ASPHALT HANDLING EQUIPMENT

Thesis for the Degree of B. S.

MICHIGAN STATE COLLEGE

R. M. Pearce

1948

Asphalt Handling Equipment

A Thesis Submitted to

The Faculty of

MICHIGAN STATE COLLEGE

of

AGRICULTURE AND APPLIED SCIENCE

by

R. M. Pearce

Candidate for the Degree of

Bachelor of Science

June 1948

. . . . INTRODUCTION . . . .

The building of any type of asphalt surfacing is essentially a manufacturing process. A book of specifications provides the various steps which must be taken in the process of paving to insure uniform results. To accomplish this purpose, a variety of mechanical aids are employed and the trend of the times is to provide new types of equipment and to further improve those already in use. The purpose of this thesis is to try to picture and advise as to the use and the handling of the latest, most modern equipment.

In the past few years, many concrete pavements have scaled and failed in various other ways. The cheapest, most economical in long life as well as initial payment is a patching then resurfacing with some kind of asphaltic material. In making a complete asphaltic concrete pavement, shaping to crown, laying, and finishing are simplified. There is a minimum initial outlay for materials with cheap maintenance. These things are what are bringing asphalt into a new era. For the above mentioned reasons, I thought this subject an important one. Asphalt has its drawbacks, however, in that it has a much shorter life than concrete.

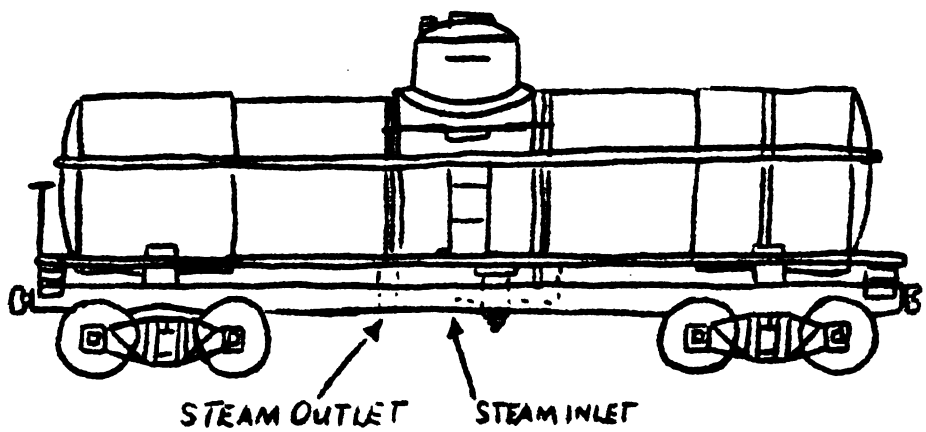
6/4/43
8 -

TRANSPORTATION PROCEDURES

In the shipping of asphalts the major problems introduced are in the loading and unloading of the substances. These problems are dependent upon the type of asphalt transported as well as the shipping method chosen.

One method of loading is accomplished in Venezuela by a long belt. At the loading end of the belt is an old lake bottom which contains asphalt. The asphalt travels down the belt almost entirely by the force of gravity into the hold of a ship. The majority of these ships are destined for Gulf Coast ports where it is refined. This "native asphalt", as it is called, even after refining is too hard for most road and street uses and must be softened by adding softer petroleum asphalts.

This asphalt must be kept heated to facilitate loading into tank cars and trucks in order to be moved about in the United States. There is a great fire hazard in the handling of the asphalt. When unloading tank cars, you must keep lights and fires away and never use gas or air pressure to speed unloading. To heat the asphalt for unloading, use steam at from 90 to 125 pounds pressure. In order to pump readily, heavy paving asphalt of 45 to 60 penetration should be heated to 240° F.; 100 to 150 penetration to about 225° F.; and lighter grades should be heated to 200° F. to 215° F. Before introducing steam into the inlet valves, be sure that both outlet valves are wide open. If there is a defective coil in the car, which will be indicated by a bubbling of



TANK CAR

steam through asphalt accompanied by a rumbling, the contents may be heated by inserting a temporary coil through the dome. Tank cars should be braked and blocked and the dome cover should be opened for unloading. Upon completion of the unloading operation, all pipes should be thoroughly drained, the dome cover closed, then the inlet valve and finally the outlet valves closed. In no case during the operation should an open flame be introduced. The capacity of these tank cars run from 10,000 gallons, or 40 tons, down to 6,500 gallons.

Transport trucks are heavy steel tanks which should be equipped with baffle plates to prevent surging. They may be insulated and often contain heating flues. Pumping equipment is also desired. When two trailers are used in tandem, the total load is almost that of a small railroad tank car -- about 6,000 gallons.

Shipment of asphalt may be made in 50 to 55 gallon steel drums. Asphalt cements may be shipped in friction top drums constructed of 24 to 28 gauge metal. Asphalt up to 200 penetration can be shipped in 24 gauge metal drums, while 28 gauge metal is strong enough for asphalt cement of 85 penetration or lower. Liquid and softer than 200 penetration asphalts require a heavier drum of 18 gauge steel equipped with bungs.

Asphalt heaters are a vital part of the equipment used in the handling of the asphalt. Since the advent of the gasoline roller, they have had to find another way of

heating the asphalt instead of just connecting up to the steam roller or portable steam boilers. Now special heaters are made which consist of a small boiler fired by oil burners and having a return system which efficiently returns all the condensate back to the boiler, in so doing saving water, fuel and preventing scaling of the tubes. For one large tank car (10,000 gallons) it requires about eighteen (18) hours to heat the material to 250° with a 90 gallon fuel consumption. To obtain higher temperatures, a heater known as a booster is used. The asphalt will be in a pumpable state. The asphalt is pumped from the tank through the booster and back into the tank, thus quickly raising the temperature of the entire load in a short time.

Another type of heater is the heating kettle used in maintenance and repair work. Heat is furnished by oil burners. These kettles come in sizes of 50 to 325 gallon capacity. This type heater is portable and should be equipped with hand spray and pump.

ASPHALT APPLICATION

An asphalt distributor is a key piece of equipment in the construction of surface treatments, mixed in place types, and penetration macadam. It is used to apply asphalt to the surface in measured quantities and at a specified rate in order to give a uniform surface. This piece of apparatus consists of a truck or a truck-drawn trailer with a mounted insulated tank, or a tank with some kind of heating system. Sometimes the heating system is made up of steam coils, but

ASPHALT DISTRIBUTOR
WITH SPRAY BAR

more often it is an oil burner with direct heat applied by passing the flue through the tank. Another necessary part of the distributor is a power-driven pump capable of handling light cold application road oils to heavy asphalt cements at 400° F. At the end of the tank is attached a spray bar. This spray bar ranges in coverage from six feet to a maximum of twenty-four feet. There also should be some kind of hose attachment to enable an operator to cover areas not reached by the spray bar. Distributors come in sizes from 300 gallons to 4,000 gallons. Control of the rate of application is had through using a tachometer. Knowing the width of the spray bar, the capacity and speed of the pump, a simple calculation will give the tachometer reading, which gives the speed the truck should be driven. There are two types of pumps on these distributors -- one operates on a separate motor, and the other is operated by a power take-off from the driveshaft of the truck.

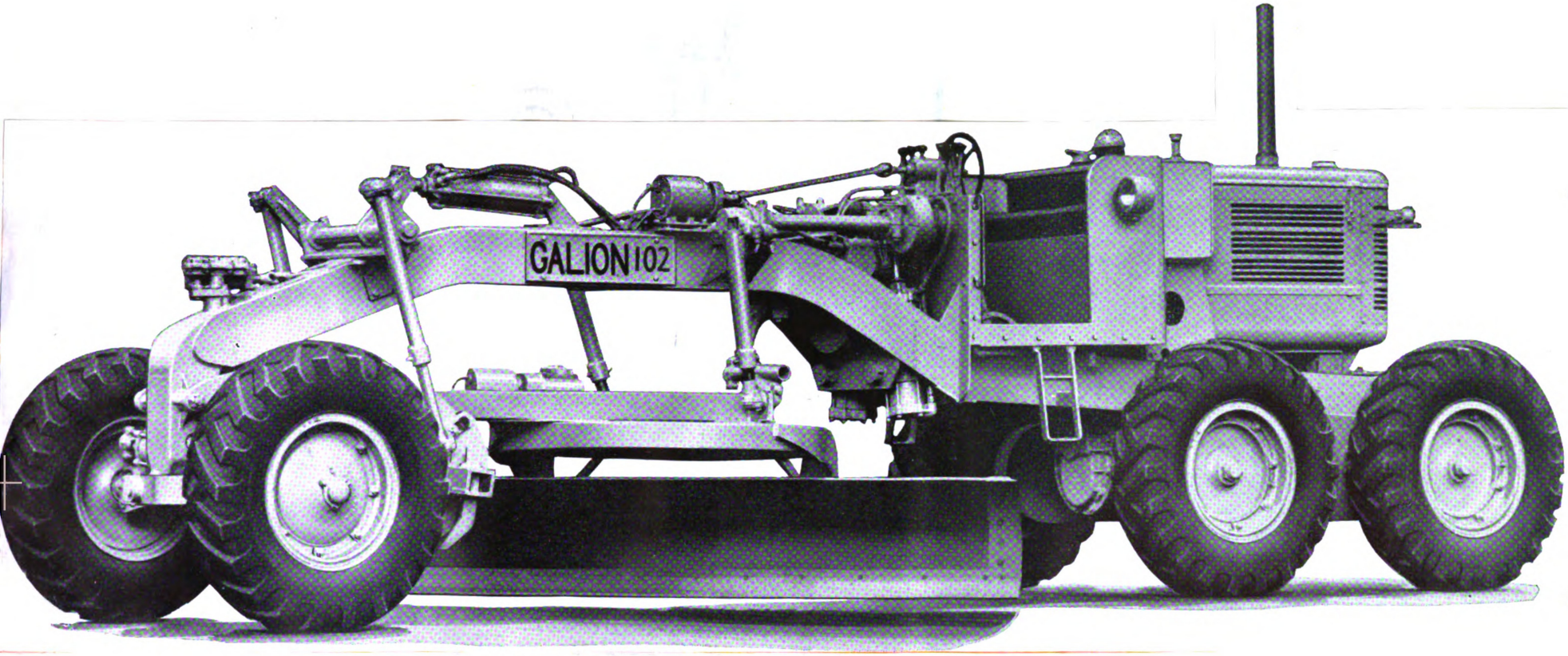
For thin applications, such as surface treatments, an aggregate spreader is needed. Aggregate can be spread from the tail gate of the truck onto a steel plate equipped with vertical vanes which distribute it uniformly over the surface area. Another type consists of a steel plate on rollers which whirls around, spinning the aggregate over the surface. A third type is a hopper type on wheels. This type is used for layers of aggregate one inch or more. The spreader usually covers one-half the width of the lane under construction and usually uses two spreaders so that the full width is

brought along approximately equal.

MIXING IMPLEMENTS

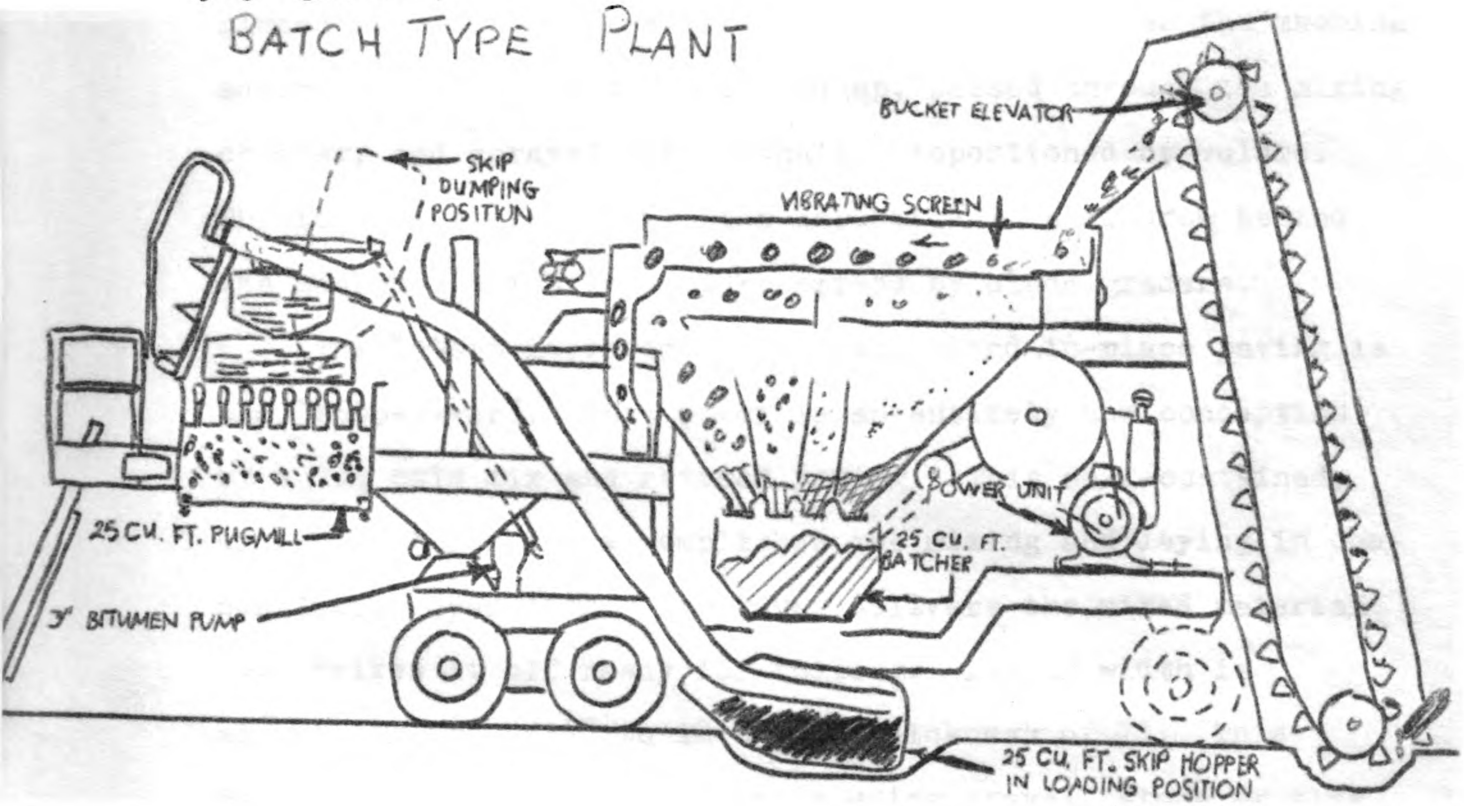
For surfaces that are mixed-in-place, a single blade grader hauled by a tractor or a truck were the early type of equipment, but improvement was gained by mounting a number of blades on one frame so that as much mixing was done by one pass of this as was done by fifteen or twenty passes of the single blade. Some machines also have rotating mixer blades in addition to the fixed blades so that complete mixing is accomplished in one passage of the equipment. The use of such equipment accomplishes the work with a minimum of delay to traffic, but permits the use of a higher viscosity asphalt and a quicker setting of the surface. A multiple blade drag consists of four or more blades in pairs of mixing blades, diverting blades and a strike-off blade. A depth of twenty inches is minimum for efficient blade depth and the blade should be curved in order to give the best mixing action for the amount of aggregate handled.

Other types of mixers for mixed-in-place equipment are rototillers, maintainers, and harrows. A rototiller is of turtle-back design. There are a number of spring controlled arms which force the aggregate against the steel cover and produce a thorough mixing action. A maintainer is similar to a multiple blade mixer but of lighter construction and having a blade depth of not over six inches. Harrows, both disc and spring tooth variety, are used principally for dense graded aggregate surface types and are similar to agriculture equip-



MOTOR GRADER

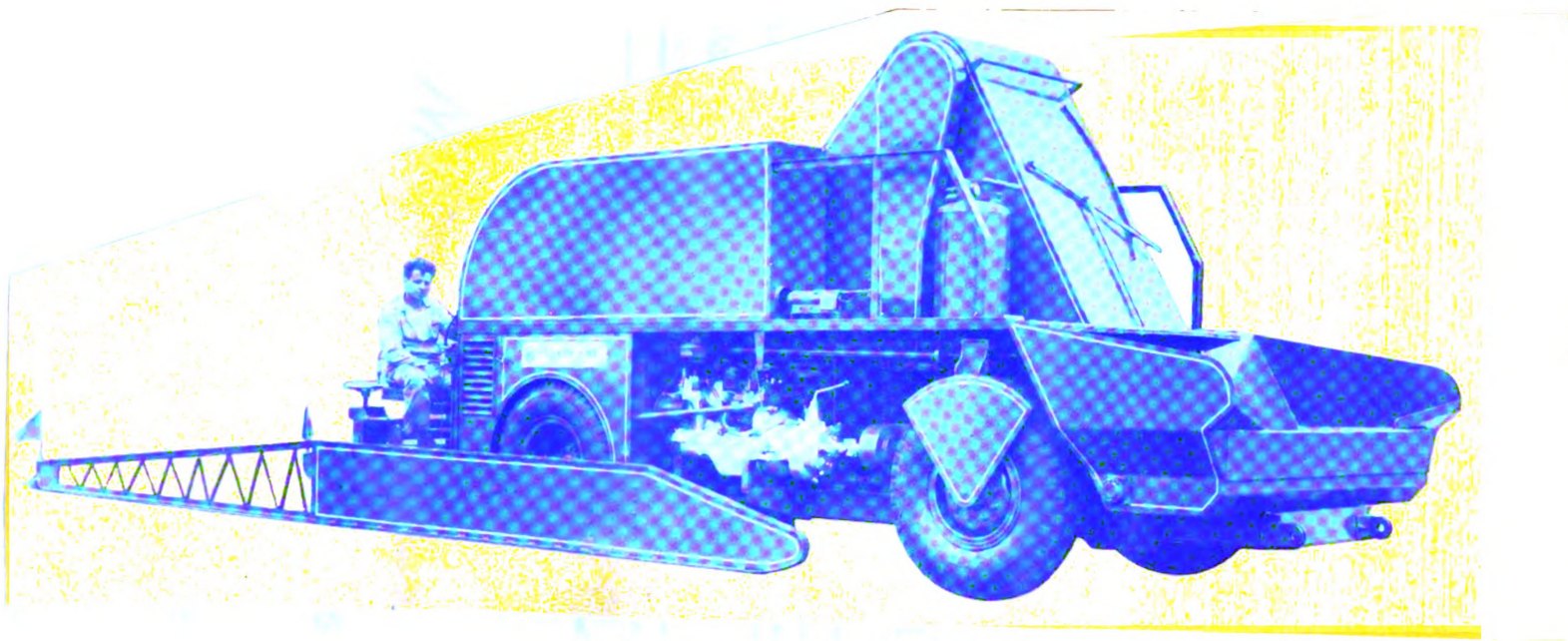
PORTABLE 25 CU.FT BATCH TYPE PLANT



ment except that recent models are set in a frame so that they can be raised when turning the tractor and thus avoid churning the surface.

The travel plant is in between the mixed-in-place and the stationary asphalt plant. It contains many of the parts found in the usual asphalt plant with the exception of the drier and the screens. This plant is different in that it operates right over the area to be paved. The aggregate is placed in windrows ahead of the machine so that as the machine advances the aggregate is picked up, passed through the mixing chamber, and sprayed with asphalt, proportioned by volume. The resulting mixture is then deposited in a windrow behind the machine, which is in turn spread by blade graders.

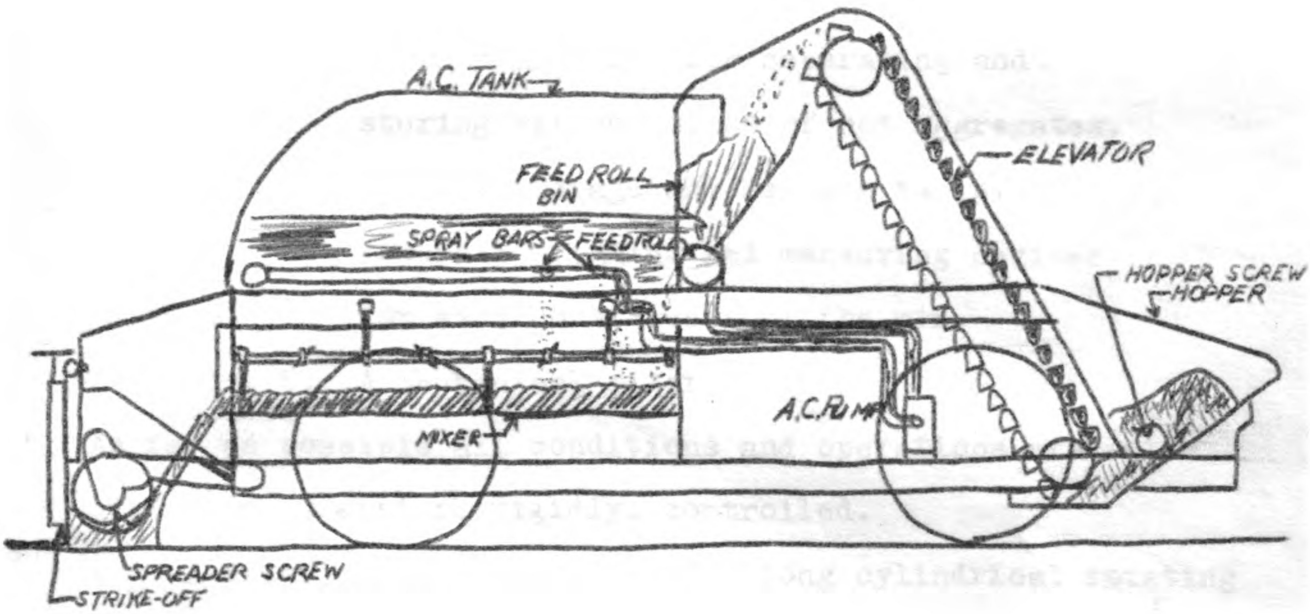
The latest improvement in doing mixed-in-place paving is the "Moto-paver". This paver is an entirely new conception of doing cold mix and retread paving. This self-contained, single unit machine accomplishes the mixing and laying in one continuous operation. The paver delivers the mixed material and strikes it off ready for rolling. Paving width is adjustable from 8'6" to 12'0" and thickness of 7". This machine can successfully operate using gravel, stone or slag aggregates with most types of emulsions, medium and rapid curing asphalts and tars. Within it is a twin shaft pugmill mixer for mixing material. The Moto-paver has pneumatic tires and is capable of moving itself from job to job itself at nominal speeds. Paving speed minimum is two feet per minute. It has a hopper at the front which can be filled with aggregate



MIXER & PAVER

MIX-IN-PLACE TYPE

FLOW DIAGRAM



MOTO-PAVER

DOES THE COMPLETE MIXING & PAVING JOB

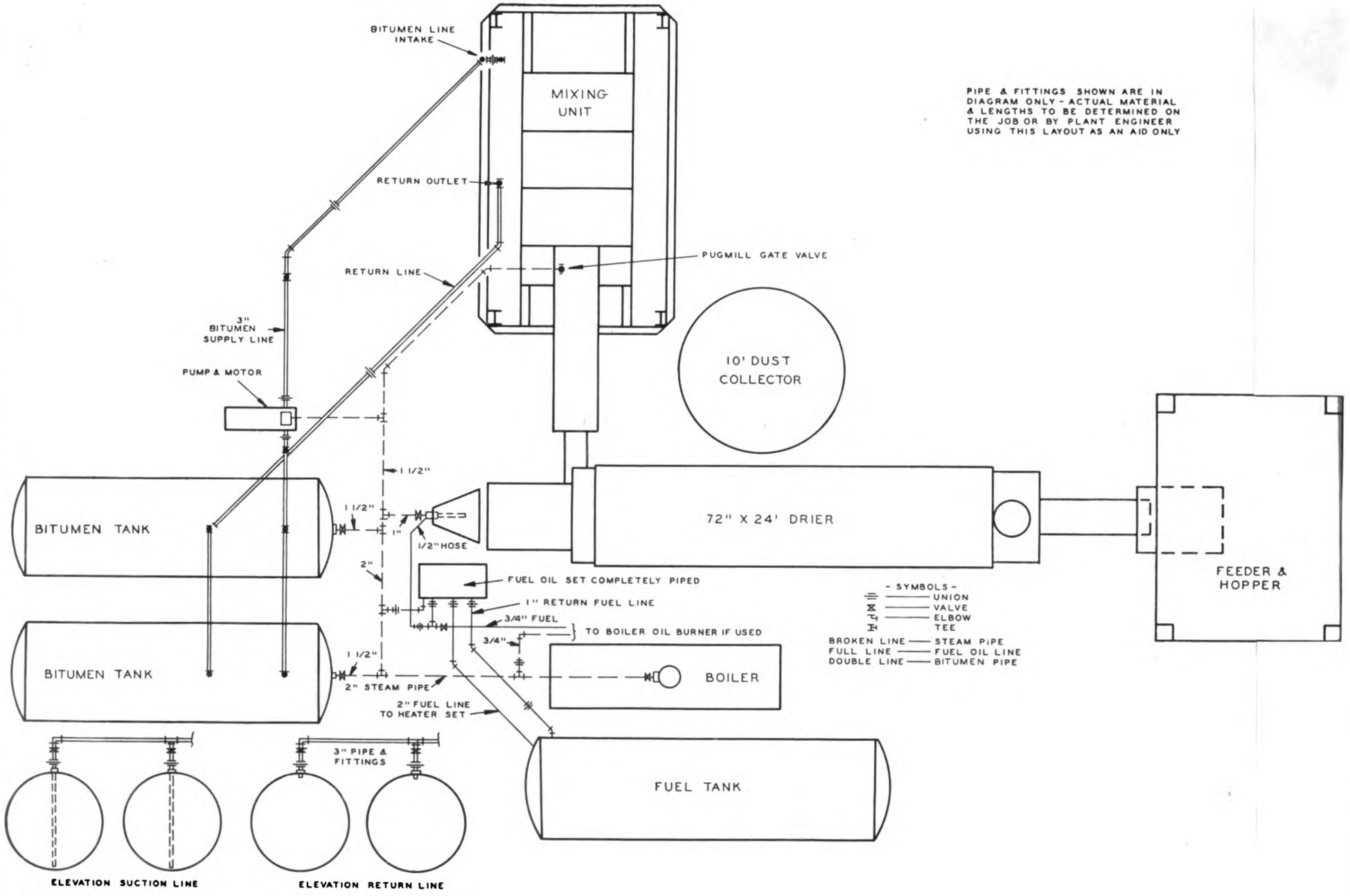
by trucks as it moves. There are two 500 gallon bituminous tanks on the vehicle.

An asphalt paving plant is a factory for turning out asphalt paving mixtures in accordance with specifications. The crudest form of plant is a concrete mixer, wheel barrows, and buckets for proportioning the emulsified asphalt volumetrically with the aggregate. For a hot mix type of paving mixture the elaborate set-up consists of five principal parts:

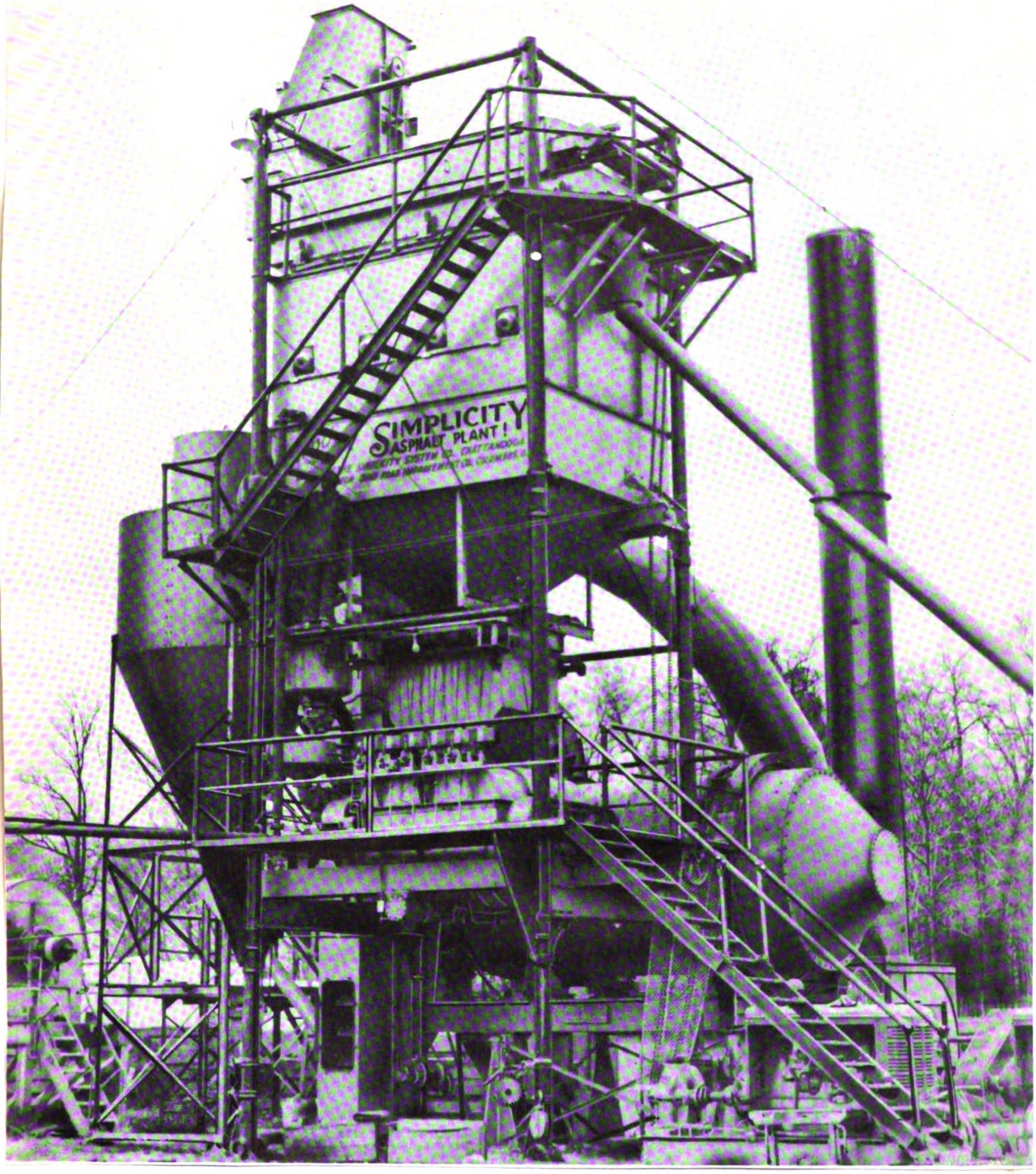
1. An aggregate heater known as the drier.
2. Screens and bins for separating and storing various sizes of hot aggregates.
3. Asphalt storage and heating tanks.
4. Accurate weighing and measuring devices for each constituent of the mix.
5. A mechanical mixer.

As far as possible all conditions and operations are automatically, therefore rigidly, controlled.

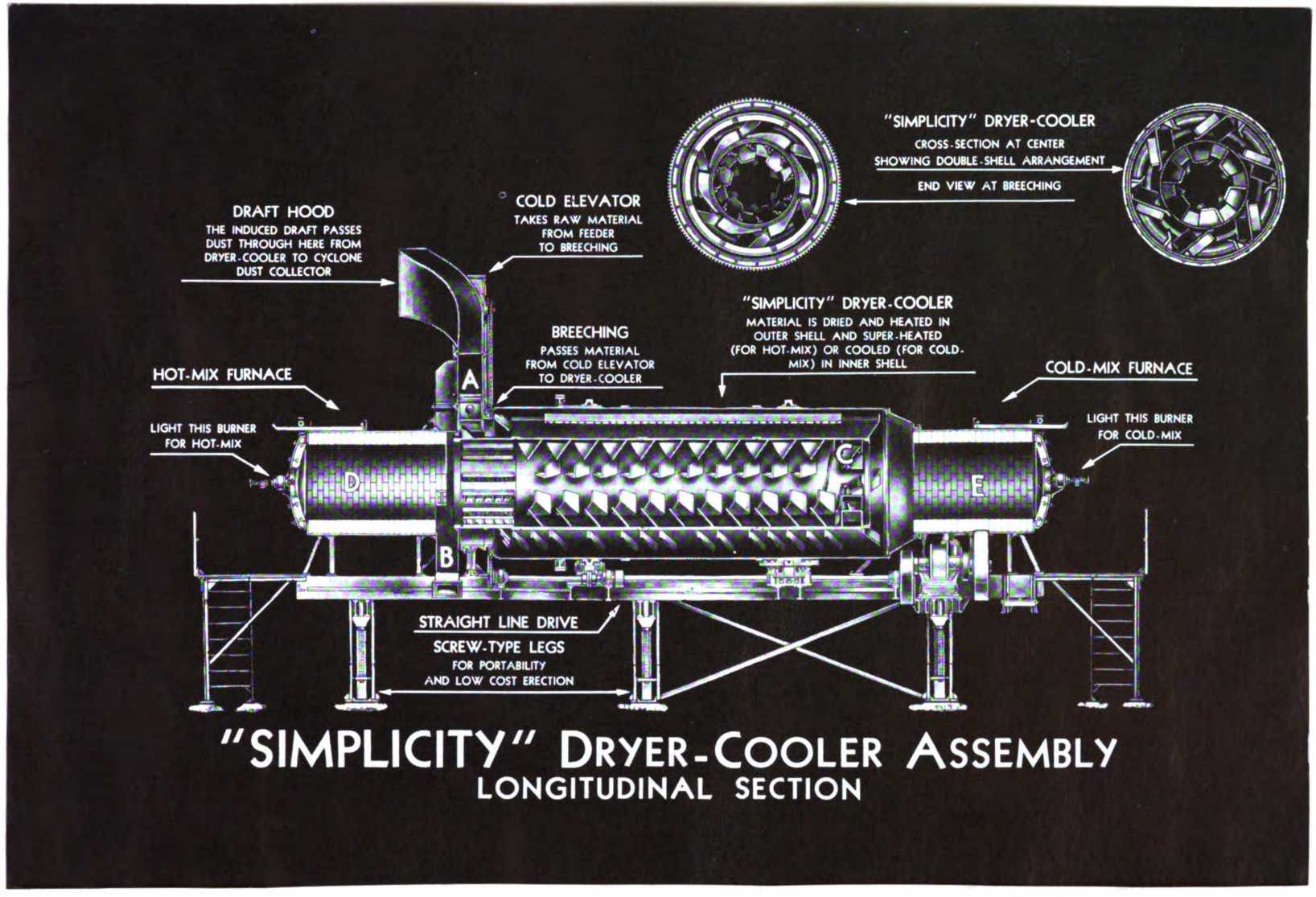
A drier usually consists of a long cylindrical rotating steel drum mounted at a slight angle from the horizontal. The unheated aggregate is fed into the higher end and as it passes through it is picked up by means of steel angles fastened to the inner face of the drums and cascaded through hot gases from an oil burner which dry and heat it to the desired temperature. The drier should be equipped with an accurate electric pyrometer at the discharge chute to register the temperature of the aggregate as it passes to the screens and the hot storage bins. The drier is usually the bottle-



ASPHALT PLANT DIAGRAM



TYPICAL ASPHALT PLANT



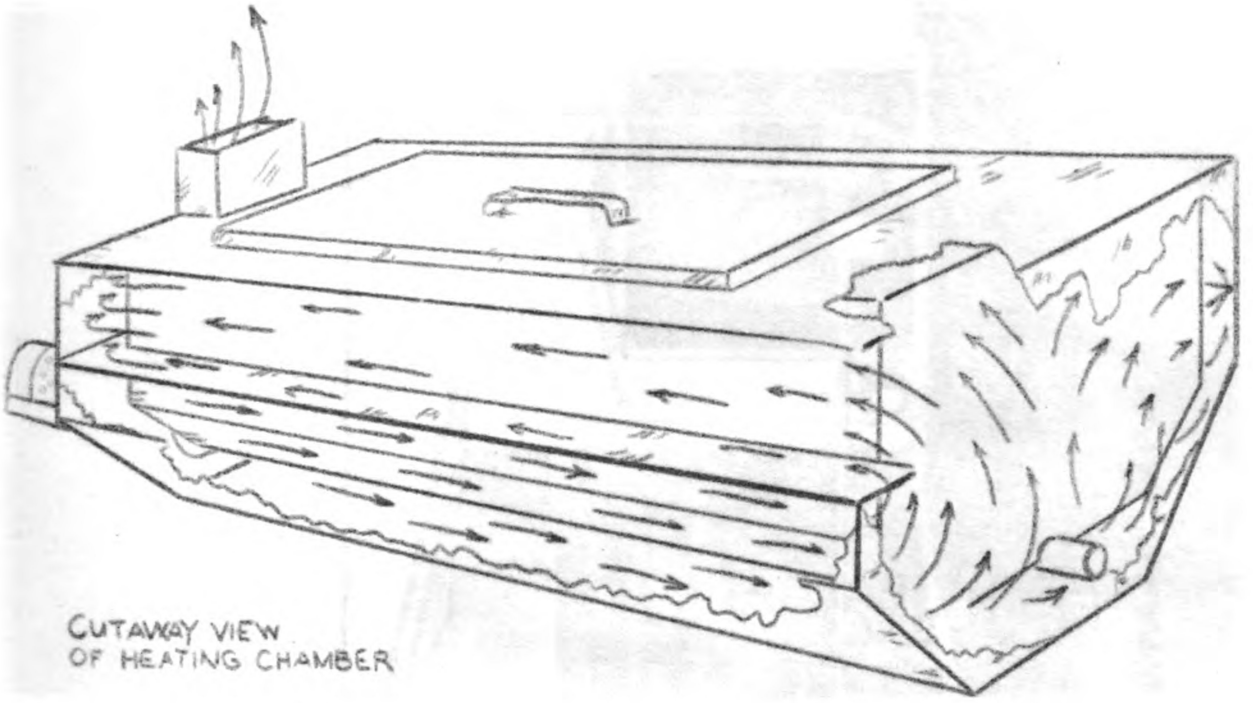
DRYER SECTION

neck of an asphalt plant as its capacity controls the plant output. It should be capable of producing a somewhat larger yield than is needed to keep the mixer in operation. Simplicity puts out a dryer which can heat the aggregate after drying for hot mix or alternately dry and cool the aggregate for cold mix asphalts. Driers of 100 tons or more capacity are in common use.

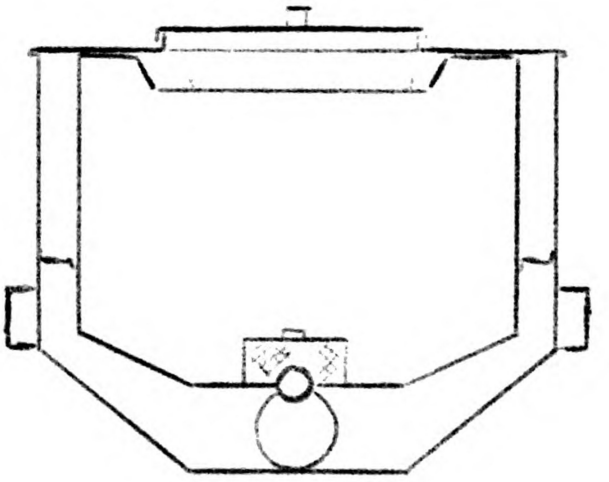
The screens used can be either rotating or the vibrating type and are located above the hot storage bins. Upon leaving the drier all hot aggregate should be passed over screens to separate it into suitable sizes for use in the mix. The bins which contain the aggregate after separation should be so constructed as to prevent an overflow of one size aggregate into a bin containing another size. The total capacity of storage bins should be not less than four tons and each compartment should be equipped with a discharge gate directly over the weigh hopper. The gate should be so constructed as to prevent leakage when closed. In case of cold mix, some kind of arrangement for cooling the aggregate should be made.

Asphalt tanks such as kettles and hot storage tanks which deliver asphalt directly to the weigh bucket or proportioning device should be equipped with thermometer and a means for positive control of asphalt temperatures at all times. The storage tanks should have a total capacity sufficient to keep the plant running for ten hours. They should be heated not by direct fire but by steam or electricity. Steam jacketed or electrically heated lines should be used for transfer of

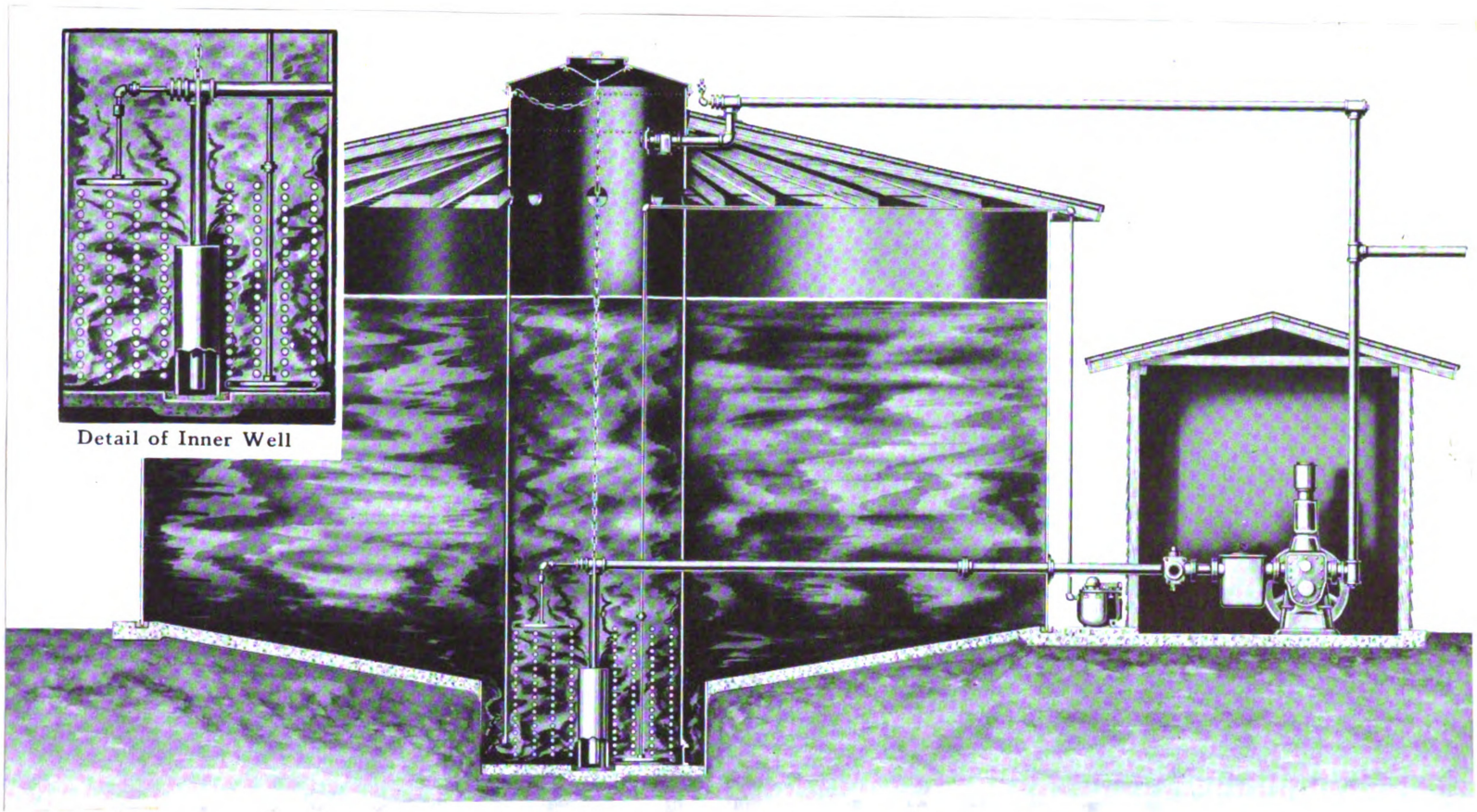
KETTLE OR MELTING TANK



CUTAWAY VIEW
OF HEATING CHAMBER



END VIEW CUTAWAY



ASPHALT STORAGE TANK

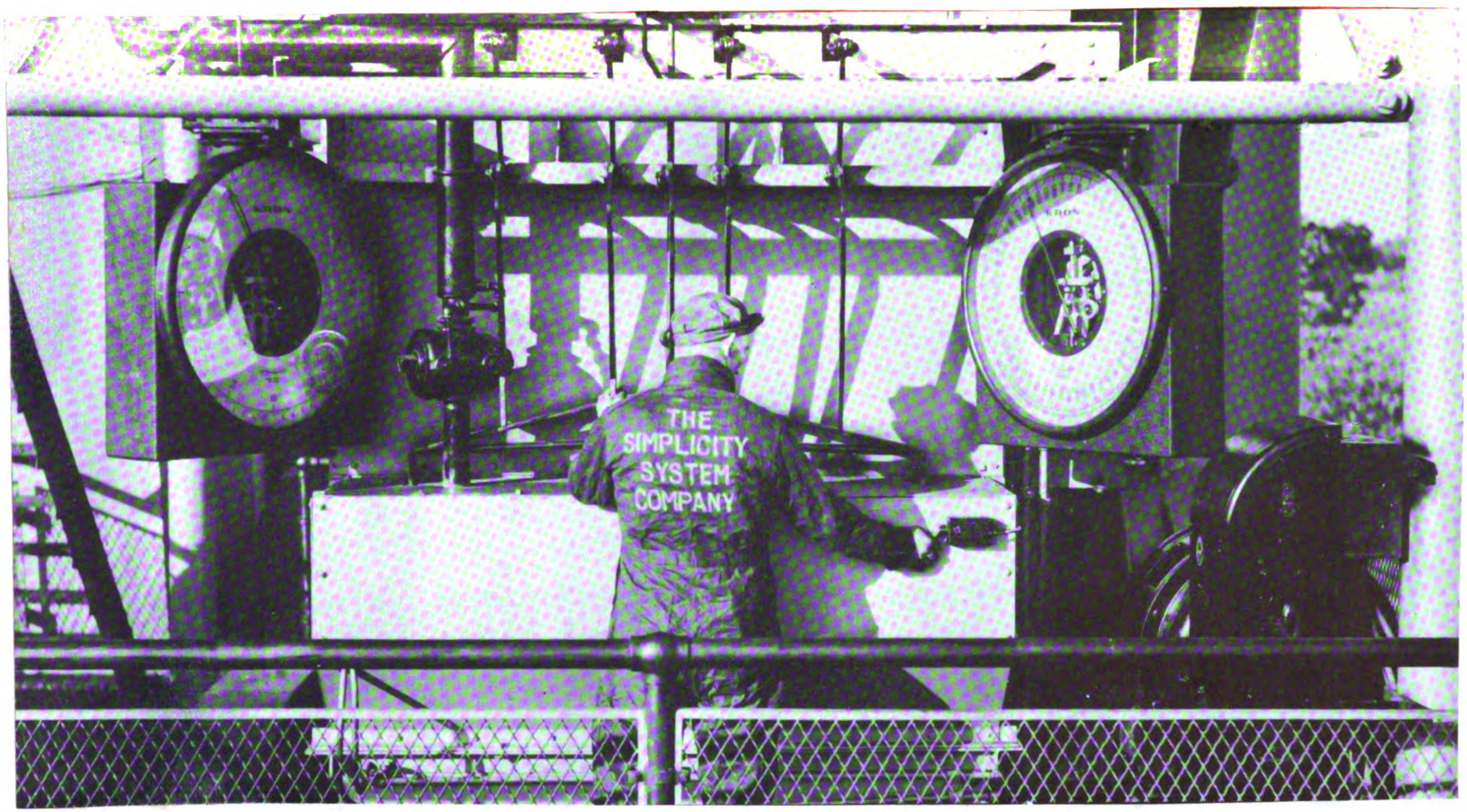
the asphaltic material. Continuous circulation of the hot asphalt through the draw-off pipe with return to the kettle is desirable. When a flux is added to a refined asphalt, some suitable means of agitation is needed for the asphalt in the storage bin.

Proportioning may be done by weight or by volume. When proportioning by weight the device to do so consists of a weigh box or hopper for the aggregate and a weigh bucket for the asphalt. The weigh box is mounted under the gates of the hot storage bins and over the mixer. It may be equipped with either a dial or beam scale, which should be sensitive to one-half or one per cent of the maximum load that may be required per batch. The weigh box is usually rectangular in shape, open at the top and equipped with a full length discharge gate at the bottom so that as soon as a batch of aggregate has been weighed, it may be transferred immediately to the mixer. The asphalt bucket for weighing the asphalt cement should have sufficient capacity to hold not less than twenty per cent of the weight of aggregate required for one batch. This also should be steam jacketed or electrically heated to prevent loss of heat as well as accumulations of chilled asphalt in the bucket. It should be suspended on dial or beam scales so that the net weight of the asphalt can be read accurately to within two per cent of the weight required per batch. The bucket should be arranged so that it can deliver the molten asphalt in a thin uniform sheet over the aggregate in the mixer. The asphalt weigh bucket is mounted on the mixer platform so

that it can readily be discharged into the mixer.

When proportioning by volume, the gradation control unit should include a feeder mounted under the hot storage bins. Each bin should have an accurately controlled individual gate to form an orifice for volumetrically measuring the aggregate drawn from each bin compartment. The orifice should be rectangular, about eight by nine inches, with one dimension adjustable. Means should be provided to afford positive interlocking control between the flow of the aggregate from the bins and the flow of the asphalt from the meter.

The most common type of mixer is known as the twin pugmill mixer. It is set in the floor of the mixing platform directly under the aggregate weigh box and at an elevation sufficiently high to permit it to discharge directly into a truck or into a hopper. The twin pug consists of a rectangular steel box with an approximately semi-cylindrical bottom with an entire bottom gate operated from the mixing platform by a hand lever or by compressed air. The usual plant capacity ranges from two thousand to four thousand pounds. The mixing apparatus is made up of two shafts rotating in opposite directions at a speed of approximately seventy revolutions per minute to which are attached removable mixing blades set at such angles as are found efficient. The blades should be adjusted so that the clearance of the blades from all fixed and moving parts will not exceed 3/4 inch, except when mixing the coarsest asphaltic concrete mixtures and then the clearance should be increased to 1 1/2 inches. The mixer box should be inclosed in some manner so as to prevent



AGGREGATE WEIGH BOX & SCALES
ASPHALT WEIGH BUCKET & SCALES
PUG MILL MIXER & HOUSING

the loss of dust into the air. For batch mixing the mixer should be equipped with a lock timing device by means of which accurate control of the mixing cycle may be maintained. A mixer timing device is a complete self-contained unit mounted on one side of the mixer and driven by steel roller chain off the mixer shaft. This device locks the measuring box lever after the aggregate is discharged into the mixer; it also locks asphalt bucket, permitting dry mixing of aggregate. (Period of dry mixing can be regulated.) Also, it locks the mixer gate valve from the time aggregate is introduced into the mixer until batch is discharged. Timing of batch can be regulated by the inspector on the dial, located within the cabinet, to suit any requirements from one-half minute to four minutes.

The continuous mixer also usually uses a twin pug mixer, the difference being that the batch type has closed ends while one end is open in the continuous mixer. The mixing time is the same in both types of mixers. In the continuous mixer, the material progresses through the mixer continuously with new aggregate and asphalt added at one end while the completed mixture is discharged at the other.

A variation from the usual type of open top batch mixer is the so-called pressure drum type. It consists of a horizontal rotating drum or cylinder. The weighed aggregate is charged through a manhole while the cylinder is at rest, after which an air-tight cover is clamped in place. When the drum is revolved the aggregate is cascaded over a series of baffles or blades attached to the inner face of the cylinder.

The weighed asphalt is sprayed in under pressure through a manifold connected with the trunion bearings. Air pressure of about fifty pounds is maintained within the drum during the mixing process.

Another type of mixer employs the principle of interrupted centrifugal flow. This type is primarily designed for small repair work. It consists of a concrete mixer drum equipped with mixing plows or blades. The drum revolves at rather high speed and as the aggregate is thrown toward the center of the drum by the blade action it is sprayed with asphalt, which is measured volumetrically.

FINISHING AND ROLLING PAVEMENT

Spreading and finishing procedure for asphalt pavements must be divided into two methods; one for the kind of mix which sets slowly and allows a large amount of time for manipulation, such as cold laid mixes and mixed-in-place surfaces; and another method for hot mixes which must be laid and finished before cooling to atmospheric temperatures.

With the first type of procedure, finishing is often accomplished by repeated light blading, thus correcting slight dips and holes created by traffic. This is the recommended method for dense graded aggregate mixtures where slow curing asphaltic products are employed. For coarse graded mixtures containing cut-back asphalt, spreading may be accomplished also by blading, but as set up is more rapid, the final cross section should be obtained rather quickly and compaction made by early

rolling. Multiple blade graders having wide flaring rear blades are used often for spreading cold laid plant mixes, especially for initial placing where further smoothing is to be done by additional blading.

With the hot type mixes, mechanical spreading and finishing by special equipment is desirable. There are several kinds of spreaders, the most common being a hopper into which the plant-mix is dumped and having a horizontal opening at the bottom through which the material flows out upon the surface as the spreader is dragged or propelled along. The object is both to save time and to insure uniformity of the layer. The spreading hopper is attached usually to the front end of the finishing equipment with a revolving screw therein to carry the mixture across the full width of surface being laid.

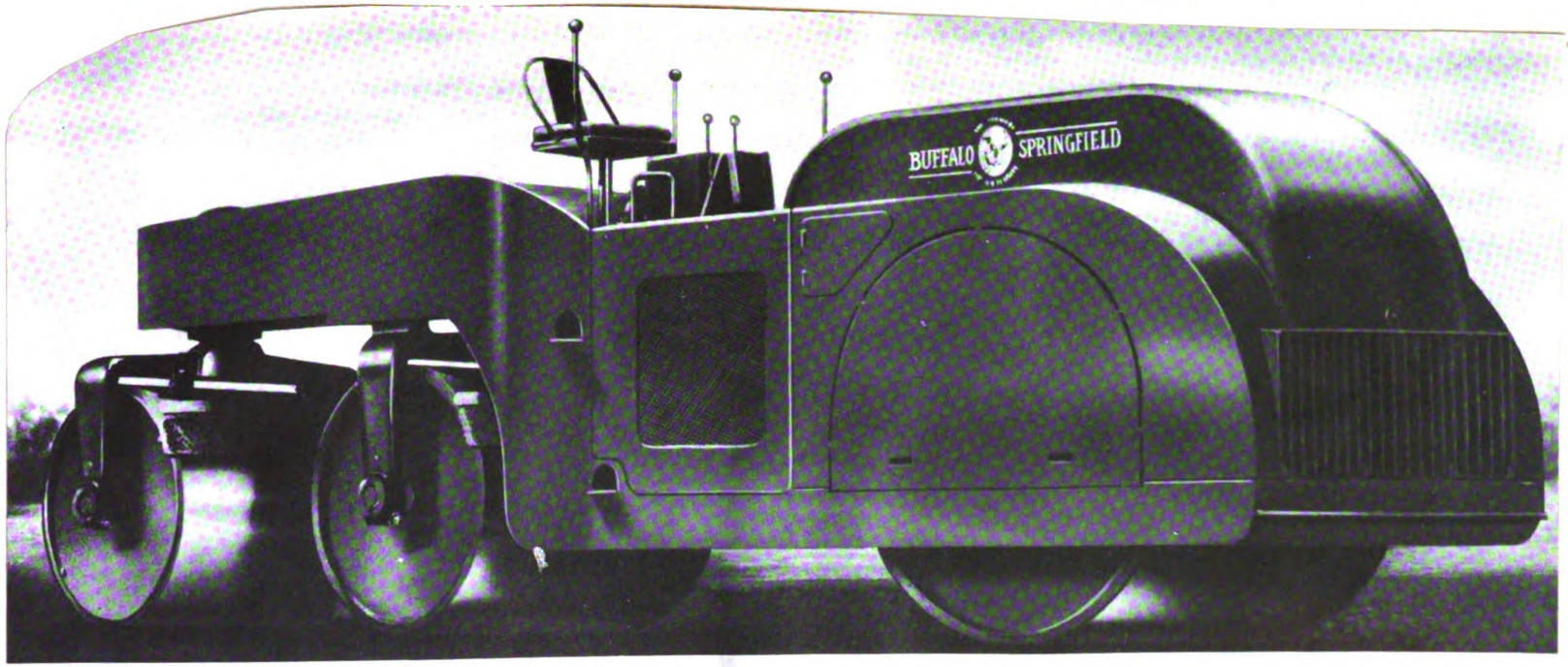
Finishers are of three types; one type running on fixed side forms of steel or wood; another supported on long runners which move with the machine and serve as side forms; and the third is supported by wheels or rollers. The improved mechanical spreader deposits the mixture in such a manner that side forms are not necessary. Since the first type uses forms the other two are used more often. The last two have a sufficiently long wheel base to compensate for the lack of forms in order to minimize any irregularity in the base. The machine consists essentially of a power driven chassis having one or more traverse operating members called screeds which place the asphalt mixture to the desired cross section. It should be operated so that the mixture is spread free from

lumps and of uniform density. The machines usually have a hopper into which the mixture is dumped, containing a screw feed of some kind in order to uniformly distribute the material in front of the finishing screed.

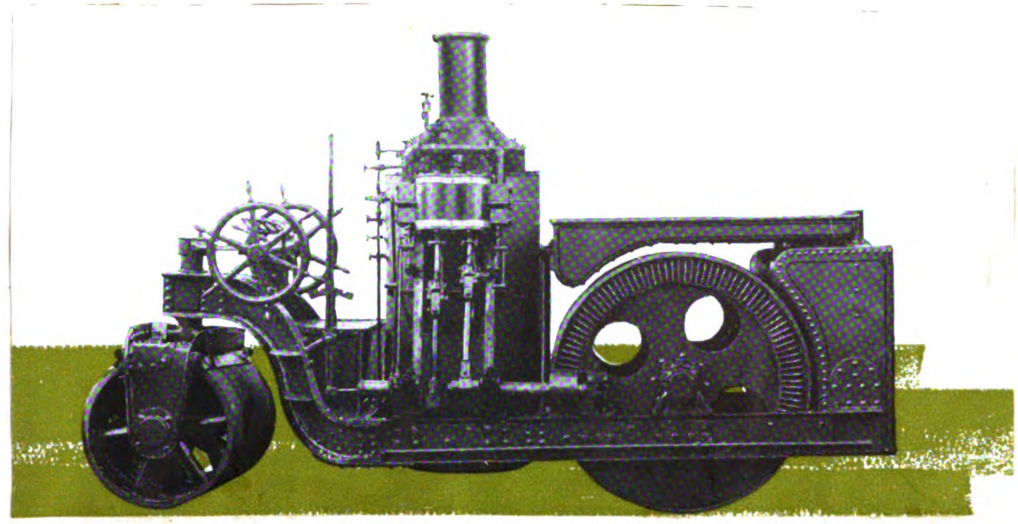
The most modern type contains tamping and leveling screeds. Tamping, leveling, and striking-off simultaneously, this finisher automatically measures the correct amount of compacted material needed for depressions, and, consequently, gives a level surface that is maintained under additional compaction of rolling and traffic. The tamping reduces the amount of rolling needed and improves the joints between lanes and forms a better bond between courses. Crown and thickness are easily and completely achieved while operating. The receiving hopper holds five tons. The outstanding feature of this finishing machine is its versatility. It is designed to handle the greatest possible variety of materials from sheet asphalt to stabilized mixes.

ROLLERS

There are several types of rollers, including steel-faced rollers and pneumatic rollers. Steel-faced rollers are three wheel, tandem and more recently three axle rollers, the latter having the additional roll so arranged that a large part of the total weight of the machine may be applied thereon if required on high spots. Three wheel rollers are made in five to fourteen ton sizes. Nearly all rollers are now made with gas or diesel engines for power, and many delays formerly had with steam equipment are eliminated. The three wheel rollers



MODERN
3-AXLE TANDEM
ROLLER

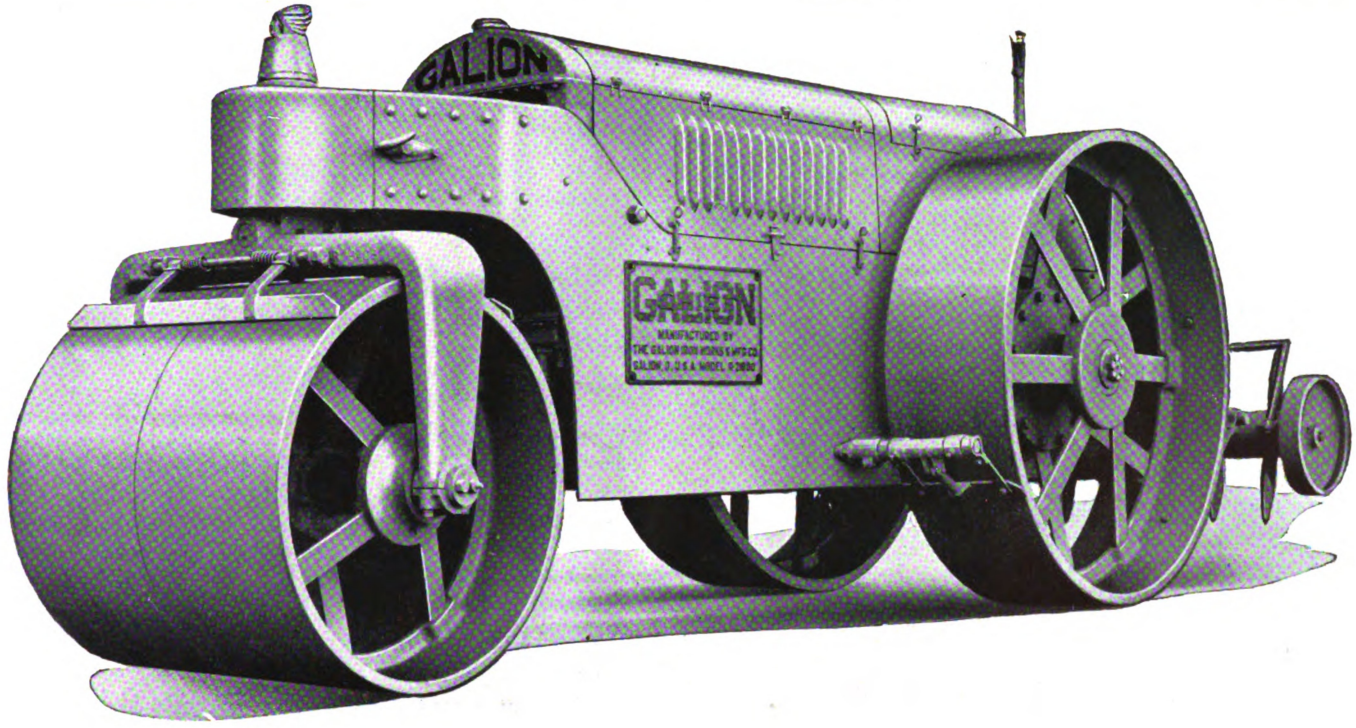


OLD STYLE STEAM POWERED TANDEM
ROLLER

are used on all types of surface treatment, mixed-in-place types and penetration macadam for full rolling requirements, and often on sheet asphalt and asphaltic concrete for initial rolling requirements. Tandem rollers are used as finishing rollers and on sheet asphalt are often used for full rolling requirements. Due to the way the three axle roller transfers its weight, it has greater compaction per inch width of roll than the tandem roller. It also produces greater density in coarse aggregate mixes where keying in of particles is required. A special form of steel-face roller called a "trench roller" is used for compaction of sub-grade and base courses for widening operations. The roll is only twelve inches wide and is set in a triangular frame. It is a three wheeled roller...two twelve inch rolling wheels and a third riding wheel. Pneumatic rollers consist of flat platforms on which sandbags or a load of some kind can be placed over one or two axles on which are a number of rubber tired wheels. This type roller is used in the consolidation of earth sub-grades, granular bases and in final surface treatments for mixed-in-place and dense graded cold laid plant mixtures. The load which is placed on these rollers is equal or greater than the expected traffic load.

There is also a type of roller with scarifier attachment. Another type of roller is a small trail-o-roller which is used for maintenance.

In maintenance or complete resurfacing, prior to the operation it is necessary to clean the existing surface thoroughly. This can be best accomplished with a revolving broom. Places



THREE WHEEL ROLLER

WITH SCARIFIER

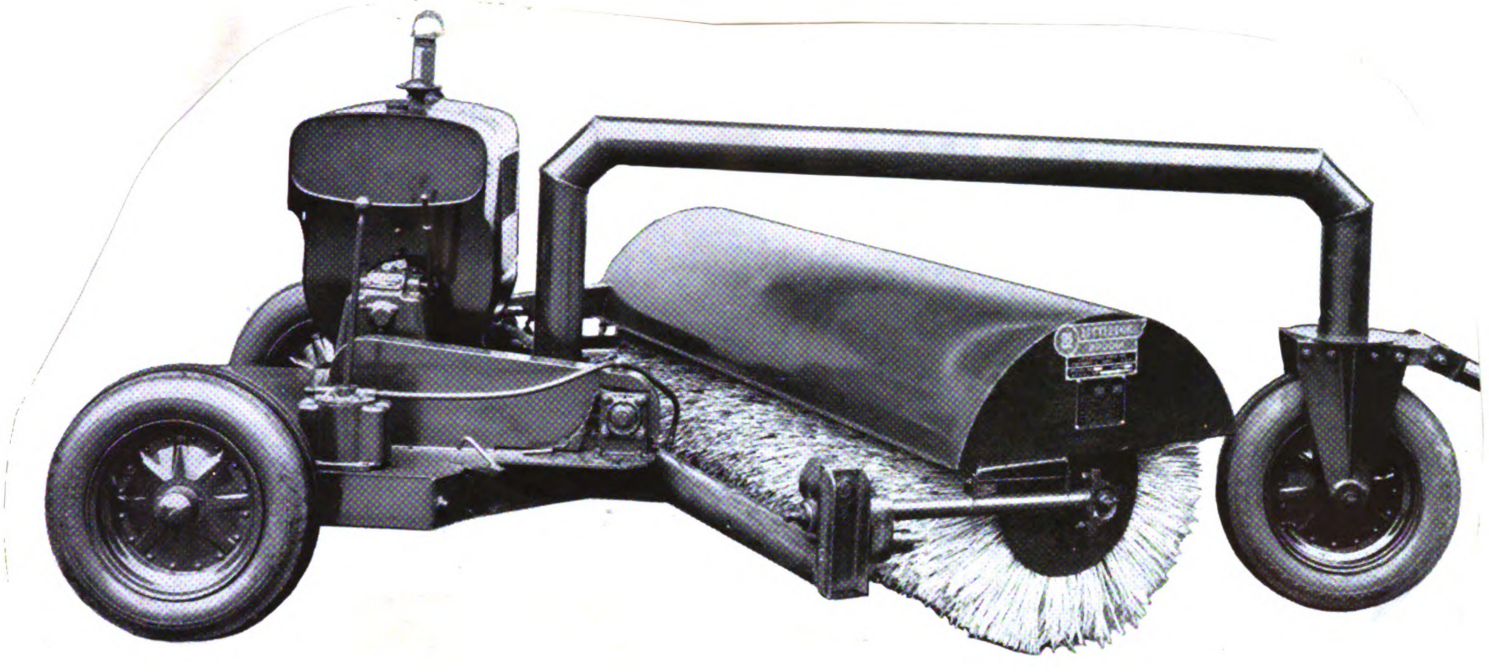
not reached by the revolving broom should be brushed by hand. One type of revolving broom is the traction driven, another has a separate motor to drive the broom. Steel, rattan or fibre are used on the brooms.

In reconstruction or resurfacing, breaking up of the existing surface is needed in order to shape to grade and crown more easily. The tool used in this operation is called a scarifier. The scarifier usually consists of teeth on a drag, but in some cases they put removable teeth on the rollers in order to get the surface broken up. They are usually adjustable to depth desired. A road planer is also used for this reshaping of a surface. One type planer is a steel frame on which are mounted banks of steel discs with a wheel adjustment as to angle. The cut is a shearing action. The other type is very similar to a scarifier.

Surface heaters are used in maintenance and resurfacing. The heater can heat the pavement to such a degree that the top surface can be raked off without disturbing the lower surface. The heater is an inverted steel pan with a group of burners which can confine the heat directly to the surface. They are made in sizes from 2' by 4' with two burners to 7' by 8' with six burners. These heaters were originally used for patching, but now the large ones are used for resurfacing entire streets.

HAND EQUIPMENT

There are many hand tools that I have not mentioned heretofore. There are various types of pouring pots used in



ENGINE DRIVEN - PULL TYPE BROOM

maintenance and patching. The rosebud type pot is for light asphaltic materials and for heavy products the wide slotted nozzle is required for even distribution. Tampers and smoothers are the hand tools used for hot mixes around service openings and along curbs and structures inaccessible to the roller. These tools are of heavy iron and must be heated for ease in handling on a portable oil burner. Rakes, shovels, and stilt sandals are also used in asphaltic construction. The sandals keep one's feet up from the heated asphalt.