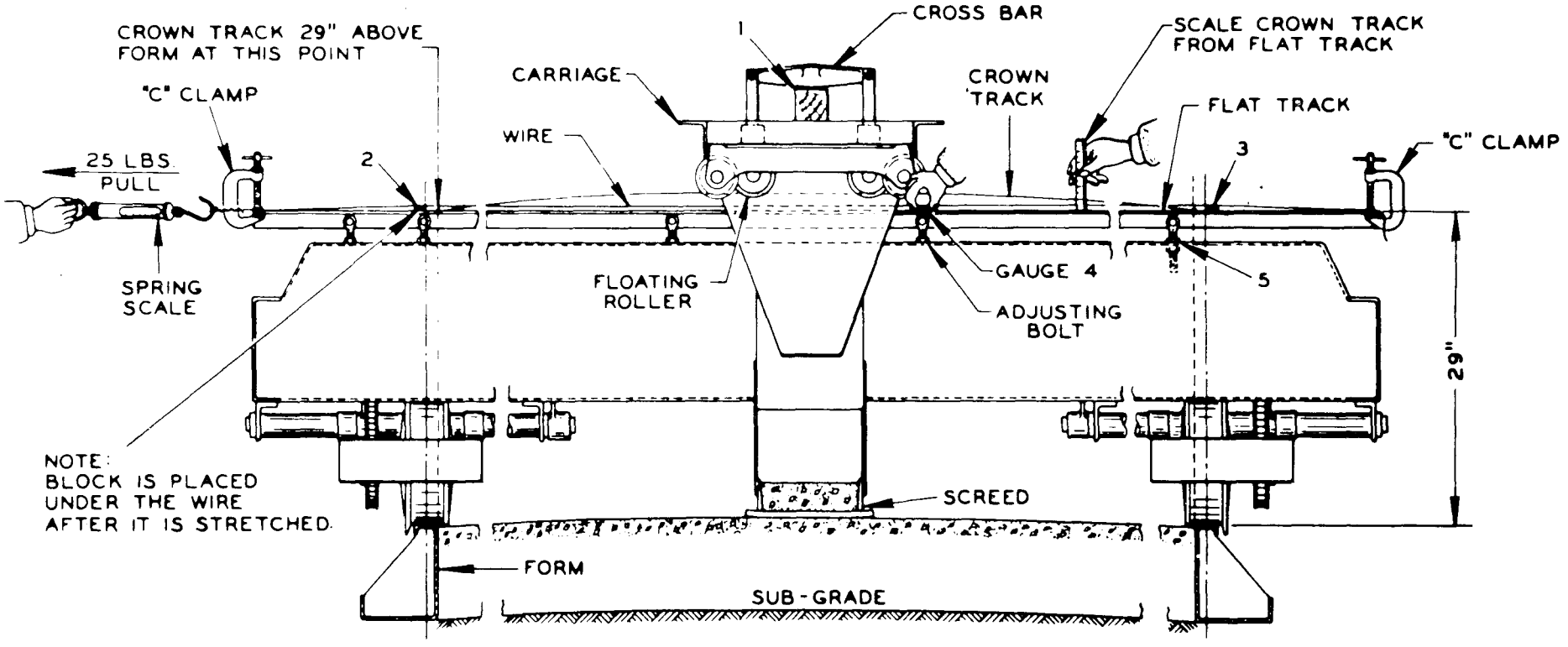
the plane of the bottom of the wheels at all four points above the form rails. Before making this check take special care to insure that the forms are clean on the rail-top, tightly latched and staked, properly lined and tamped, free from irregularity in elevation at the joints, are on a uniform (preferable a flat) gradient and not on a vertical curve. (a tightly stretched fine nylon cord could be used to mark the plane of the bottom of the wheels in some special case). Next, stretch a fine nylon cord tightly across the top of the crownrails and "right-over" the form lines. Now, measure the distance from the top of the crown-rail (as established by the nylon cord) to the form-rail (or to the plane of the bottom of the wheels) near or at the crown-track. This distance from the top of the crown-rails to the top of the properly conditioned form rails at these four points must be exactly the same and is in-the-order-of 29 inches. As previously mentioned, different manufacturer's machines may have slightly different recommended heights. The contractor is supposed to have a copy of the manufacturer's operating instructions available.

The crown-rail alignment, to conform to the specified shape of the surface, is accomplished by the now-familiar method of stretching a fine nylon cord along the rail from end to end. Then slip a block (of equal thickness) between the cord and the track at each end, and by means of the adjusting studs, uniformly spaced along the length of the track, taking into consideration the thickness of the

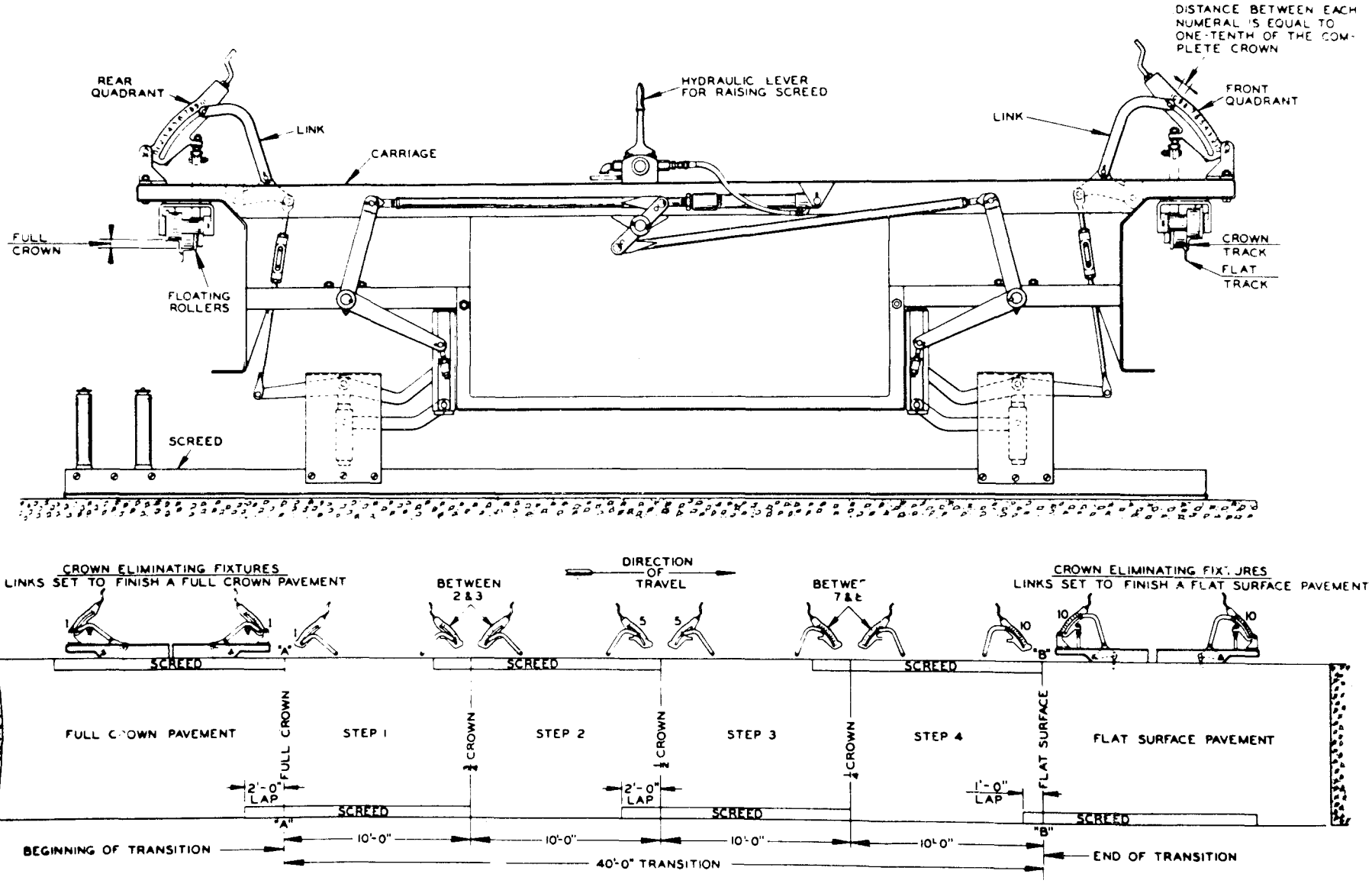
block under each end of the cord, make the track conform to the required surface shape. (Figure 54) As a final check, some points may have to be given a slight additional adjustment to attain a satisfactory "sighted-in" alignment check.

One manufacturer employs a double track to convey the screed assembly across the slab. One of these tracks is always flat The other one controls the shape of the surface of the pavement. When circular or parabolic crowns are to be established, the crown in this track is set to ordinates measured up from the flat tract. To make crown transitions to flat surface, and vice-versa, with this type machine, the crown can be removed in increments by the adjustment of quadrants at both ends of the screed (or float) carriage - (Figure 55) Cranks attached to the quadrants are used to set the screed. Each quadrant has a scale, divided into ten increments so that the proportion of crown change can be determined and set.

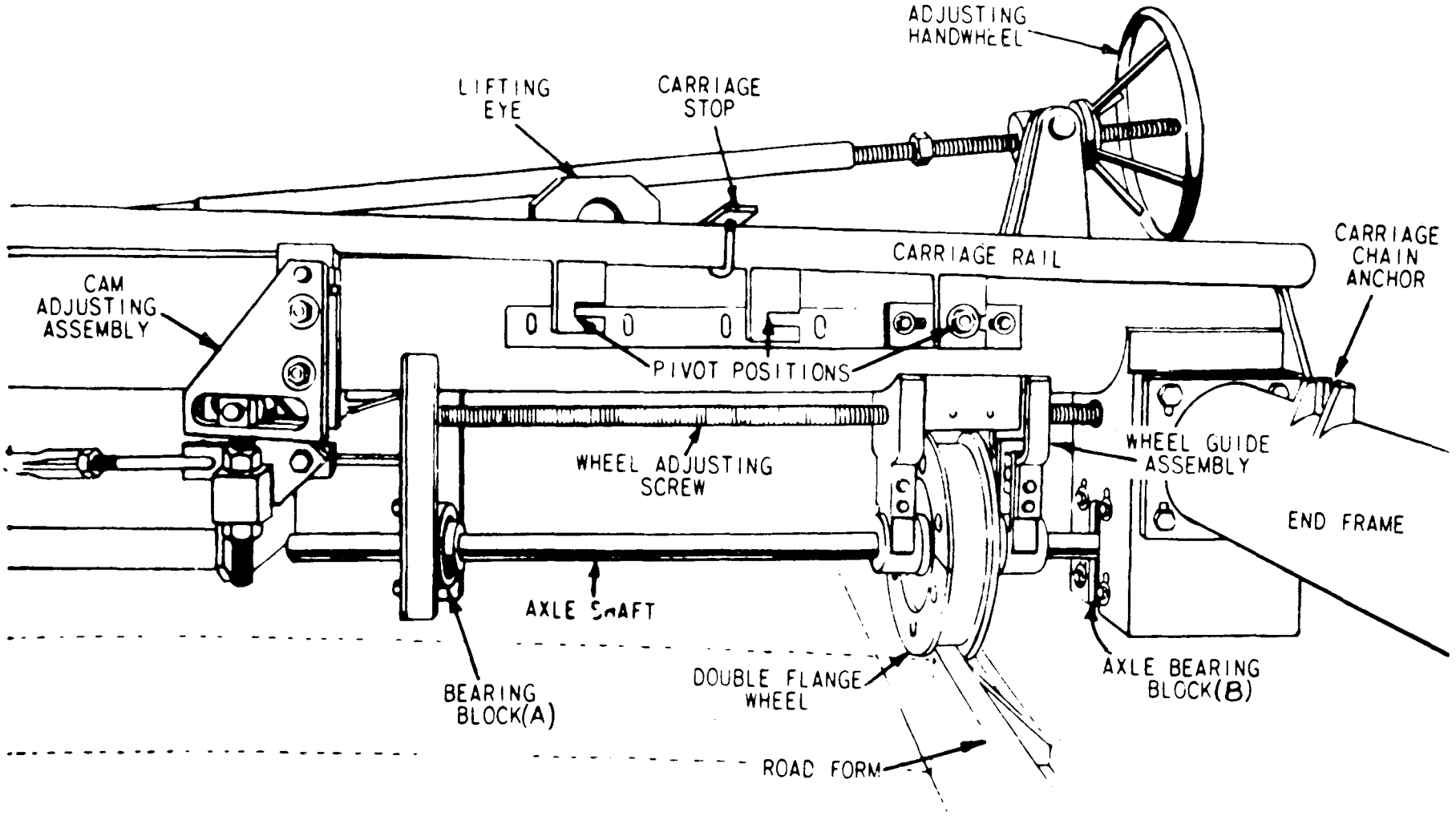
Another manufacturer uses only one track. It can be changed from full crown to flat position by cams. The position of the cams is controlled by a rod which is moved back and forth by a wheel, operating a worm gear. (Figure 56) Markings on the "worm" indicate the proportion of the total crown remaining in the track. To adjust this type, set the cams in position for a straight track and then check the alignment by means of the nylon cord and blocks. The cams are then turned 90 degrees to the position they occupy at full crown.


CROWN TRACK 29" ABOVE FORM AT THIS POINT
"C" CLAMP
25 LBS PULL
SPRING SCALE
2
1
CROSS BAR
CARRIAGE
WIRE
CROWN TRACK
SCALE CROWN TRACK FROM FLAT TRACK
FLAT TRACK
3
"C" CLAMP
FLOATING ROLLER
GAUGE 4
5
ADJUSTING BOLT
29"
NOTE: BLOCK IS PLACED UNDER THE WIRE AFTER IT IS STRETCHED.
SCREED
FORM
SUB-GRADE

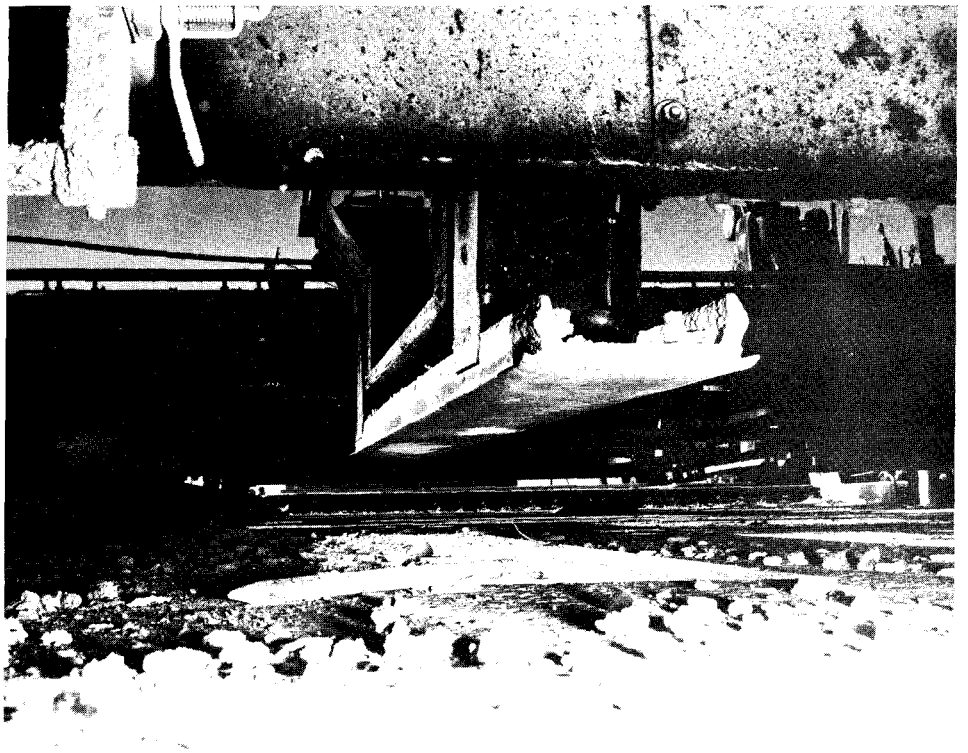
(Figure 54)


DISTANCE BETWEEN EACH NUMERAL IS EQUAL TO ONE-TENTH OF THE COMPLETE CROWN
REAR QUADRANT
LINK
CARRIAGE
HYDRAULIC LEVER FOR RAISING SCREED
FRONT QUADRANT
LINK
FULL CROWN
FLOATING ROLLERS
CROWN TRACK
FLAT TRACK
SCREED
CROWN ELIMINATING FIXTURES
LINKS SET TO FINISH A FULL CROWN PAVEMENT
DIRECTION OF TRAVEL
BETWEEN 2&3
BETWEEN 7&8
CROWN ELIMINATING FIXTURES
LINKS SET TO FINISH A FLAT SURFACE PAVEMENT
SCREED
FULL CROWN PAVEMENT
FULL CROWN
STEP 1
½ CROWN
STEP 2
½ CROWN
STEP 3
½ CROWN
STEP 4
FLAT SURFACE
FLAT SURFACE PAVEMENT
2'-0" LAP
1'-0" LAP
"A"
"B"
BEGINNING OF TRANSITION
10'-0"
10'-0"
10'-0"
10'-0"
END OF TRANSITION
40'-0" TRANSITION

(Figure 55)


ADJUSTING HANDWHEEL
LIFTING EYE
CARRIAGE STOP
CARRIAGE RAIL
CARRIAGE CHAIN ANCHOR
CAM ADJUSTING ASSEMBLY
PIVOT POSITIONS
WHEEL ADJUSTING SCREW
WHEEL GUIDE ASSEMBLY
END FRAME
AXLE SHAFT
BEARING BLOCK(A)
DOUBLE FLANGE WHEEL
AXLE BEARING BLOCK(B)
ROAD FORM

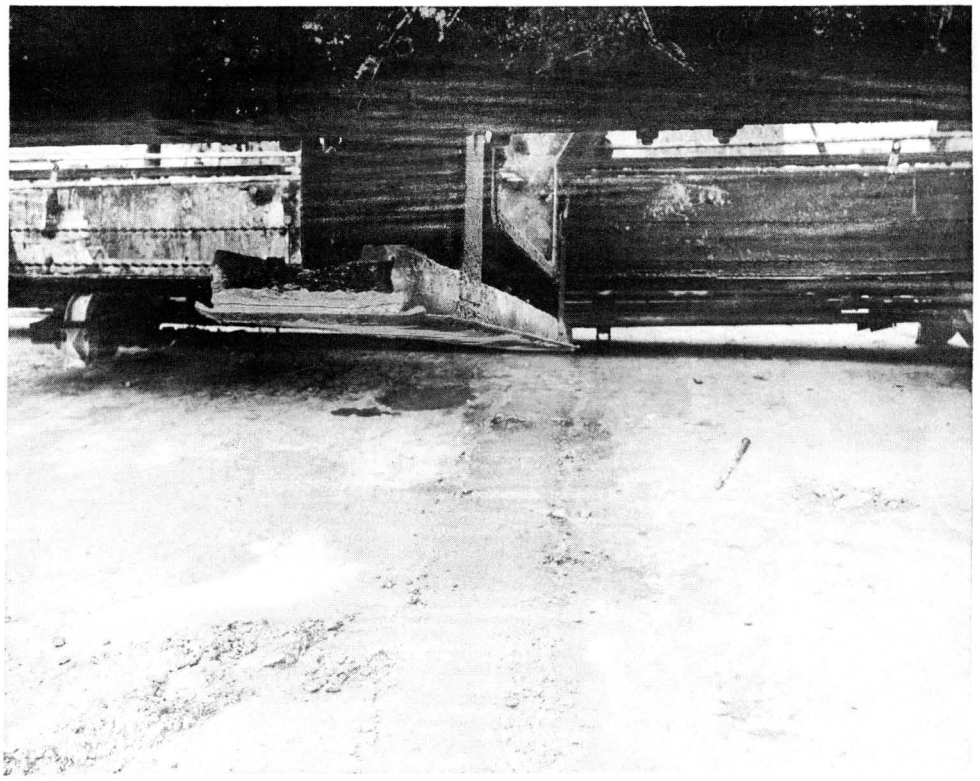
(Figure 56)



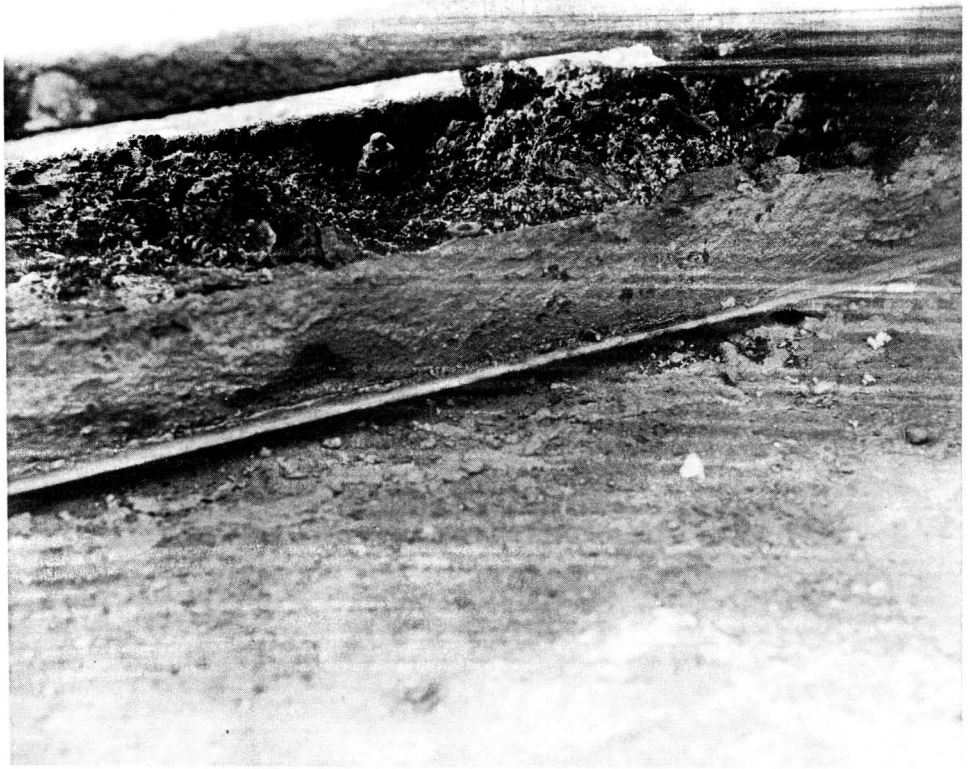
(Figure 57)

The lengths of the cam arms are then adjusted to produce the design crown.

The screed bottom is a sort of "pan", turned-up along the edges and which is vertically adjustable for "streightedge" alignment. It is connected to the screed "beam" with adjusting bolts, or studs, uniformly spaced along each edge. (Figure 57, 57-A, 57-B) If the pan is not pulled up tightly against the beam, (which is quite likely, due to previous adjustments which may have been made), the space between the pan and the beam will almost certainly be filled with set-up concrete. This accumulation of concrete is unavoidable, but should be cleaned out after each day's work. In fact, <u>all</u> the mixing, spreading and finishing machinery and equipment <u>must</u> be washed-off and/or otherwise



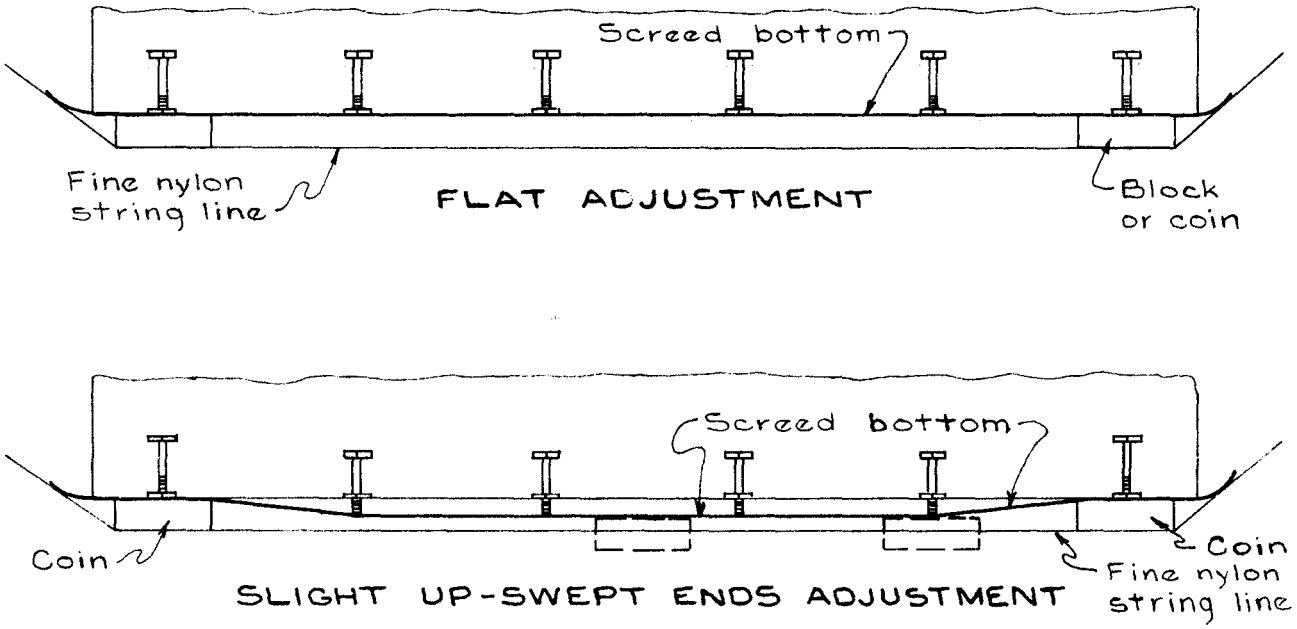
(Figure 57-A)



(Figure 57-B)

cleaned of concrete and mortar accumulation at least at the end of each days work if it is to function properly, and as intended, on the next day's work. If this hardened accumulation is present, its removal may be necessary before satisfactory adjustments can be made. When this becomes necessary, the pan bottom must be detached from the screed beam and the hardened concrete chipped off the metal, then reassembled and adjusted. A fine nylon cord is stretched tightly along and near the front and back edge of the pan bottom. Coins of the same thickness (pennies are recommended) should be used, (five in number is convenient) as gauges, to set the screed. Place a coin between the taut cords and the screed bottom at or very near each end of the screed. Then adjust each pair of studs - except those on each end of the screed - so as to push (or force) the pan down toward the cord and away from the beam at the intermediate studs, slightly but uniformly, by 1/3 to 1/2 the thickness of the coin, at the most. (Figure 58) The slight upturn thus put in the end sections of the screed will make its operation much smoother and satisfactory by breaking the vacuum between the screed and the plastic concrete at each end, thereby preventing the ends from "digging-in."

Obviously, if the screed is twisted, it will not finish properly nor even satisfactorily. The contact surface (with the exception of the end-sections as described above) of the screed must operate in the same plane of, or one parallel to the plane of, the specified shape of the surface



LONGITUDINAL-FLOAT SCREED

FIG. 58

of the slab, and to that of the "crown-track" of the machine. On some models there are four bolts, or studs, with which to make this adjustment, located on each side of each end of the screed frame while on others, the addition of shims will be required.

Before beginning the adjustment, the screed must be centered between the forms and in the lowered operating position with the anticipated operating load on it (operator, plus ballast, if it is to be used). Then adjust, as necessary, to make the height of each edge, at corresponding points near both ends, the same distance above a nylon cord which has been tightly stretched across the tops of the forms. Some contractors will "load" the screed beam (which is actually a heavy section of "channel-iron"), with concrete for ballast.

This is not a good idea for the reason that the adjusting bolts for straightening (or for replacing when sufficiently worn) the bottom "pan" are then buried in the concrete and have to have the hardened concrete chipped out when necessary to use them. A much better form of ballast or filler, is sand from the stockpile at the batching plant or from any other convenient source. Sawdust or cotton seed hulls are both satisfactory as a filler, also. Some concrete will probably accumulate on top of the filler but its removal will be very easy and quite simple. (Figure 57-B)

In addition to being "straight," and free of twist or warp, the screed must contact with the surface of the concrete along substantially its entire length and must be parallel to the grade line as established by the line of the top (rails) of the forms. Either end of the screed can be lifted entirely clear of the concrete, or it can be pushed down so as to dig into it, by means of a turnbuckle on the support rod at each end of the screed. (Figure 55) In other words, the turnbuckles control the distance between the crown track and the bottom of the screed as well as the relative elevation of each end.

Operation: Proper timing is of prime importance in this operation. For best results, the initial settlement of the plastic concrete should be largely completed before the longitudinal finishing begins. If the concrete is still in the early stages of shrinking when the "bull-float" passes, the final surface is likely to be disappointingly rough the following day even though the finish is acceptable for

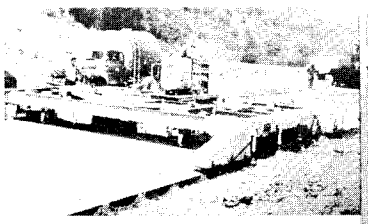
straightness at the time.

The screed of the longitudinal float oscillates parallel to the centerline, as the carriage of the float travels transversely across the pavement, while the machine, as a unit moves forward on the forms. Any of these "movements" can be executed independently of the other or simultaneously. Ordinarilly, the unit moves forward, as the screed travels transversely across the slab, at a speed such that the screed will continuously overlap its previous "pass" by at least 1/4 its length. /Item 360.8(1), top of Page 350, 1962 Texas Highway Standard Specifications/ (Figure 50-A)

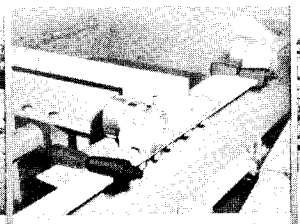
When the screed (or float) is in proper adjustment, it should touch the surface of the pavement intimately at all points and should continuously carry, "in reserve", a small roll of concrete along its length except on the rear foot or two. The mortar should "roll" along, instead of "flow," ahead of the screed and when this "reserve roll" is not enough to fill a possible low spot, if encountered, the machine should be stopped, fresh concrete deposited in the "roll" and the screeding resumed. Mortar should not be allowed to "feed-off" the rear end of the screed leaving a ridge for the straight-edges to contend with. Whenever excessive cutting or filling is required of the longitudinal float, the entire placing and finishing operation should be reviewed immediately and any equipment which is out of adjustment or which is being improperly operated should be corrected at once. As has been stated earlier, constant

(Figure 58-A)

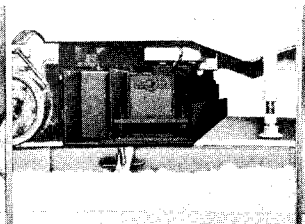
WHEN NECESSARY FOR FINISHING, EXTRA WATER SHOULD BE APPLIED BY FOG-SPRAY



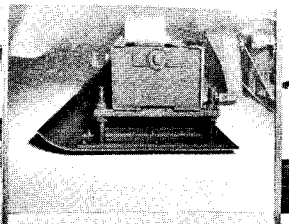
FINEST SURFACE SMOOTHNESS — The Rex Finisher-Float produces amazing surface results at a finishing rate that can surpass the production to today's fastest paving setup. It has been used successfully by contractors everywhere on road and airport jobs and Corps of Engineers projects.



INFINITELY ADJUSTABLE — The Rex Finisher-Float has infinite frame adjustment in standard widths 20' to 25' and 12' to 18½'. The exclusive Rex quick-clamping device provides a positive lock without the use of nuts and bolts. Screw adjusters (14) are provided for manual frame-widening.

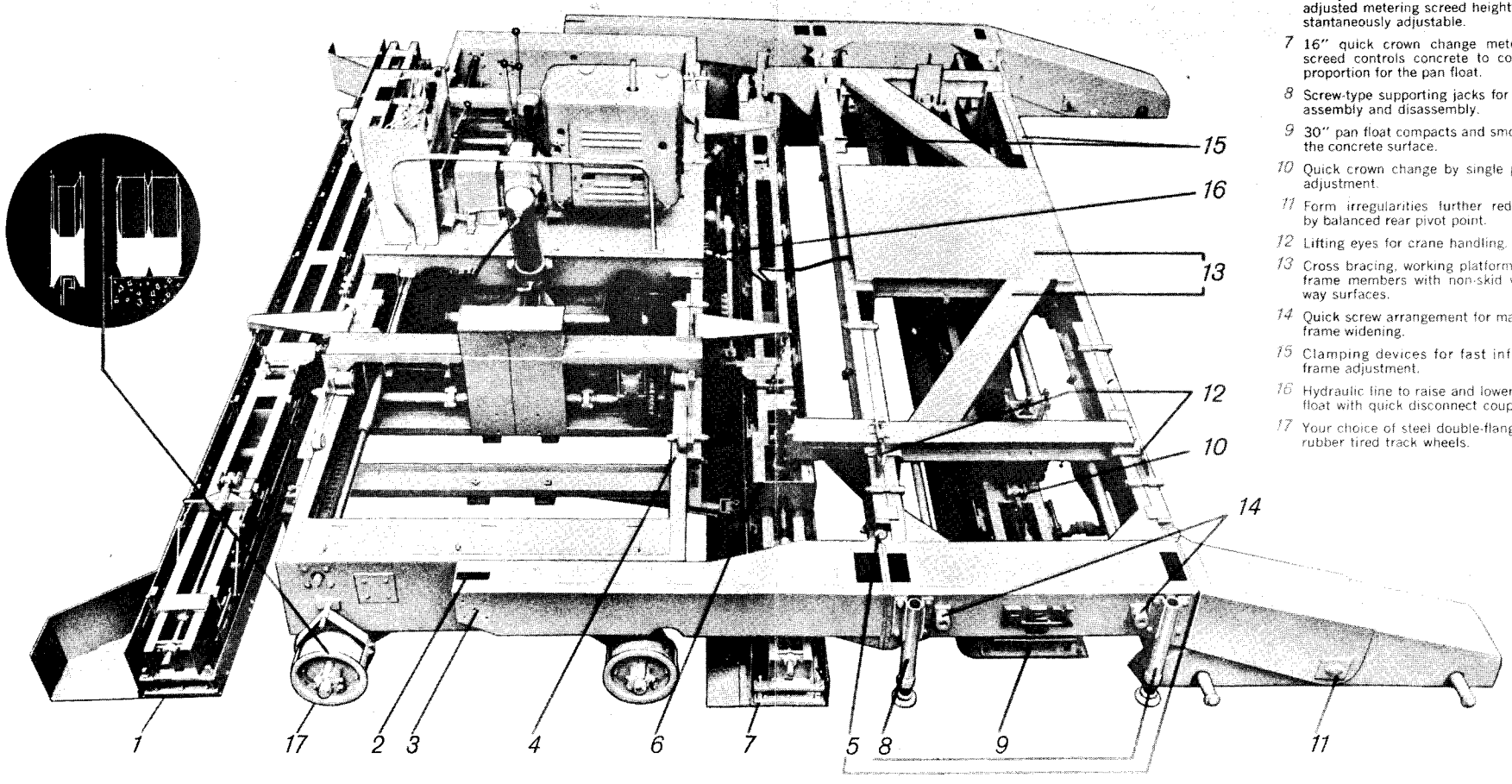


METERING SCREED — The big, 16"-wide rear screed of the transverse finisher levels and meters the concrete in the correct proportion for the pan float. With Rex design, the hinged end sections only ride on the forms and, therefore, irregularity does not effect surface results. Double-acting hydraulic cylinders raise and lower the metering screed.



PAN FLOAT — This wide 30" pan float with bull-nose compresses concrete for a superb final finish that requires little or no hand-finishing. Raising and lowering of the pan float is hydraulically controlled from the operator's platform.

PAN FLOAT TILTING DEVICE — Tilting of the pan float is adjustable to meet the varying consistencies of concrete. Two points of adjustment enable the operator to tilt the pan quickly and accurately. Check this Rex feature against more complicated methods found on other machines available today.



1 16" oscillating quick crown change front screed, standard on all Rex Combination Finishers-Floats for initial leveling of concrete and smoothing of surface.

2 Open bearing connections to stub shaft on finisher for fast, easy disassembly.

3 Pivot point imparts bogie action to Rex Finisher-Float, greatly reducing form error in pavement finish.

4 Heavy channel members give added strength and rigidity.

5 Float frame hinged at two points for legal highway travel.

6 Sturdy roller boxes maintain pre-adjusted metering screed height. Instantaneously adjustable.

7 16" quick crown change metering screed controls concrete to correct proportion for the pan float.

8 Screw-type supporting jacks for easy assembly and disassembly.

9 30" pan float compacts and smooths the concrete surface.

10 Quick crown change by single point adjustment.

11 Form irregularities further reduced by balanced rear pivot point.

12 Lifting eyes for crane handling.

13 Cross bracing, working platform and frame members with non-skid walkway surfaces.

14 Quick screw arrangement for manual frame widening.

15 Clamping devices for fast infinite frame adjustment.

16 Hydraulic line to raise and lower pan float with quick disconnect coupling.

17 Your choice of steel double-flange or rubber tired track wheels.

(Figure 58-B)

attention to, and precise control of, varying conditions is essential if a satisfactory riding surface is to result.

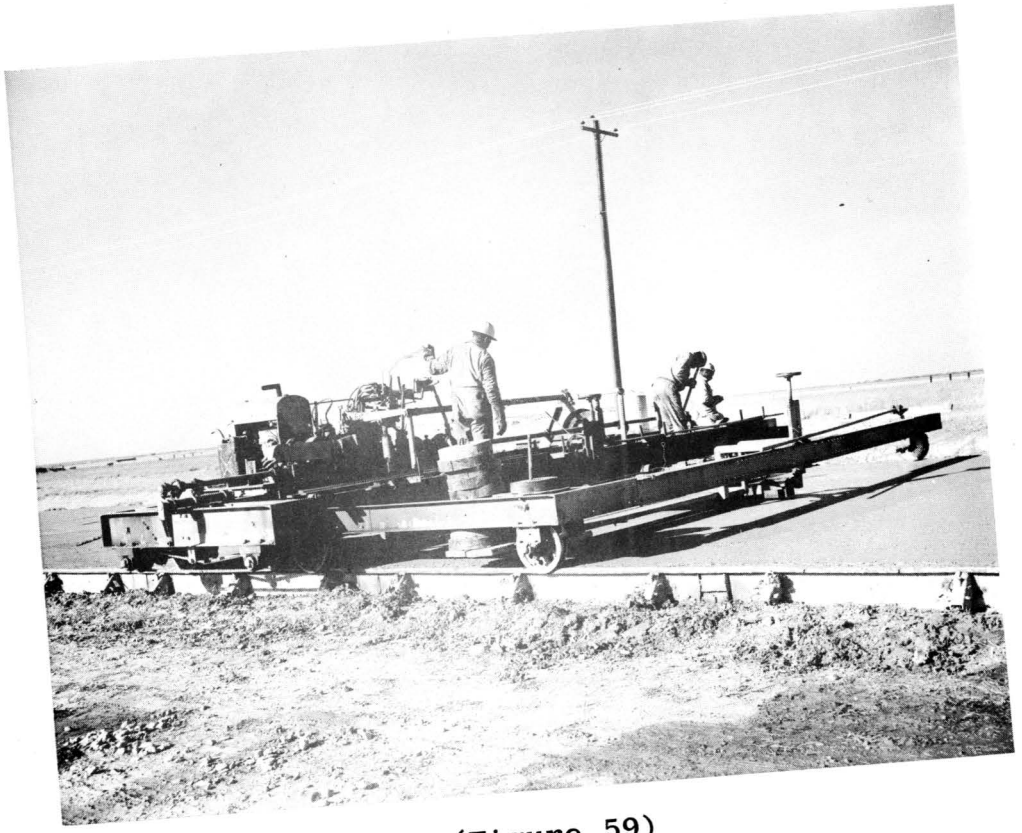
Water should not be sloshed nor splashed nor otherwise carelessly applied to "ease" finishing difficulties. If it is necessary to provide additional water for finishing, it should be used sparingly---only as much as is absolutely necessary---and applied uniformly by spraying. Remember that water applied to the surface of concrete to ease finishing operations weakens the surface mortar and causes it to scale off when opened to traffic. When used sparingly and if meticulously "worked-in", scaling can be minimized.

A recent development in finishing machinery previously mentioned on page 84, called the Combination Finisher-float, Fig. 52 & 52-A, theoretically, at least, makes the longitudinal float (commonly called the "bull-float") unnecessary. This new type finisher is on a much longer wheel base than the conventional finishing machine. It has two screeds and a stationary "pan-type" float which is suspended from the frame of the machine (Figure 52-A), instead of being free to ride on the form-rail, as do the screeds of the conventional type finishing machines and as does the front screed of this machine. Irregularities in the horizontal line of the forms do not cause as severe, incidental irregularities in this machine-finished surface as they do with the conventionalfinishing machine and "bull-float". However, it is not intended to infer that any laxity in form line requirements should be allowed because of the use of thistype of finishing machinery. All of these machines have

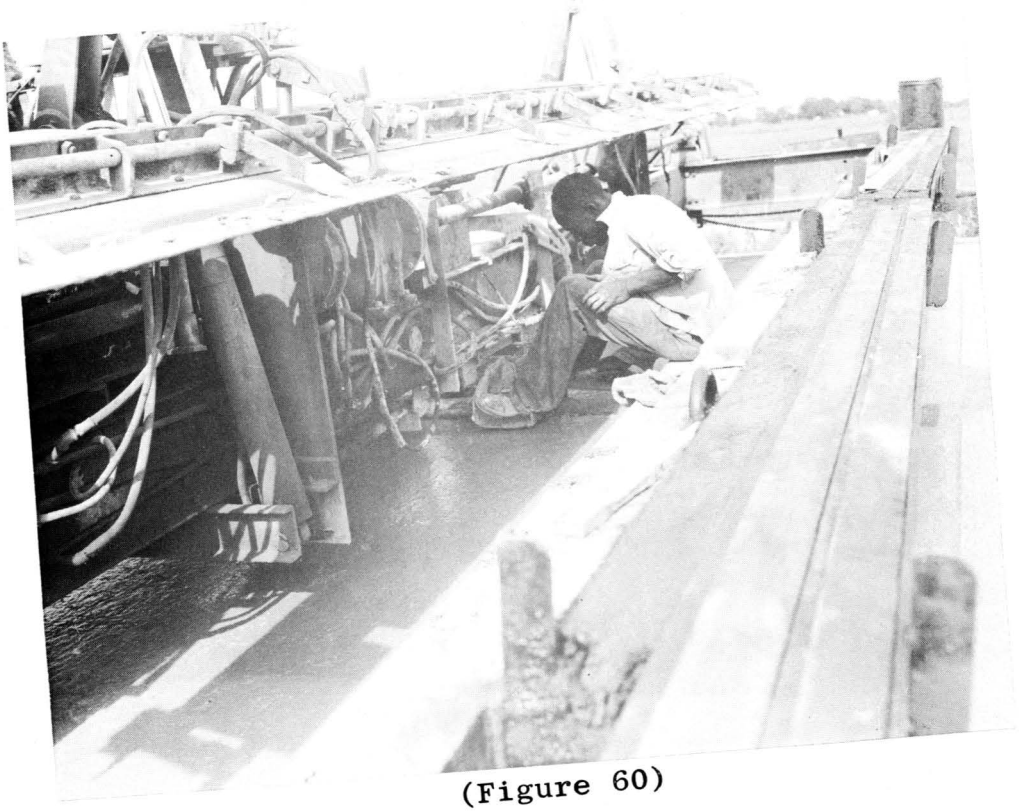
some method provided for setting and controlling the screeds, etc. (Figure 58-B) Before starting a project, these should be set at about the elevation of the top of the form rails. The screeds should be set just as the conventional finishing machine, with the back one slightly lower than the preceeding one. And, as with the older types of finishing machines, adjustments of a minor nature will continue to be necessary to produce the proper surface and finish. The combination Float-Finisher is primarily designed for a one-pass operation. More than one-pass of this machine, does not generally improve the surface, but will bring an excess of fine material to the surface.[3]

When longitudinal joint forms are not "set" on the subgrade, in advance of the concrete placement, next following the longitudinal float, is the joint installing machine, called a "Flexplane", which ordinarily does not belong to the contractor but which he rents or leases on some basis from the manufacturer. This machine (Figure 59) is motor-propelled along the forms and has both forward and backward mobility. It is rather difficult to keep this machine "square" on the form-tracks. Both the transverse and the longitudinal joints can be, and usually are installed with it. /Item 360.7,Page 344 through 347/. The "center-joint" is not always made on the center line. Consult the project plans for the correct location.

For transverse joint installation the machine is equipped with a "jig" (Figure 60) which has a vibrator attached, and to which the operator clamps two steel (or some other



(Figure 59)



(Figure 60)

sutiable material) joint-form "strips." These strips are approximately 1/4 inch thick x 2 to 3 inches wide x about 12 feet (or half the width of the placement) long. The pavement detail sheets of the plans should be consulted for correct dimensions. Where the "joint assembly" consists in part of a subgrade plate, and dowel bars, (Figure 61) the inspector of this installation as placed on

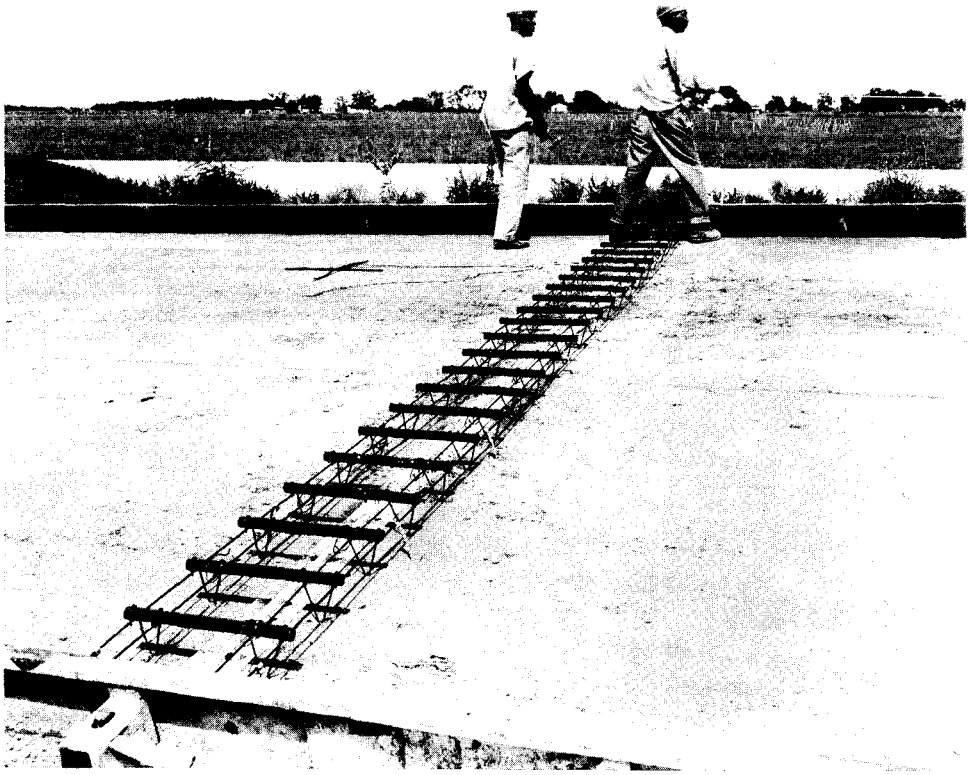


Figure 61

the subgrade ahead of the concrete placing operation has the responsibility of marking both ends of the evolving joint with a degree of oermanence that will not be obliterated before the assembly-line paving process has attained the "Flex-plane" stage, (Figure 62). By this means the inspector of the Flexplane joint-form installation establishes the exact location (with stringline at the"marks") at which the joint-form strip is to be installed,so that it will be in perpindicular alignment with the center of the subgrade plate. See diagram-figure 63 for proper installation.

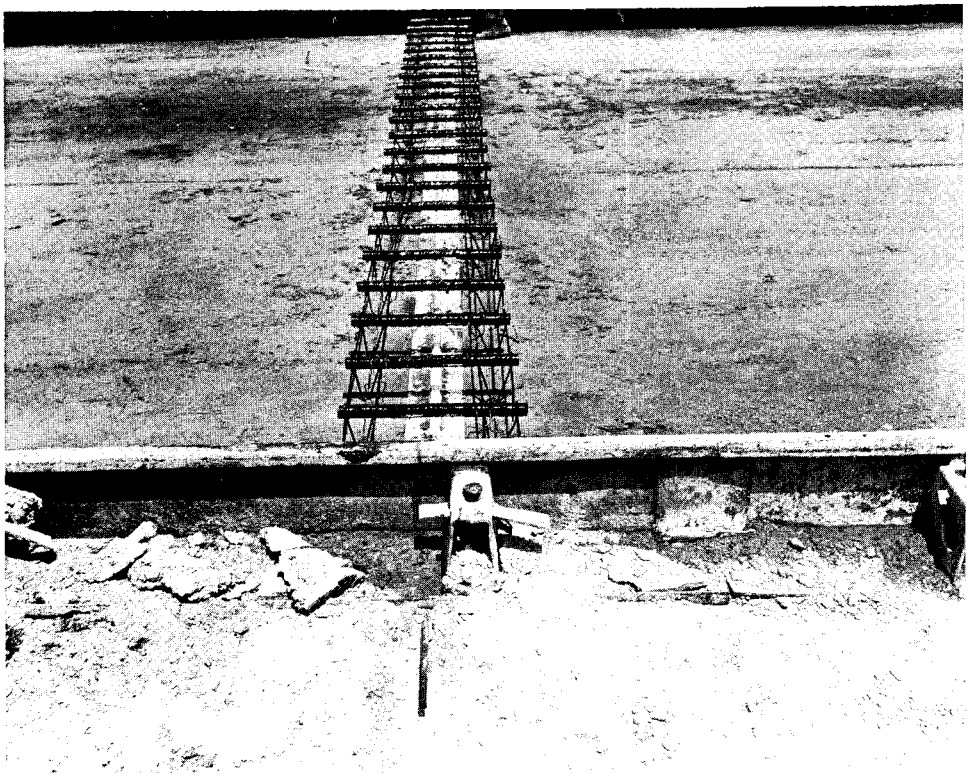
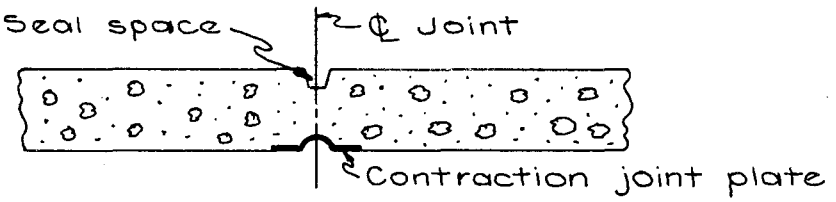
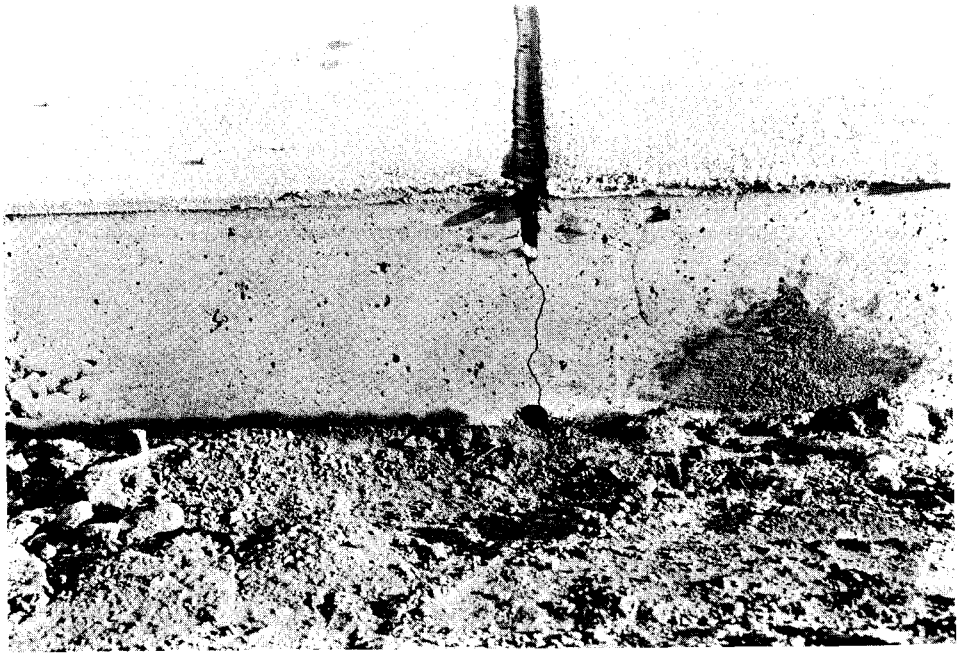


Figure 62



CONTRACTION JOINT

FIG. 63



With the help of a second person, the operator should carefully position the machine so that the "jig" will instal the seal-space form at exactly the correct location, established as described above. It is often necessary for this second person to "scotch" the wheels with wedges or by some other satisfactory means in order to hold the jig on the mark at both ends of the joint. When the correct position of the loaded jig is"fixed", (Figure 63-A) the operator lowers the jig into the concrete, with

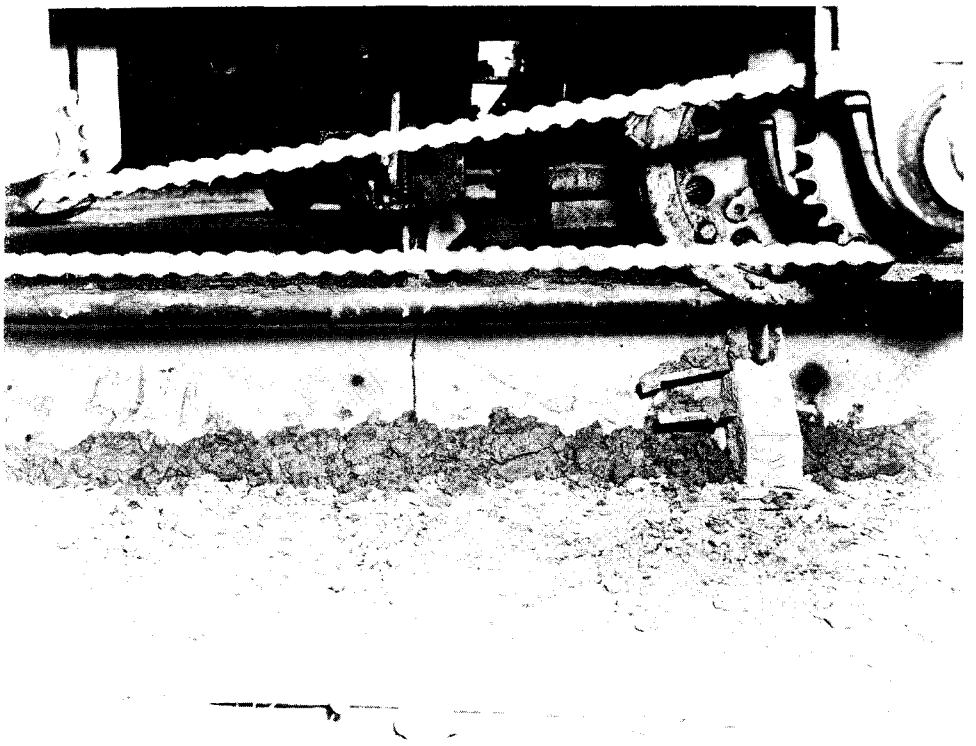


Figure 63-A

the vibrator activated, to the proper depth (Figure 63-B) as shown on the project plans. The clamps are then released and the jig is lifted out of the concrete, as the vibrator is stopped, (Figure 64) leaving the form "strips" deposited in their proper position. On occasions, the form strips will require some adjusting after the jig is lifted out of the concrete.

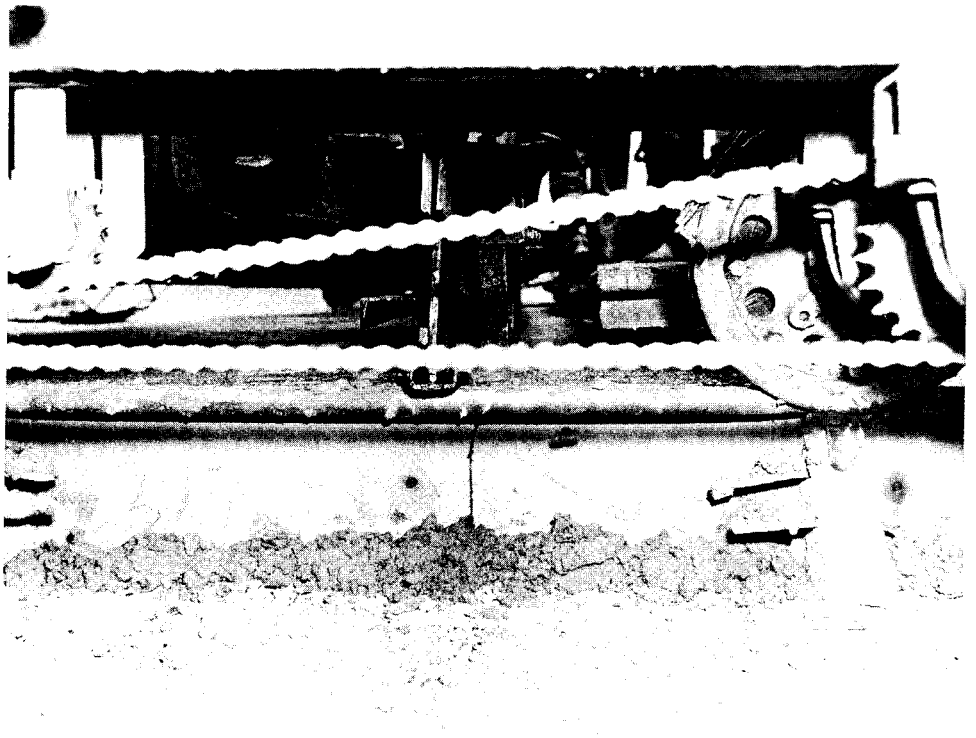


Figure 63-B

For the longitudinal joint installation, an asphalt composition ribbon (approximately 1/8" thick X 3" wide) is placed at the plan-designated location, usually a few inches off the geometric center-line of the pavement in a plane perpendicular to the

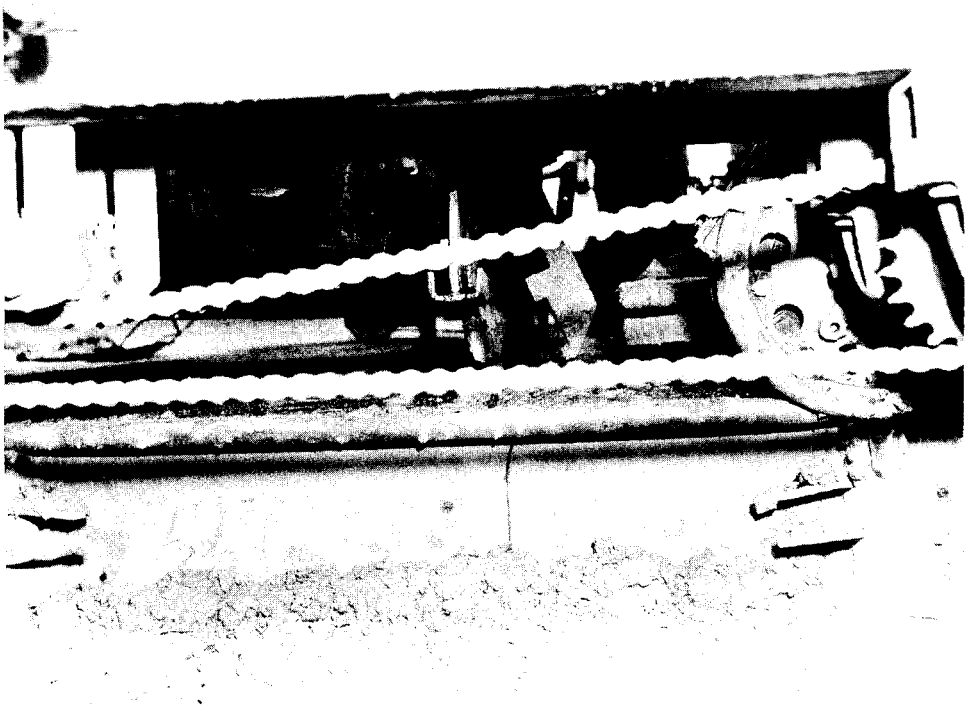


Figure 64

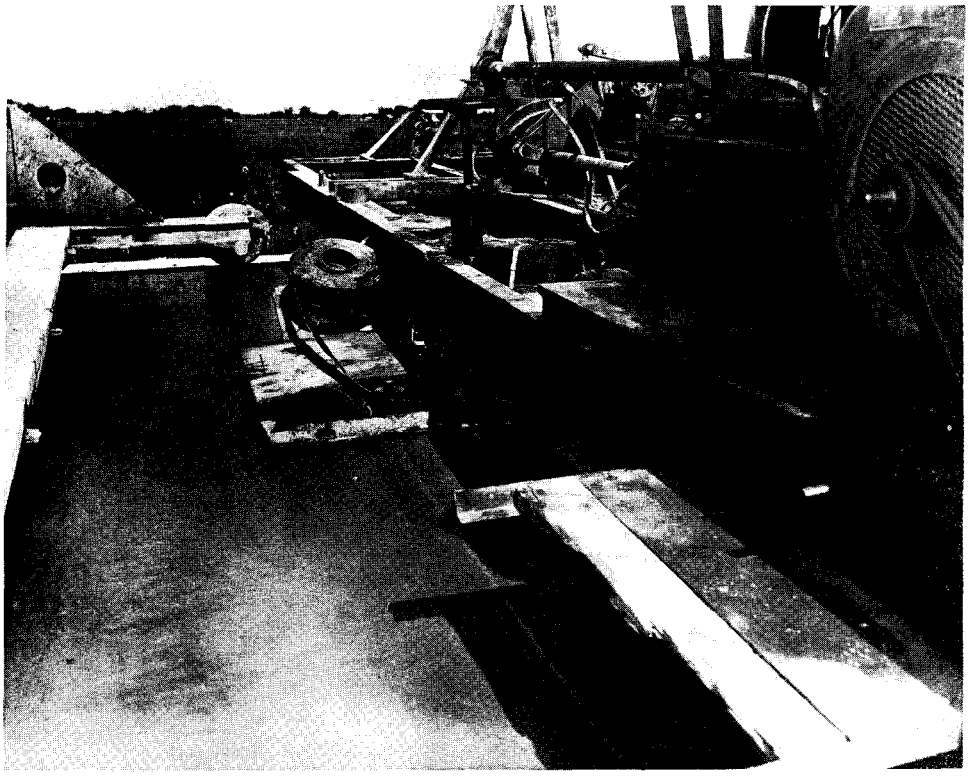
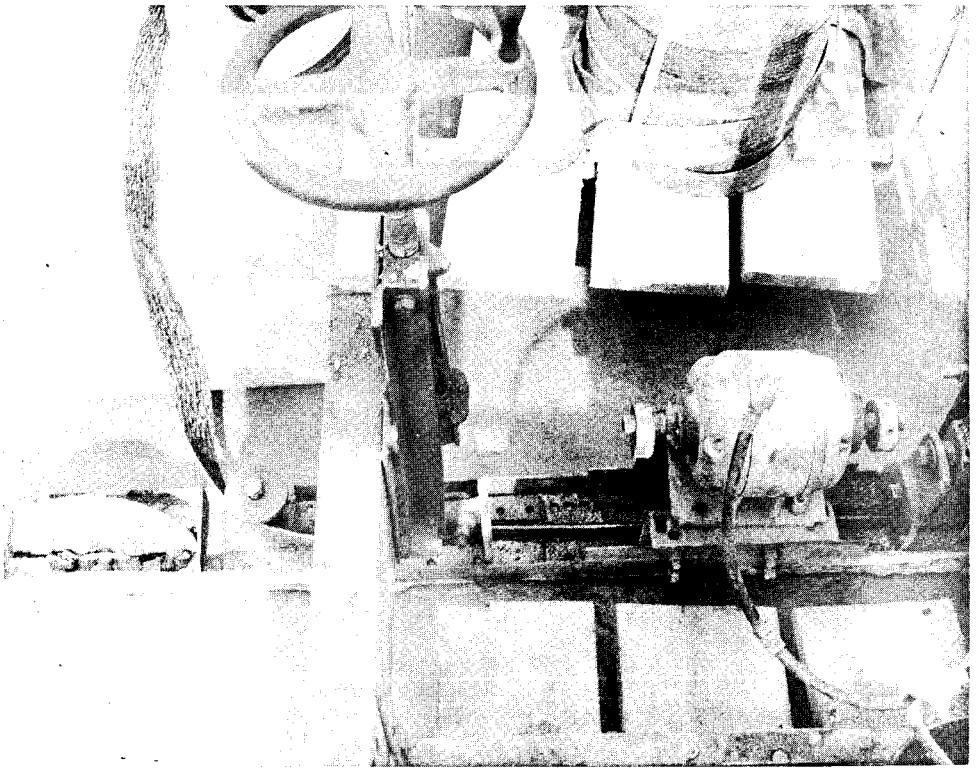
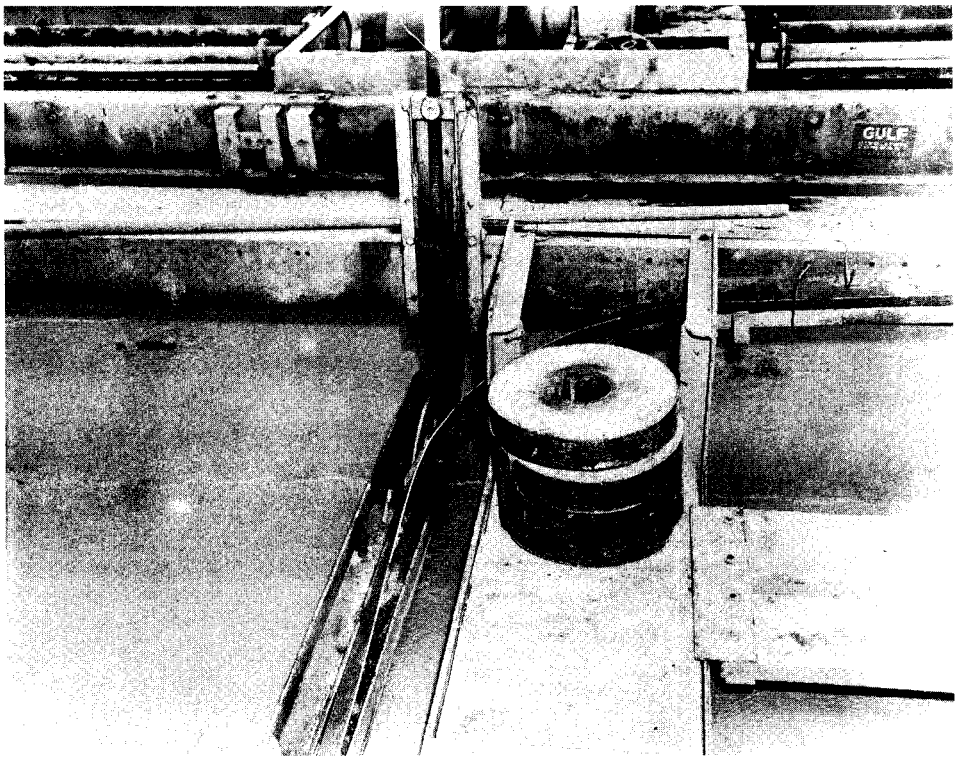


Figure 65

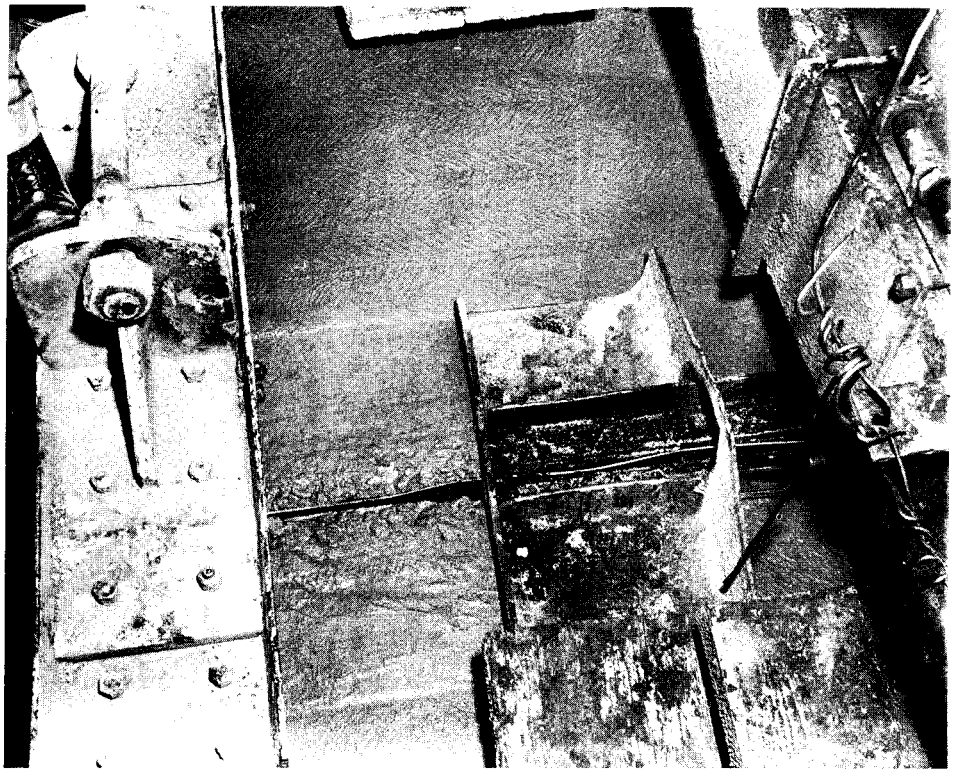
subgraed. The ribbon must be accurately aligned parallel to the center-line of the placement and with its upper edge approximately 1/8 " below the surface of the pavement. The ribbon is delivered to the job in crated rolls of approximately 100 linear feet per roll. From a vertical spindle on the forward portion of the machine, (Figure 65) the roll is unwound and "fed" along vertically, through an adjustable, inclined metal "trench" which evolves into a sort of "plow" which is open at the submerged back end, "threading" the ribbon into the "trench" which it leaves in the concrete and which was first "pilot-scored" by an upright metal disc, Figure 66-A, B, & C, set "on line" and pushed through the plastic concrete ahead of the "plow", to "nose" the coarse aggregate particles out of the way. A vibrator attached to the "plow" assists in consolidating the concrete around the ribbon. This vibration tends to create a low area along the center portion of the pavement and it is a fairly general practice for the contractor to station a man at this place on the Flex-plane (Figure 60) to re-



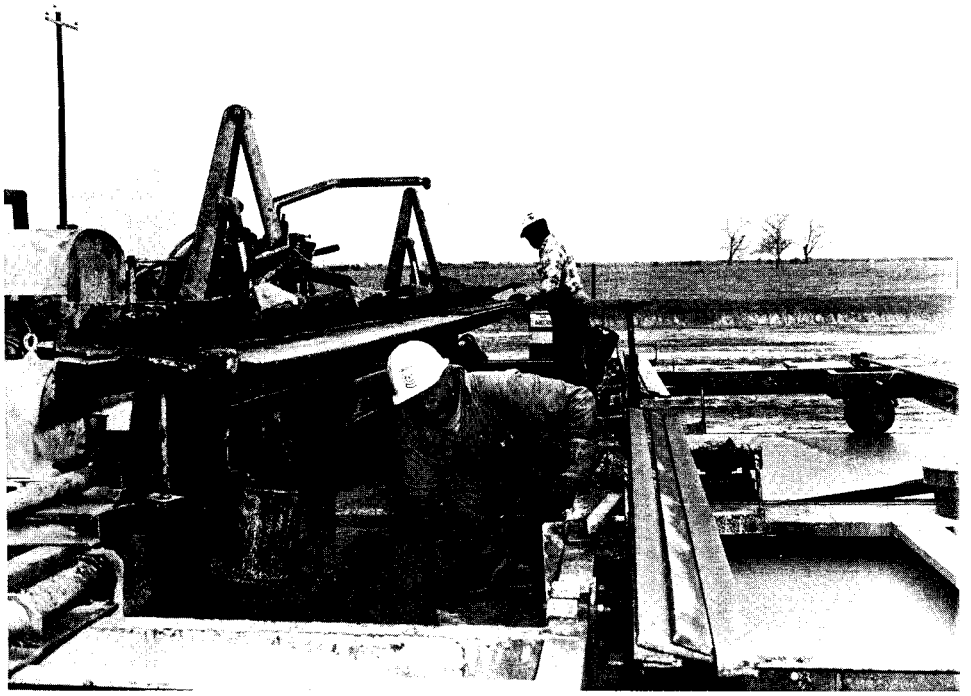
(Figure 36-A)



(Figure 36-B)



(Figure 66-C)



(Figure 66-D)

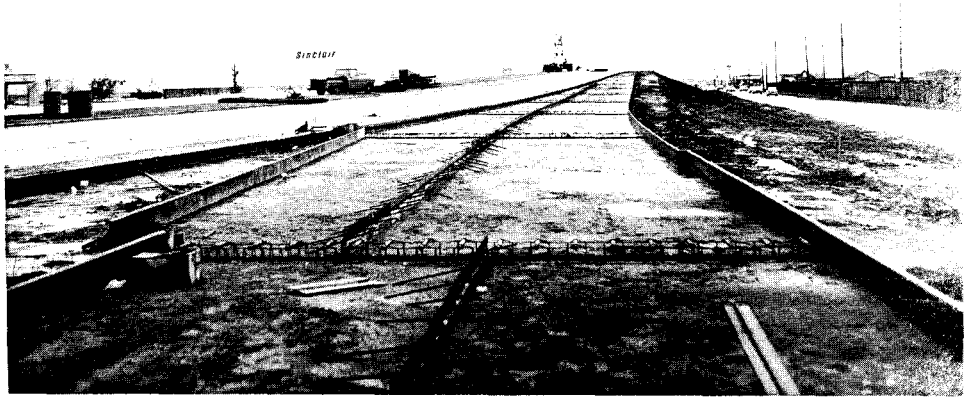


Figure 66-E

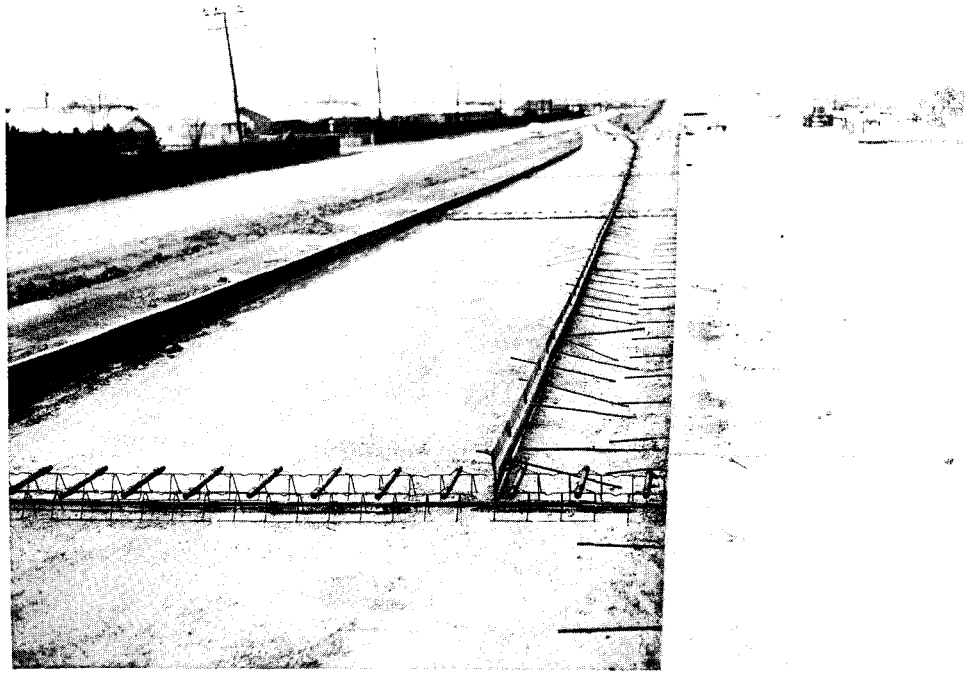


Figure 66-F

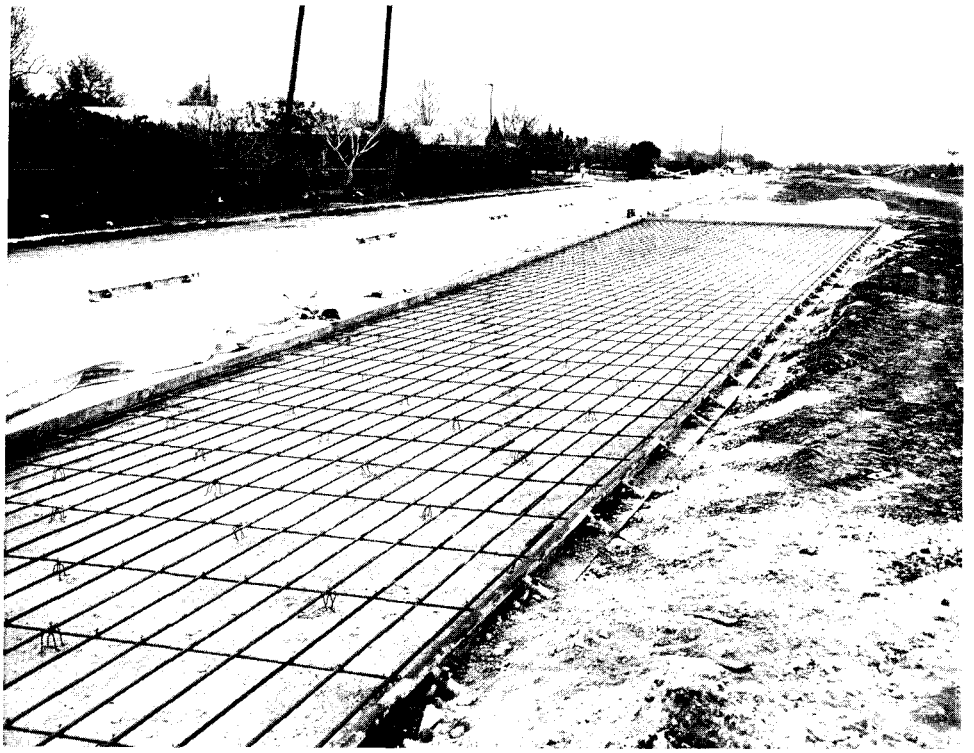
ALL ODD-SHAPED SECTIONS OR AREAS WHERE MECHANICAL INSTALLATION OF THE LONGITUDINAL (or "CENTER") JOINT IS DIFFICULT OR NOT PRACTICAL SHOULD HAVE A METAL PARTING STRIP INSTALLED ON THE GRADE AHEAD OF THE PLACING OPERATION TO ESTABLISH THIS JOINT (Figure 66-E & F).

arrange the surface of the so-disturbed concrete in order to aid in the subsequent finishing operations as well as to assure the proper placement of the"ribbon" in good alignment, perpendicular to, and just below the surface of, the concrete.

Continuously reinforced concrete pavement (Item 366) has no transverse joints except the necessary construction joint at the end of each placement and at structure connections. A longitudinal joint at or near, and along the centerline is provided for, however, As the designation implies, the steel reinforcement is continuous from the beginning of the project to the end of it except, of course, through the structures. The reinforcing is a continuous grid of $\frac{1}{2}$" longitudinal bars spaced on about 9" centers with 5/8" transverse bars spaced on about 30" centers, with special requirements for lapping and tying, Figures 67 & 68.

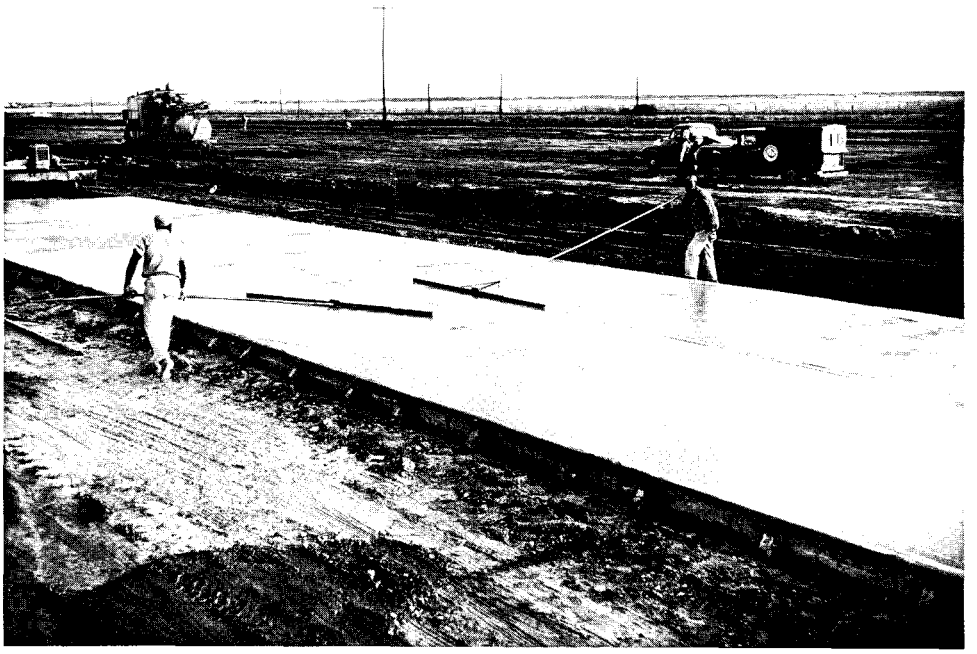
Figure 67

After the joint-form installation, the hand-finishing op-

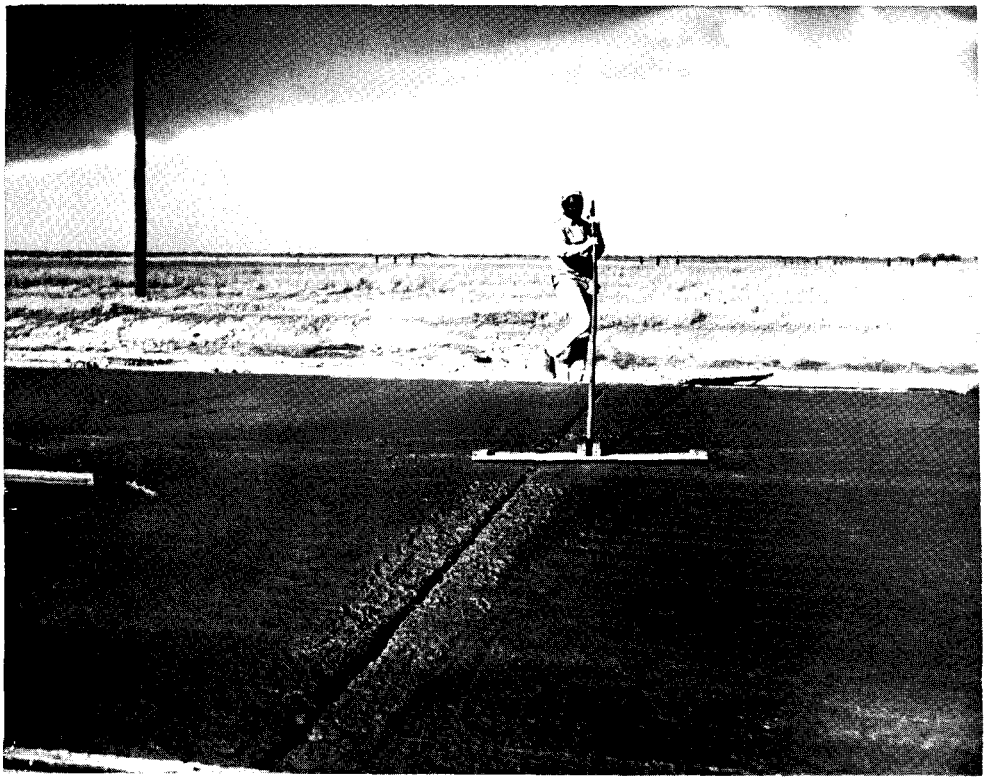


(Figure 68)

erations are performed. The first one of these is the "scraping" straight-edge operation. (Figure 69) The checking and adjustment of the straightedges has been previously explained in the discussion on checking the individual forms for alignment. (Page 22 and



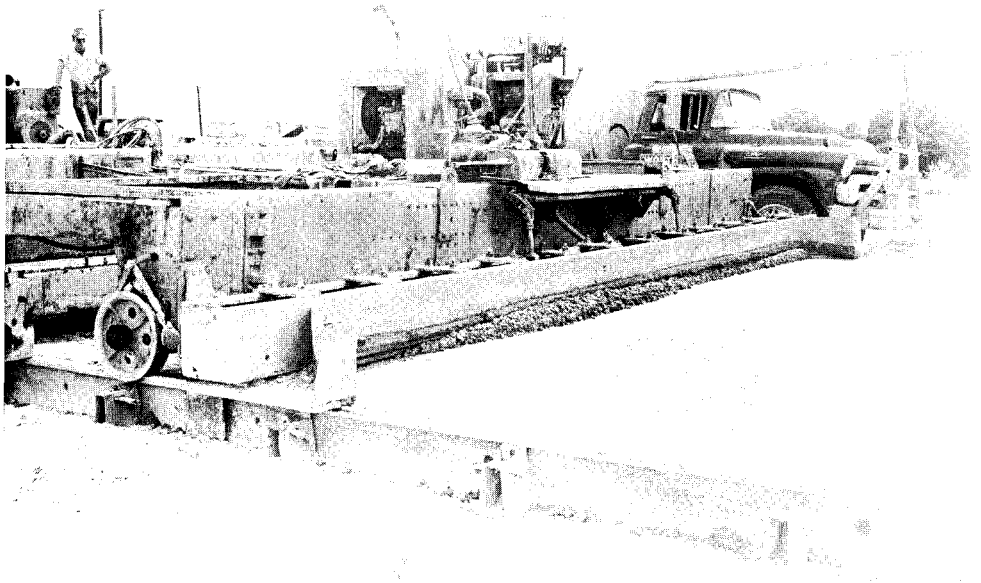
(Figure 69)



(Figure 70)

and 24) Occasionally the long-handled float (Figure 70) is "re-sorted to", to fill-in or to smooth-over open textured areas. In the case of an all hand-finishing operation, this tool is frequently a necessity. Whenever and wherever it is used, it should be a-head of, or before, the straight-edges. Note: If open-textured areas (Figure 71) persist, the aggregate handling at the plant, the grading, the possible need for a change in proportions of the aggregates as well as the methods of placing and finishing should be checked into at once by the chief inspector and his aides to determine and correct the cause of the trouble at the earliest possible moment. A properly proportioned mix should not require hand-floating if properly adjusted mechanical equipment is used. This continued difficult finishing condition is not to be tolerated.

The Straight-edge finisher should begin his operation, at the "back" end of the section at hand, by laying the straight-edge blade on the slab at a convenient working angle to the form-line (approximately 30 degrees) with the "outside" end of the blade



(Figure 71)

extending a few inches (8 or 10) over the outside of the form-line, and pushing the blade ahead along the form-line in this position (Figure 72) for a convenient working distance (25 or 30 feet or possibly more, depending on conditions and circumstances at the

(Figure 72)

moment), exposing the form rail and smoothing the surface of the concrete in the straight-edge's "path". This will reveal any low area near the form line which may need a final filling-in as well as move any possible surplus or accumulation of mortar toward the center area of the pavement which in all probability is a little bit low (Figure 73) if a center joint, as described previously,

(Figure 73)

has been installed. This "accumulation" is not to be used to fill-in if it is "soupy" or "sloppy". It must be good, live, stable, concrete. Any accumulation thus spread along over the surface will be deposited in any low areas encountered. The accumulation which has not been used-up, if any, should be carried along in similar successive, overlaping and parallel passes, progressing to the center-line of the placement, gathering mortar from any "high" areas and depositing it in any "low" areas thus discovered. If the straightedge reveals a low area which cannot

be completely filled with the accumulation at hand then additional concrete will have to be brought from the area of the placing operation and added to such low area to satisfy the requirement. (Figure 16 & 17) When this condition prevails, or recurs repeatedly, (Item 360.8 (1), Page 350 1st paragraph) it means that one or more of the mechanical finishing machines is not performing as it should. The trouble should be located at once and corrected then and there. If there is going to be a significant time delay required to make the needed correction, then the mixing and placing operation should be immediately suspended until such time as adequate, satisfactory operation can be assured and resumed.

The straight-edge is not constructed for "heavy" work and if it is used in an attempt to accomplish the results that should have been produced by the screeds of the mechanical finishing machines, this abuse will not only bend the blade out of alignment but will force an undue and unreasonable amount of work on the hand finishers and will very likely result in an unsatisfactory section of roadway surface.

The section of surface thus covered should now be checked by "gliding" the straight-edge, over the surface, between the centerline and form line, with the blade parallel to the centerline and beginning with half the length of the straight edge overlapped and gliding along on the "old" or existing surface to which the evolving section is being adjoined. This finishing operation moves ahead then in maximum increments of half the length of the straightedge, smoothing any "high" areas remaining and depositing any accumulated mortar or concrete into whatever low spots may still exist. Straightedge finishers work

on each side of the center line and opposite each other (Figure 74) so that the full width section is completed at one time. As stated previously, this operation should be delayed as long as is feasible.

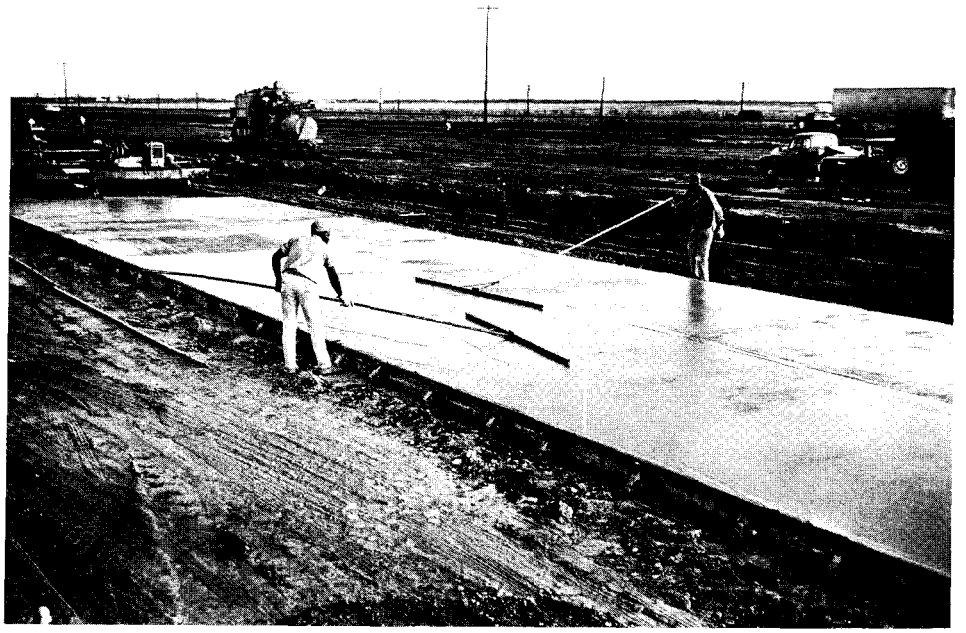
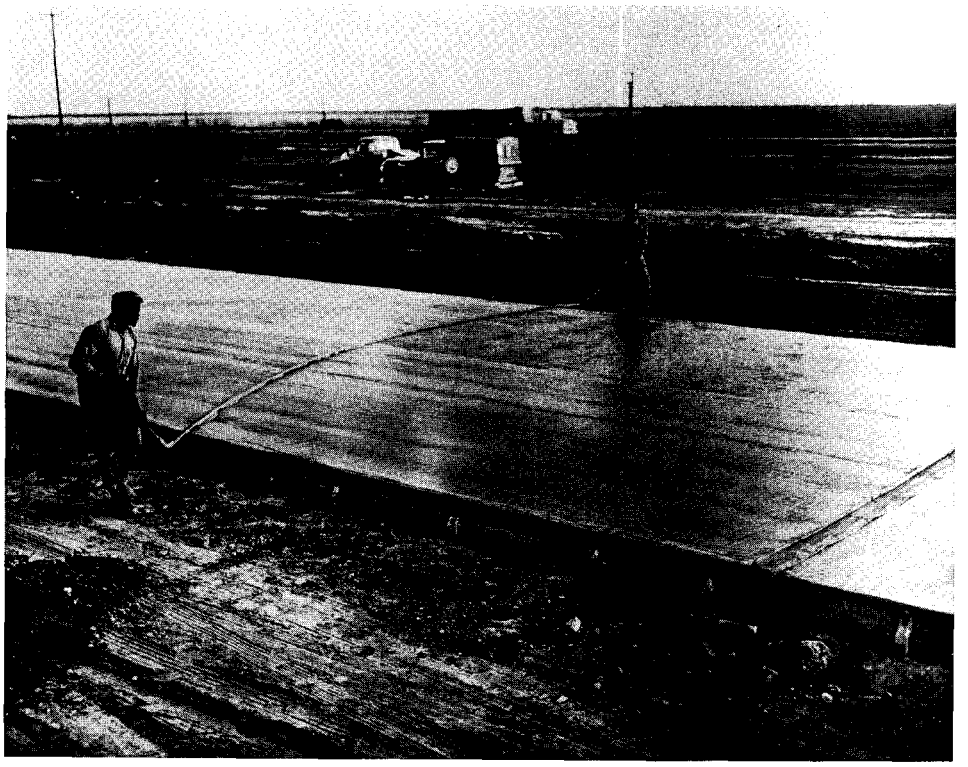


Figure 74

Next, after completion of the straightedge finishing operation, when the moisture sheen has disappeared, but while the concrete is still plastic, the final finish and texture is applied. A rubber hose of approximately 1" outside diameter is used, of sufficient length to make a "lagging" loop on the surface of the pavement when its ends are pulled along and parallel to the form lines. (Figure 75) This is just another means of further distributing and smoothing the surface mortar so that the belt, which is the next operation, will have a uniform accumulation with which to "texture" the surface. When any thin, "watery" accumulation results, it is to be wasted over the forms by sufficiently advancing one end of the hose. The same area is usually "covered" by <u>at least</u> three "passes" of the hose. Two passes being made in the forward direction and one toward the back, but always completing the opera-



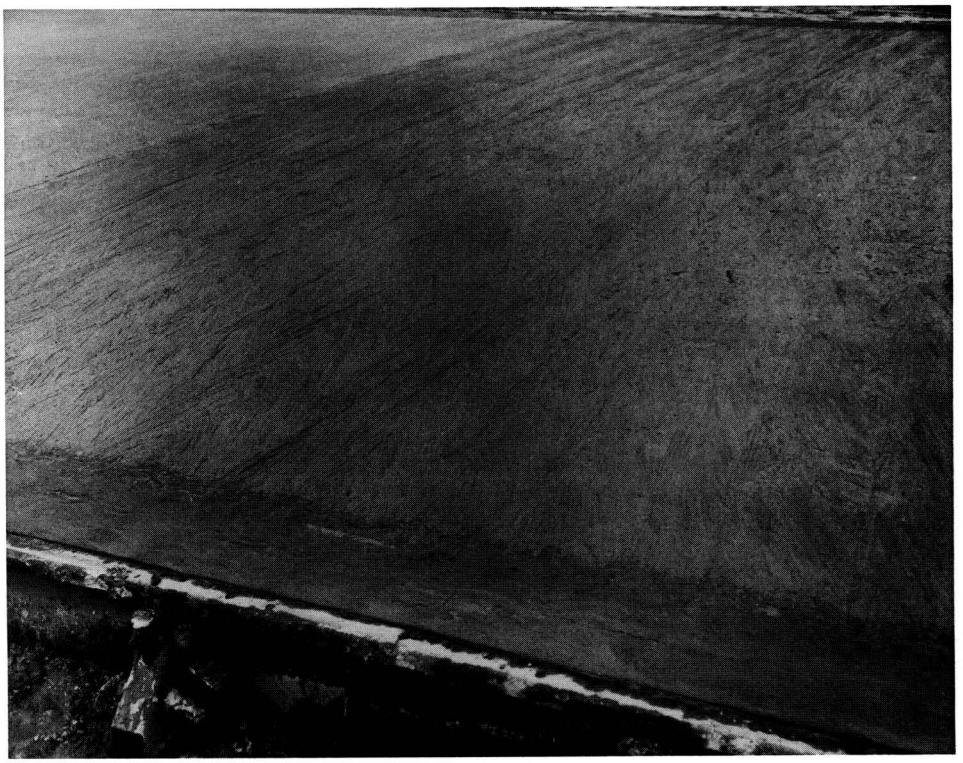
(Figure 75)

tion at the forward end of the section being thus finished.

Immediately following the hose-drag, the surface is to be given its final texture. This is usually applied with a thick canvas belt about 6 or 8 inches wide and of a length 2 or 3 feet greater than the width of the placement with "struts" fastened to its upper side at intervals, sufficient to prevent the edges from curling-up, and with a round broomstick or something similar for a hand-hold, long enough to permit a finisher to grip it on each side of the belt, sewed or otherwise fastened to each end. (Figure 76) Any unwieldly surplus length of belt can be rolled up onto the "hand-holds" and out of the way. A finisher at each end of the belt and directly across the pavement from each other, with the belt laying flat on the pavement, alternately pulls - or drags - the belt across the pavement toward himself as the other finisher leaves "slack" for the belt to move. The two finishers move slowly ahead along the form line while applying this sawing motion

(Figure 76)

to the belt. The belt must always be kept in contact with the surface of the pavement for the full width. This produces a nonskid gritty, surface with a herringbone pattern. (Figure 77) If the slab is "belted" too soon - while it is too wet - the nonskid



(Figure 77)

effect will not be obtained (Item 360.8(1), Page 350, 2nd paragraph) and it must be belted again, when the surface has reached the proper condition.

After the belting operation is completed the joints are finished. The metal-strip forms (Page 39) are first loosened in the concrete. The state of the concrete at this stage of the operation should be just "set-up" (stiff and firm) enough to retain its shape without slumping back in the groove which is left in the pavement when the strip is removed. To satisfactorily finish a "joint" requires two finishers. When the concrete has attained just enough "set" to be firm, yet is still workable, it is in the proper condition for "working" the joint. With a finisher at each end of the form-strip, the strip should be gently lifted vertically just high enough to break the surface of the pavement and to expose the top of the form-strip. (Figure 78) Then, the concrete

(Figure 78)

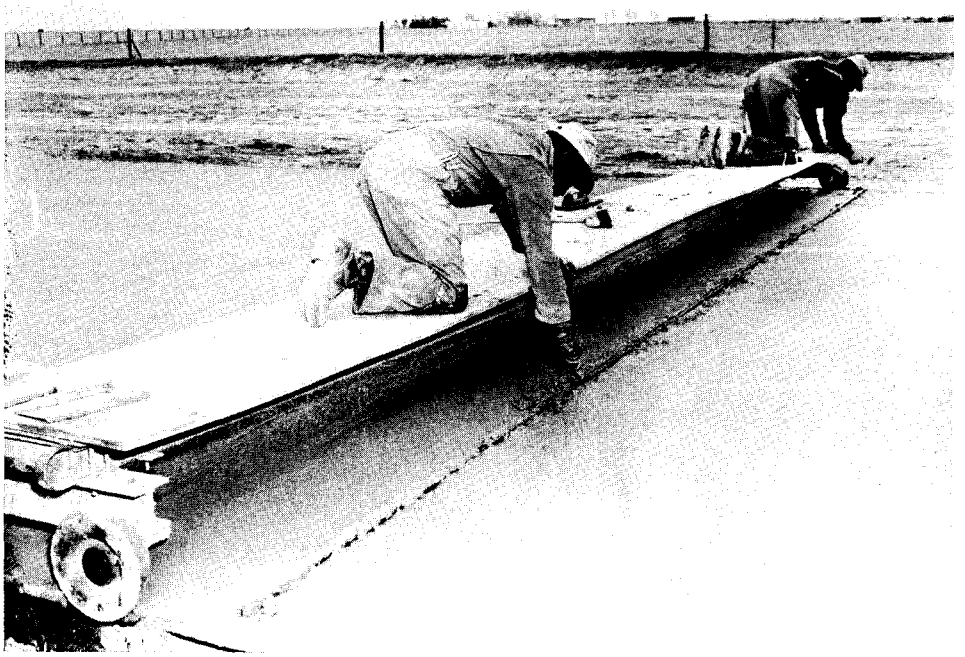


Figure 79

joint should be gently "cut" along the sides with a small trowel (Figure 79) with the leading edge of the trowel held firmly against the form strip and with the trailing edge of the trowel very slightly turned away from the strip. The idea is to very gently "plow" the sides of the joint slightly away from the form without disturbing the adjacent coarse aggregate particles and in so doing, spread the mortar film along what will be the side of the joint, and end of the slab, when the joint is finished. If the concrete is too firmly "set" and the coarse aggregate is disturbed so that the concrete adjacent to the joint appears "fractured" in the finishing process, it is quite likely that these fractures will be permanent. Even though the finisher hides, or camouflages them with a little fresh mortar, as soon as a few cycles of temperature fluctuation are, and/or traffic is, imposed upon them, these fractures will become spalls, which continued traffic and temperature differentials will develop into pavement failures.

The finisher should "work" the joint in short stages -

Figure 80

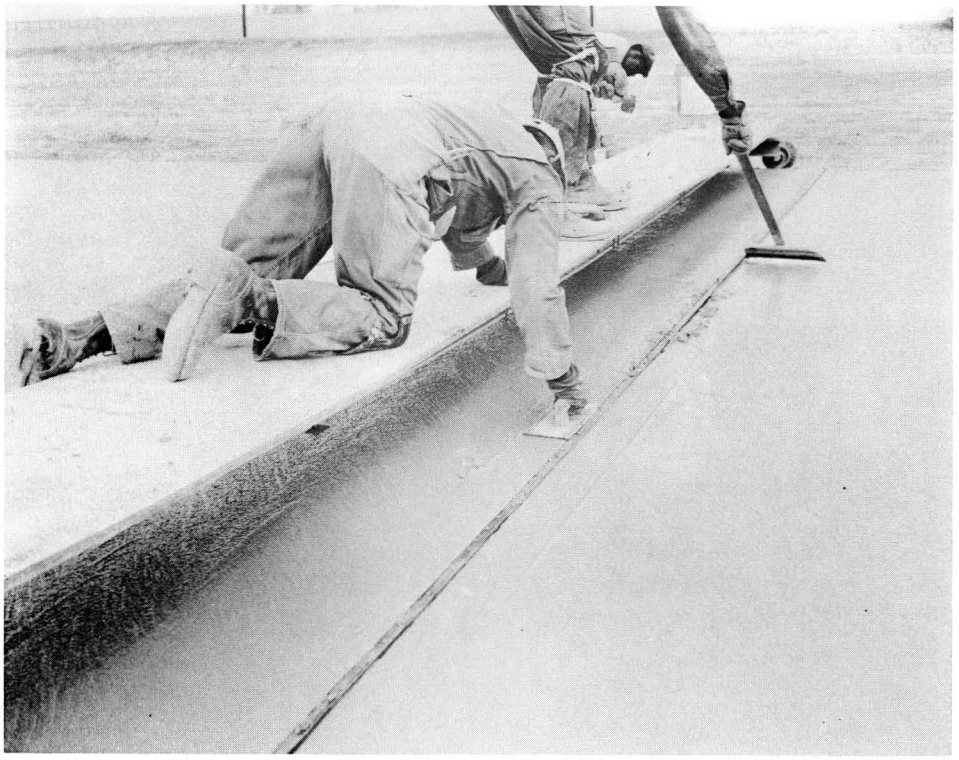


Figure 80-A

about 3 feet or an arm's length at a time. After the "cutting" along the sides, a tool called an edger - which is designed and is available in any customary radius to shape the specified edge - is plied to the sides of the joint and top of the slab (Figure 80 & 80-A) to effect a neat, uniform, rounded edge to the joint.

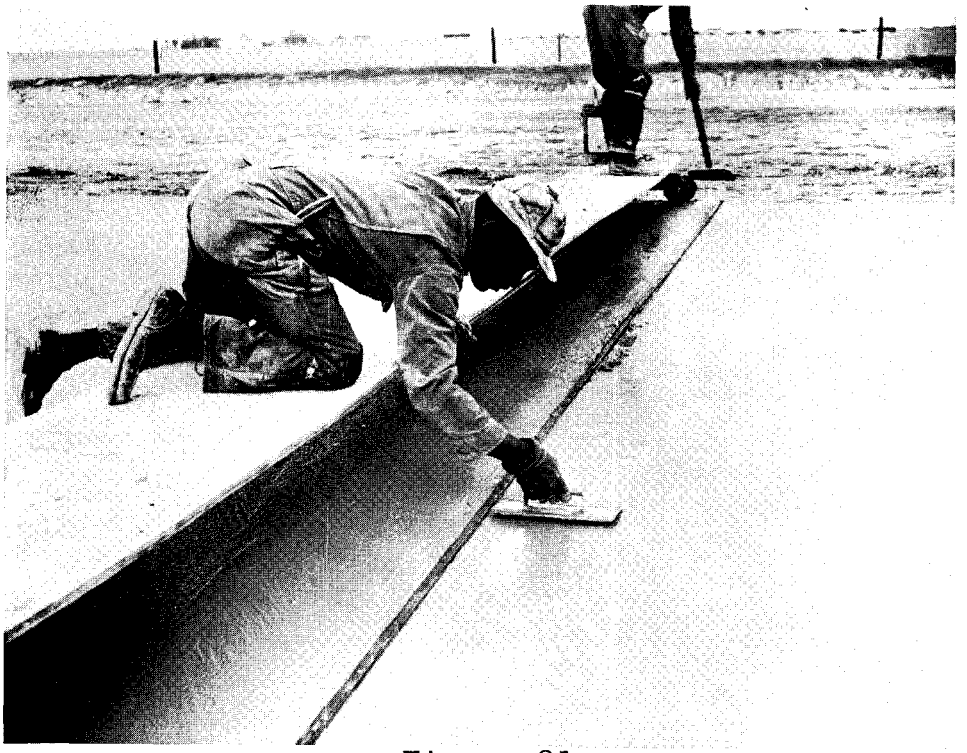


Figure 81

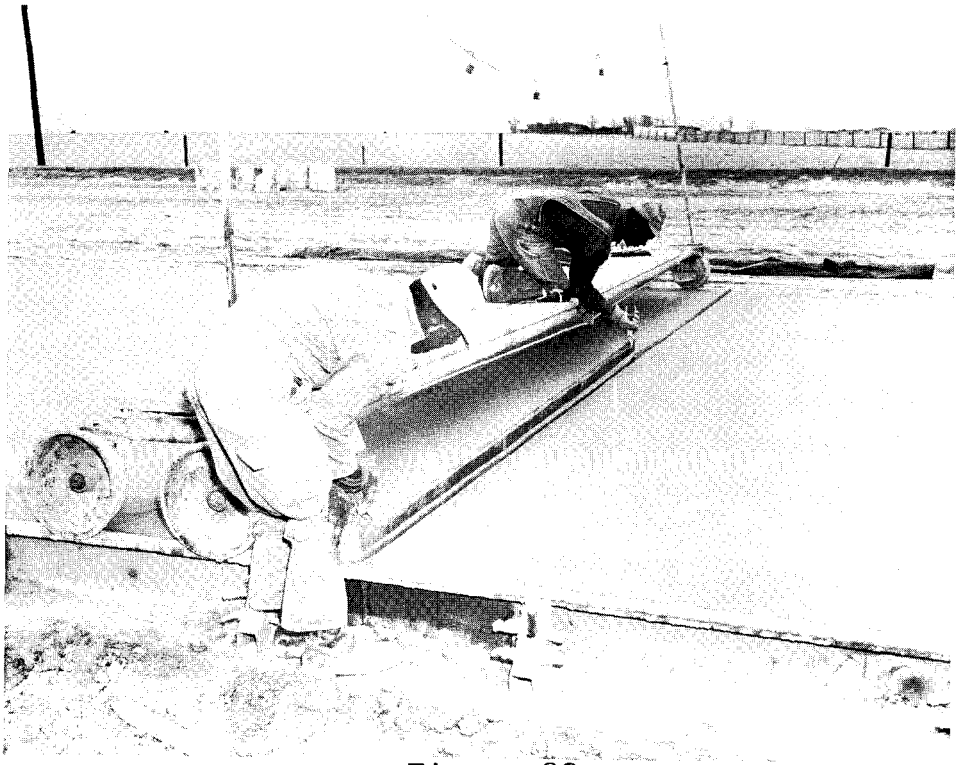


Figure 82

This tool will leave a linear "path-mark" which is to be dissipated with a 12" steel plasterer's trowel (Figure 80-A & 81). After the joint sides have been edged and troweled the form strip is to be removed. This should be accomplished by lifting the form vertically by both ends simultaneously (Figure 82) so as not to deform

or otherwise deface the "green" concrete, instead of by lifting one end and dragging the form along through the groove. The joint forms should be handled carefully to prevent their getting bent and should be cleaned and oiled after each installation. After the form-strip is removed, a 16" steel plasterer's trowel should be plied across the groove with a light stroke to equalize any remaining difference in heighth of the sides of the joint. This final "straight-edge" performance will be followed by the concluding finishing operation which is the brushing out of the final trowel marks. (Figure 83)

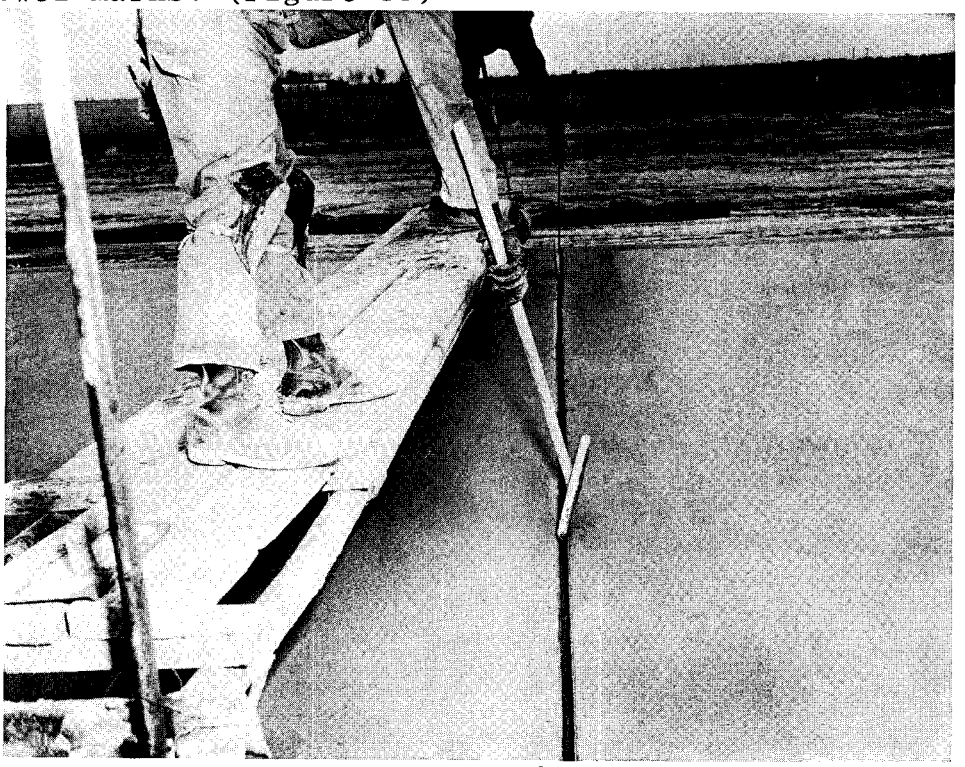


Figure 83

Both edges of the pavement along the form-lines must also be edged and brushed, Figure 84 & 85. For this brushing, a paper-hanger's style brush, with a long straight handle affixed, is used. The brush should be dipped in water and the excess then removed by "slinging" the brush a time or two.

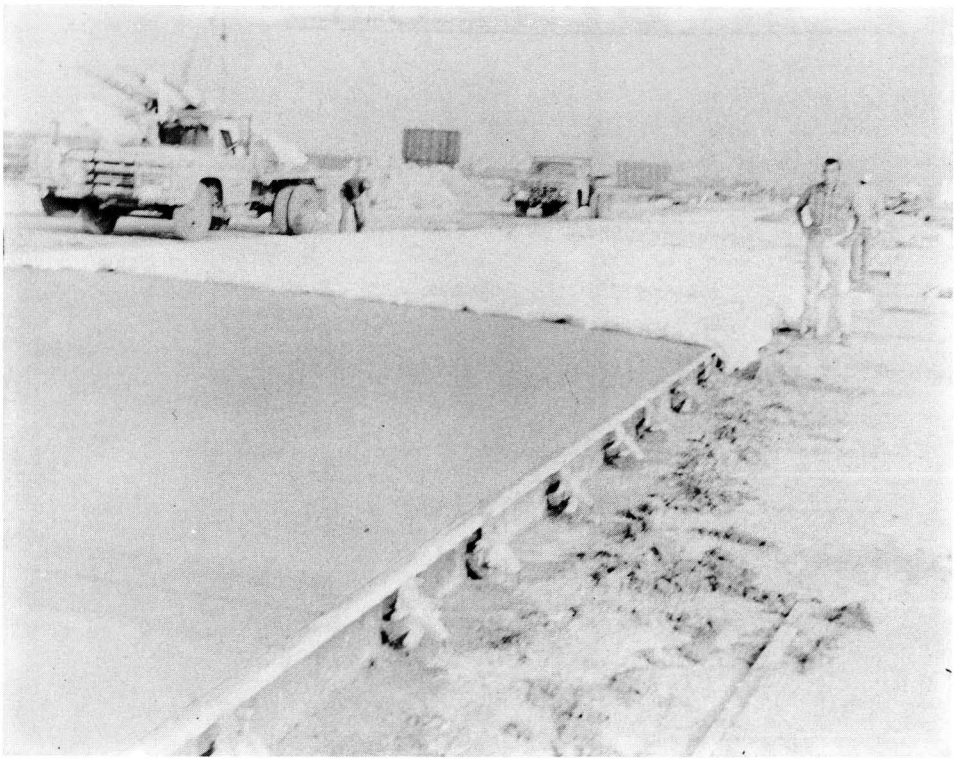
(Figure 84)

(Figure 85)

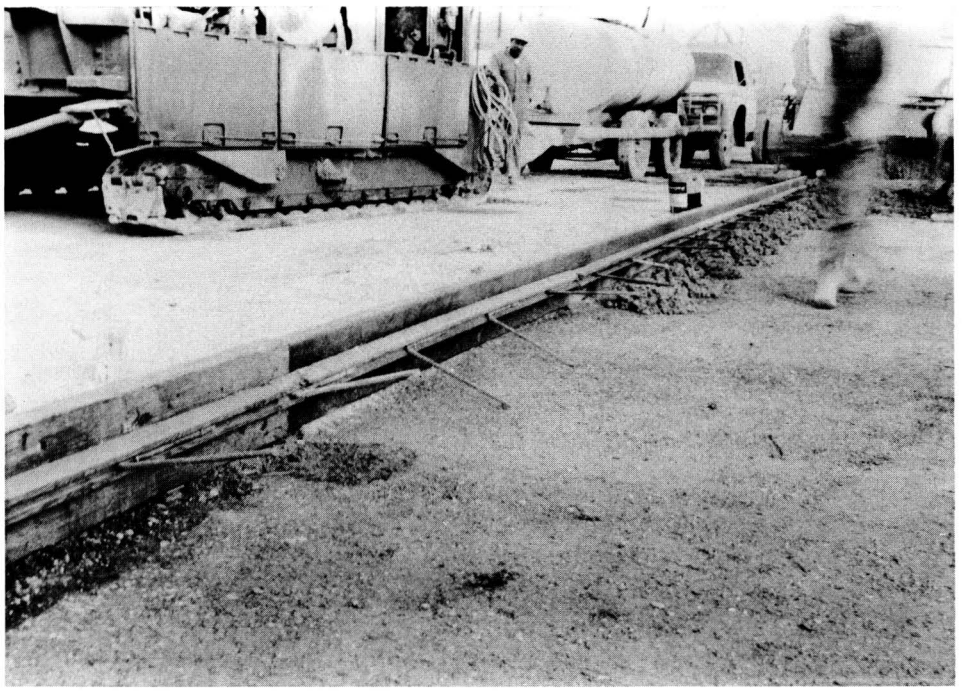
CURING: Curing is the providing of, and/or the maintaining of, sufficient readily available moisture necessary for the satisfactory hydration of the cement, to solidify the mass into a unit attaining the designed strength. It also protects the "green" concrete from adverse actions of the elements and other physical forces, both internal and external, during the solidification and strength attaining interval. The merits of the various methods are somewhat controversial among their proponents[1], but good practice requires that the concrete be protected from:

1. Temperature extremes - both hot and cold.
2. The adverse effects of driving rain and drying sun and wind.
3. Premature loading and abrasion.
4. Excess volume change due to high rates of moisture loss.

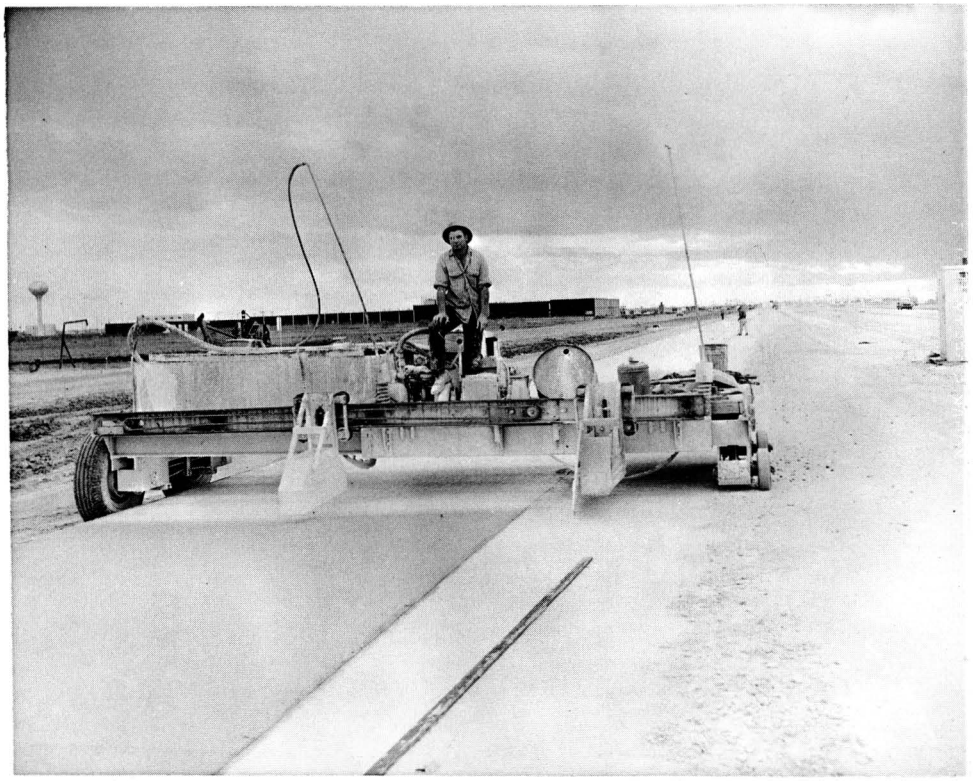
If a method of curing is employed in which a covering "balnket" is used, page 125-A, this cover should be applied as soon as it can be placed without marring the surface of the "green" concrete. It is important that the concrete be given the protection of whatever process is used, as soon as is feasible, especially in hot, dry or windy weather; since under these conditions, the surface will quickly dry-out to the extent that shrinkage cracks will develop before they are noticed unless preventive measures are taken. In these cases of "severe" weather conditions, the surface should be "fog-sprayed" with water, pages 62-A & 98, to counteract the high rate of evaporation, if the application of the curing medium is delayed at all. To splash or spray the surface with too much force, will damage the finish that has been painstakingly produced and contribute to scaling; therefore, these methods should not be employed.



"BLANKET" TYPE CURING PROCESS. SPECIALLY PROCESSED HEAVY PAPER HAS BEEN USED. SHOWN HERE IS A REINFORCED PLASTIC FABRIC SUPPLIED IN 100' ROLLS. CARE MUST BE TAKEN TO PREVENT PUNCTURES & TEARS IN THE MATERIAL FOR THIS TYPE CURING. BILLOWING MUST BE PREVENTED & CONTINUOUS CONTACT WITH THE CONCRETE MUST BE MAINTAINED.

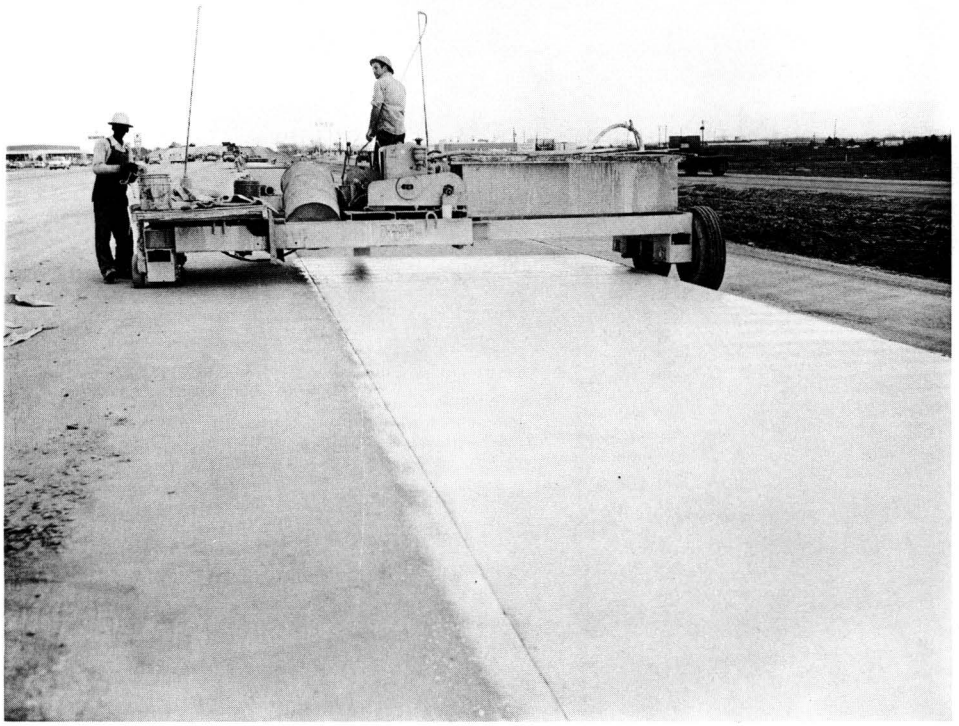


SHOWING INSTALLATION OF TIE-BARS WITH "KEY-WAY" FOR LONGITUDINAL JOINTS WHERE ADDITIONAL CONCRETE IS REQUIRED OR ANTICIPATED ALONG SIDE.



(Figure 86)

Where a curing membrane is to be applied, the mechanical equipment should be adjusted and maintained to obtain complete and uniform coverage. (Figure 86 & 87) The timing of the application and the pressure of the spray should be so regulated that the tex-

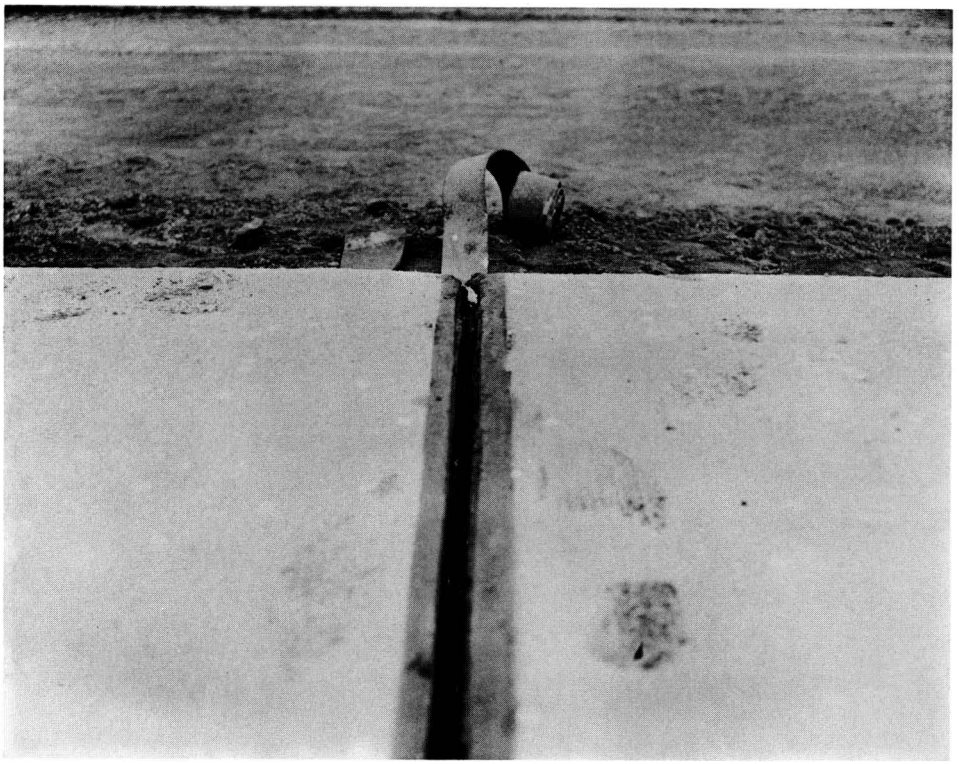


(Figure 87)

ture of the "green" concrete is not harmed. The curing compound supply tank should be provided with a means of agitation and the curing compound should be frequently, if not constantly, agitated so that a uniform water-impermeable film will be applied to the concrete.

Whatever method is used, it should be promply applied and maintained in good condition throughout the required period (Item 360.9(1) Page 351). The application of the curing medium, whatever it might be, should not be delayed beyond its proper time for any reason. Placing operations are to be suspended if necessary, in order to insure the proper execution of the curing operation. If it is necessary to temporarily remove or deface the curing cover for some other related construction operation - joint sawing, joint sealing, surface checking or correction or revision, etc. - the operation should be so planned that the interruption of the curing phase will be the shortest possible.

After the curing period has terminated and before any traffic is permitted on the pavement, the joints are to be cleaned and sealed, (Item 360.10(2), Page 356), the pavement cleaned-off and a roll of earth pushed up against the edges. Any joints that have not had the seal-space opened entirely across the slab (Figure 88) should be so "cleaned" at this time. Any concrete that must be cut out of the joint ends should be chipped from the outside edge inward toward the centerline. To knock the "block" out toward the edge of the slab will spall the outside corner of the joint and pavement edge. This is not only unsightly, but it tends to cause, future distress of the pavement at these joint ends, with all the attendant maintenance operations and costs.



(Figure 88)

In conclusion a few ideas regarding reports and records is considered appropriate. As has been mentioned several times in the course of this treatise, uniformity is one of the most important considerations in all our efforts to attain the principle objective - a modern smooth riding facility, safe for the users properly constructed of good quality materials at a reasonable cost with a fair profit for the work done. Because the list of possible variables is so long, and so many of them are not controllable on the project, it is safe to say that no two projects ever built have been identical. This lack of uniformity then demands that complete records must be kept if improvement in the "art" of concrete paving construction and inspection is to be made. All construction people feel that they are buried in record keeping and a considerable measure of time is spent on this phase of the work. Almost all of what we consider to be the fundamental records are kept as a sort of "second nature" to us. Such records as material received, when and where used and in what quantity and proportions,

the strength of the materials, individually and combined, etc., all of the ordinary, every-day, run-of-the-mill events are documented nice and neat and in-line. As far as the records reflect, this has been a perfect job - everything as it should be, in place, on time, the correct size; no variation; the right proportions; everything according to plan and specification. But what about the morning that the sand scale was unintentionally 200 pounds light (or heavy) and it was not discovered for a "round" or two of the batch trucks (and not recorded) - or it was not discovered until the time that a change in cement was made that was duly recorded. Then some years later on a condition survey, it would be logical (without the recorded facts) to draw erroneous conclusions as to the affect or quality of the different cement. Such accidental errors or "boo-boos" of any nature are seldom if ever found in job records for various reasons, fear of reprisal, or of ridicule, or inability to understand the possible significance of such a triviality, or for some other reason. Inspectors should be encouraged to record unusual events of any and all kinds, mistakes, accidents "foul-ups", "boo-boos" and all such deficiencies. Far more can be learned from a project on which some things went wrong, if the facts are made known, than from one which ran (according to the job record) as smooth as silk, all according to the book, with everything the right dimension, in the right place, and at the right time. If you have ever had to check back through job records looking for some explanation or reason for either exceptionally good or bad performance of a section of road of whatever type, then, at least, you will appreciate the true value of accurate, complete, and fully factual records.

BIBLIOGRAPHY

1. Peyton, R. L., "Criterion for Present Day Concrete Pavement Construction", Highway Research Board Bulletin 162, Publication 522, Washington, D. C., 1957.

2. Harwood, Warner, "Adjustment of Concrete Paving Equipment", Highway Research Board Bulletin 265, Publication 778, Washington, D. C., 1960.

3. Barbee, J. F., Ohio Department of Highways, "Construction Practices for Placing Finishing and Curing Concrete Pavement" Highway Research Board Bulletin 265, Publication 778, Washington D. C., 1960.

4. Stingley, W. M , Concrete Engineer, State Highway Commission of Kansas, Topeka, "Construction Practices for Materials Control and Batching Operations for Rigid Pavement", Highway Research Board Bulletin 265, Publication 778, Washington, D. C., 1960.