

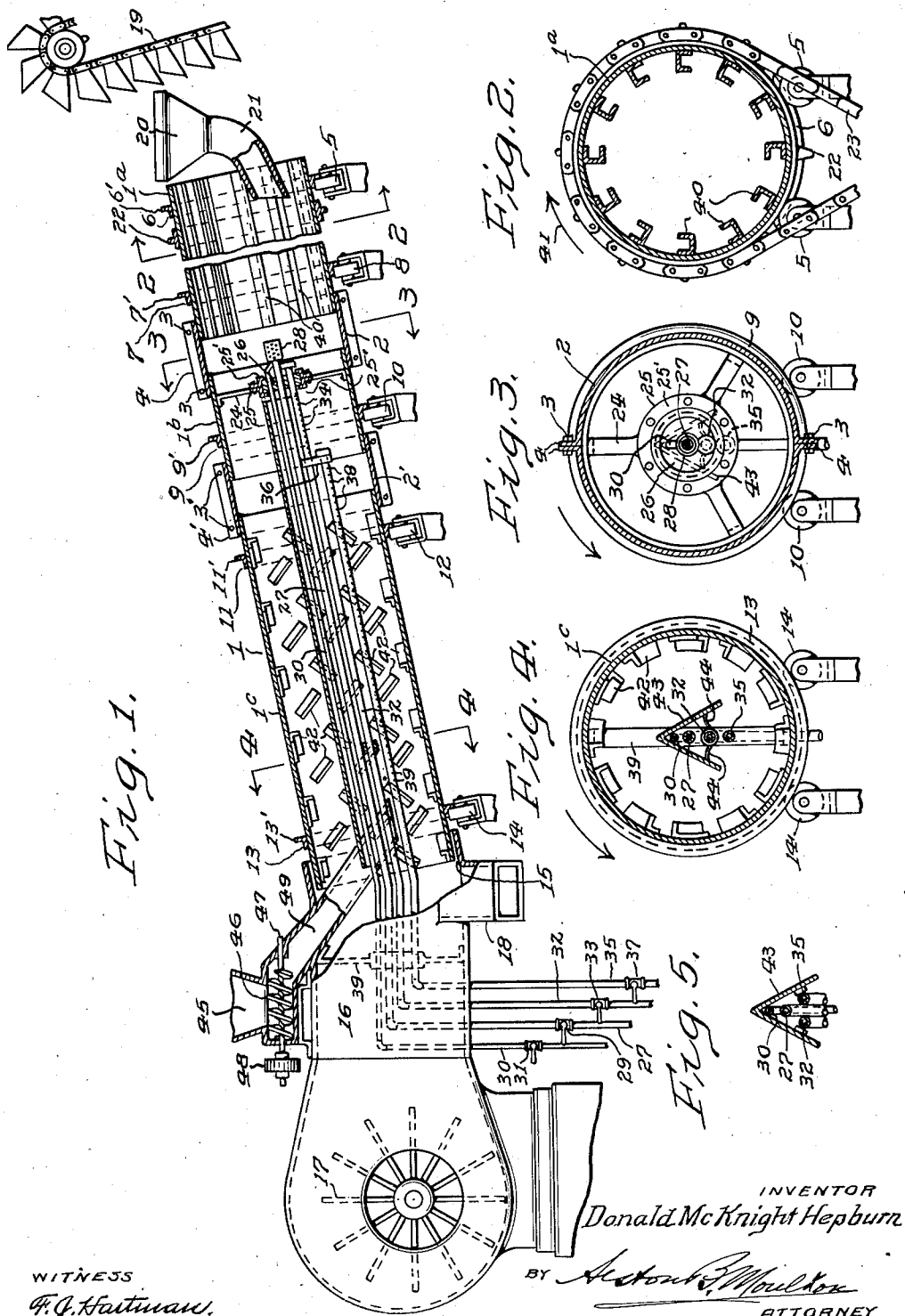
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APPARATUS FOR PREPARING PAVING COMPOSITIONS

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APPARATUS FOR PREPARING PAVING COMPOSITIONS

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My invention relates to machinery for making paving material and more particularly to an apparatus particularly arranged and adapted for continuously drying, heating, mixing and coating mineral aggregate of the various sizes which are suitable for the different courses or layers of roadways of either the cold laid or hot laid bituminous, aggregate type, and by the use of which

stone, sand, or gravel, as it comes from the gravel pit or breaker at the quarry, may be forthwith dried, waterproofed and coated in a continuously moving stream, in such a manner that upon leaving the apparatus it is finished, and may be delivered either directly to the cars or trucks for transference to the place where the roadway is being laid or to a conveyer and carried to a suitable place where it may be stored in bins or bunkers until it is needed for road construction.

One object of my invention is to combine in one machine means for removing moisture and dust from the aggregate, means to apply a waterproofing or other liquid to the aggregate whereby the aggregate after being dried and dusted may be treated with any suitable liquid prior to the true coating operation, and a mixing device wherein the bituminous or similar coating material is continually supplied to the stream of aggregate while it is subjected to a thorough agitation, whereby every portion of the surface of the individual pieces of aggregate may be provided with a coating of the bituminous or similar material, and wherein, when desirable or necessary, small quantities of other ingredients, such as sand, "fines," sulphur, lime, rubber and/or the metal salts or fatty acids may also be added for the purpose of imparting to the binding material qualities or properties particularly desirable in bituminous materials employed in road making, such as increasing the viscosity of the binding material, when cold; making the fluid binder more penetrating when hot; increasing the thickness and toughness of the coating on the aggregate, and similar purposes.

A further object of my invention is to provide a mechanism for drying, waterproofing and coating of the aggregate, progressively

and continuously in one treatment of the aggregate therein, and wherein the aggregate continuously delivered to or fed into the apparatus at one point emerges from the machine in a continuous stream as a completely coated aggregate ready for storage or direct placement upon the roadway, or transportation to the roadway.

A further object of my invention is to provide an apparatus in which coated aggregate, suitable for the making of roadways, may be easily produced in large quantities at a minimum cost, at the quarry, sand pit or gravel pit where it is obtained.

A further object of my invention is to provide an apparatus which may be used with different grades of bituminous or similar material which may be used in the preparation of said type of road materials and the operation of which may be varied considerably to adapt it to the making of the different kinds or grades or qualities of paving material; and which may be used to successfully coat aggregate of widely differing kinds and sizes in order that the apparatus may be used at quarries and gravel pits in various parts of the country without substantial change or alteration therein to adapt it to the character of the aggregate which is available at any particular locality and the kind of pavement which it is desired to make.

A further object of my invention is to provide an apparatus, one or more parts or sections of which may be used without the others to provide (1) a drying and dusting apparatus; (2) a drier and duster combined with a waterproofing apparatus; or (3) an apparatus wherein the aggregate is dried, freed from dust, waterproofed and then coated, by mounting the main cylinder on an axis somewhat inclined to the horizontal, and making it in sections which may be uncoupled from each other, and one or two of them rotated, independent of the adjacent section from which it has or may have been disconnected, without disturbing or changing the disposition or assembly of the parts which have been separated from the section or sections being operated.

A further object of my invention is to

provide an apparatus in which a stream of aggregate is kept continually flowing gravitationally from one to the other end thereof, and in a direction contrary to that of a strong blast of air driven therethrough, the air at the end of the cylinder at which the aggregate is introduced being heated by a relatively large flame extending within the cylinder and fixedly mounted therein, said air in its flow through said apparatus being operative to abstract the heat from the aggregate which has been heated and to transfer it to the aggregate being then treated at the entrance end of the apparatus, and to distribute continually over the aggregate in its travel towards the exit end of the cylinder, first suitable waterproofing material, such as kerosene, naphtha, light petroleum oils designed to act as liquefiers or modifiers of the coating material, to add to said aggregate a suitable binding material while the aggregate is being continually thoroughly stirred and agitated.

Further objects of my invention will appear in the specification and claims below.

In the drawings forming a part of this specification and in which the same reference characters are employed throughout the various views to designate the same parts,

Fig. 1 is a side elevational view, partly in vertical section of the essential parts of my apparatus.

Fig. 2 is a transverse cross-sectional view on the line 2—2 of Fig. 1.

Fig. 3 is a transverse cross-sectional view on the line 3—3 of Fig. 1.

Fig. 4 is a transverse cross-sectional view on the line 4—4 of Fig. 1.

Fig. 5 is a view, similar to the central part of Fig. 4 to illustrate a modified disposition of the pipes within the mixing chamber.

The rotatable cylinder 1 is composed of preferably three aligned sections, the axis of said cylinder being slightly inclined upwardly. The upper section 1^a constitutes and provides the heating chamber wherein the mineral aggregate introduced into the cylinder at the upper end thereof is heated to remove the moisture therefrom and is simultaneously subjected to a strong blast of air to free the dried aggregate from fine dust. For convenience, this upper section 1^a is herein termed the heating chamber or section. In the intermediate section 1^b the material leaving the heating chamber may be treated with a waterproofing liquid while it is subjected to an unheated blast of air flowing there-through into the heating section 1^a and for convenience, this intermediate section is herein termed the waterproofing or intermediate or cooling chamber. The third section 1^c comprises a mixing chamber wherein the binding and coating material is continuously supplied to the aggregate and the aggregate is continuously stirred and subjected to agi-

tation for the purpose of thoroughly coating and covering the entire surface of every piece of aggregate with a bituminous or similar coating and this part of the cylinder 1^c is for convenience called the mixing chamber.

The adjacent ends of the heating chamber 1^a and of the intermediate section 1^b are preferably spaced from each other and the gap therebetween is closed by a split ring 2 tightly fitting the adjacent end of the two sections of the main cylinder 1 and is firmly secured to said ends by bolts 3 passing through radially extending flanges 4 of the split ring 2. The adjacent ends of the waterproofing or cooling chamber 1^b and of the mixing chamber 1^c are similarly spaced apart and the gap therebetween is also closed by a like split ring 2' with flanges 4' and bolts 3' passing through said flanges.

The rotatable cylinder 1 is preferably supported on a series of pairs of wheels or rollers 5, the heating chamber or section 1 being provided with a pair of such rollers 5—5 upon which travels a flanged ring 6 surrounding said chamber 1^a near the upper end thereof. Near the opposite end of said heating chamber 1^a is a like flanged ring 7 adapted to travel on a pair of rollers 8—8 and by means of which the lower end of said heater section 1^a is rotatably supported. The intermediate section 1^b is also preferably provided with a flanged ring 9 preferably as near the lower end thereof as it is practical to place it to track on a pair of supporting rollers 10—10.

The upper end of the mixer chamber or section 1^c is also preferably provided with a similar flanged ring 11 and a like pair of supporting rollers 12—12 and near the lower end of the mixing section is a like flanged ring 13 running on a pair of supporting rollers 14—14 in engagement therewith. Because the cylinder 1 is supported with its axis inclined, it tends to slide or slip downwardly on the rollers when the cylinder is rotated, the rings 6, 7, 9, 11 and 13 are therefore provided each with a flange 6', 7', 9', 11', 13' respectively at the upper edges thereof, adapted to engage the higher faces of the said rollers respectively, to hold the cylinder in a fixed position longitudinally while it is being rotated.

The lower end of the mixer section 1^c rotatably fits within a circular opening 15 in the stationary housing 16 which is in communication with a centrifugal fan 17 of a size sufficient to produce a strong blast of a large quantity of air, at atmospheric temperatures, delivered to the cylinder 1 at the lower end thereof through said housing 16.

The housing 16 is also preferably provided with a chute 18 adjacent the lower end of the mixer section 1^c through which the coated aggregate delivered from the mixing cham-

ber 1^c is delivered to a conveyer for storage or to a truck or car for transportation.

Adjacent the upper end of the rotatable cylinder 1 is a bucket elevator 19 arranged to discharge its load into a hopper 20 having a chute 21 extending into the upper and otherwise open end of the heating section 1^a. Near the upper end of the heater section 1^a I provide a toothed or sprocket wheel 22 upon which is mounted a sprocket chain 23 (see Fig. 2) driven from any suitable source of power, for continuously rotating the cylinder 1.

Near the upper end, the intermediate section 1^b is provided with a spider 24 rigidly secured to the inside thereof and having at its center two alined rings 25—25 concentric with the axis of the cylinder 1, and having inwardly extending flanges 25' fitting against the marginal surfaces of the outside outer faces respectively of a disk 26.

Within the cylinder 1, and extending practically axially thereof from the lower end thereof to substantially the upper end of the intermediate section 1^b is a series of pipes passing through the housing 16 and through the lower wall thereof. Extending preferably through the center of the disk 26 is the heater fuel pipe 27, the upper end of which is provided with a burner 28 projecting forwardly into proximity with the lower end of the heating chamber 1^a. This fuel pipe 27 is preferably provided with a valve 29 by means of which the flow of fuel oil to the burner 28 may be regulated and controlled. Extending substantially parallel to the fuel pipe 27 is a small pipe 30 by means of which air, under pressure, is supplied to the burner 28 to aid in the complete combustion of the fuel and in the projection of a large flame forwardly to substantially fill the chamber 1^a. This air pipe 30 is also provided with a valve 31 to control the flow of air there-through.

Also passing through the disk 28 is a pipe 32 closed at its upper end and provided with a controlling valve 33. This pipe 32 is provided at its upper end with a series of perforations 34 through which a liquefier is sprayed or otherwise discharged upon the stream of aggregate in the section 1^b just after it leaves the heating and drying chamber 1^a.

The pipe 35 is the one through which hot liquid binding material, bituminous or oily, is delivered to the mixing chamber 1^c. It is preferably placed well above the bottom of the cylinder 1 and its upper end terminates at or about the place where the perforations 34 in the pipe 32 begin so that the aggregate passing under the pipes 32 and 35 in its travel through the machine is sprayed with a liquid delivered from the pipe 32 before it receives the coating and binding material delivered thereto from the pipe 35. In the drawings is shown the upper end of the pipe 35 as sus-

ended by a hanger or clamp 36 from the pipe 32 immediately in the rear of the perforations 34 in the pipe 32. Said pipe or tube 35 is also preferably provided with a hand operated valve 37 and is connected to a tank or reservoir (not shown) containing the hot bituminous or oily coating material for the aggregate. Through the perforations 38, with which that portion of the pipe 35 within the chamber 1^c is provided, the hot coating and binding material is continuously discharged upon the aggregate in its passage through said mixing chamber 1^c.

Within the housing 16 is a strut or bracket 39 through which the pipes 27, 30, 32 and 35 extend or to which they are secured and rigidly held together. The spider 24 which is rigidly mounted within the intermediate section 1^b is free to rotate with the cylinder 1 around the disk 26 which fits within the rings 25 between the flanges 25' but the disk is prevented from rotating with the spider by reason of the rigid mounting of the pipes 27, 30, 32 therein and in the bracket 39. The spider 24 forms a rotating support for the stationary disk and thus the pipes are supported stationarily within the cylinder 1.

The heating chamber 1 is preferably provided on the inner surface thereof with a series of troughs 40 preferably extending parallel to the axis of the cylinder so that when the cylinder is rotated in the direction of the arrow 41 (Fig. 2) these troughs sweep transversely through the stream of aggregate on the bottom of the heating chamber and are filled with aggregate. As the trough is near or at the highest point in its circular travel around the axis of the cylinder, then the material is spilled from said trough and falls to the bottom of the cylinder transversely through the blast of air impelled there-through from the fan 17 and transversely through the flame from the burner 28. By this treatment of the aggregate to the action of the blast of air and to the flame, the individual pieces of aggregate are quickly heated and the aggregate is substantially freed from dust.

The interior surface of the mixer section or chamber 1^c is provided with a plurality of circumferential series of stirrer blades 42, the blades of each series being spaced from each other in said series and all the blades of each series are inclined at an angle of substantially about 45° to the direction of their motion with the cylinder. The inclination of the blades of any selected series are disposed at an angle of substantially 90° to the blades of the adjacent series. The blades in any selected series of stirrer blades are preferably disposed in a staggered relation to the blades in adjacent series.

Within the cylinder 1 and over the pipes 27, 30, 32 and 35 is a guard-plate or shield or

roof 43 of sheet metal supported on the upper pipe of the group of pipes in the stirrer section 1° and providing walls diverging downwardly. Any aggregate, coating with bituminous material, and which may stick for a time to the stirrer blades 42 and afterwards fall therefrom as the blades pass through the highest portion of their circular path, may not strike and stick to and accumulate on the pipes, nor on the sharply downwardly inclined sheet metal walls of the roof 43. To hold the sides of the shield or roof 43 stiff and at a fixed angle with respect to each other, I preferably provide braces or props or brackets 44 extending from one or more of the pipes within the cylinder 1 to the undersides of the shield 43.

Upon the housing 16 is a hopper 45, the bottom of which is provided with a feed screw 46 mounted on the shaft 47 provided with a pulley 48 for continuously rotating it. This apparatus is for the purpose of continuously feeding, into the mixing chamber, small portions of sand, "fines" and other dry solid materials which it may be desirable to have in the finished mixture. Sands and "fines" are added at this point after the coating of the aggregate has been substantially completed for the purpose of imparting thickness or body to the coating of bituminous material.

When it is desired to modify or improve the binding material, by adding thereto small quantities of such ingredients as lime, sulphur, rubber or the salts of fatty acids, such materials, if powdered and dry, may be introduced with the sands or "fines"; or certain of said materials may be contained in the liquefier, when a liquefier is used; or some may be provided with a suitable liquid vehicle and sprayed through the tube, when a liquefier is not used, or some may be mixed with the coating material itself in the tank from which the pipe 35 is supplied with coating material.

Since the lower end of the chute 49 is well above the upper surface of the material being treated in the mixer section 1° the strong blast of air drives the sands or "fines" and particularly any powdered material mixed therewith forwardly well up into the mixing chamber 1° so that the paving material under agitation has a substantial distance to travel before it reaches the lower end of the cylinder 1 and in this way a thorough mixing of said mineral ingredients into the hot bituminous binding material in the section 1° is assured.

In Fig. 1 the four pipes 27, 30, 32 and 35 are arranged vertically one over the other for the purpose of clearly indicating each of them in the drawings, but in practice, they are preferably arranged somewhat in the manner indicated in Fig. 5 because this arrangement is more compact and because all

four pipes may well be arranged to have their upper ends pass through the disk 26 to be supported thereby.

The operation of the complete apparatus, as above described, and as illustrated in Fig. 1, is as follows. The fuel oil from the burner 28 is supplied from the fuel pipe 27 upon opening the valve 29. Opening the valve 31 supplies air for ignition at the burner and assists in creating a flame which may reach to substantially the upper end of the section 1° and may substantially fill it. The fan 17 impels a strong blast of air at atmospheric temperature through the mixer section 1° and through the intermediate section 1^b but in traversing said sections it becomes somewhat heated by absorbing some of the heat from the heated aggregate flowing therethrough from the heater section 1°. Upon entering the heater section or chamber 1° the air becomes highly heated by the flame from the burner 28 sufficient to quickly dry the aggregate and to heat it to a temperature of 460° F. when that high temperature is desired. In ordinary practice the aggregate leaving the section 1° is at a temperature from 250° to 300° F.

The cylinder 1 is continually rotated slowly in the direction indicated by the arrow 41 in Fig. 2 and by the arrows 50 in Figs. 3 and 4, it being understood that while the arrows 59 indicate that the cylinder section shown in Figs. 3 and 4 is rotated in an anticlockwise direction, and that in Fig. 2 in a clockwise direction, this is because in Fig. 2 the observer is looking toward the right from the plane 2—2 of Fig. 1, while in Figs. 3 and 4 he is looking to the left from the plane 3—3.

The elevator 19 continuously discharges the aggregate into the hopper 50 whence it is fed into the upper end of the heater section 1°. From the time of its placement in the heater section 1° until it is gravitationally delivered into the intermediate section 1°, the aggregate is continually lifted by the troughs 40 and dropped transversely through the hot current of flame and air to the bottom of the section. Because the cylinder 1 is mounted on an inclined axis the general flow of the stream of aggregate through the cylinder will be slow and downwardly in a direction contrary to that of the blast of air from the fan 17. The lifting and dropping of the aggregate in the section 1° in the blast of hot air performs two functions, (1) the aggregate is heated to a temperature sufficient to drive off the water contained therein and heat the aggregate to any temperature desired in the subsequent coating step, and (2) when dry, the aggregate is cleaned of dust, which is shaken off and blown out of the cylinder by the blast of air.

Upon leaving the heater section 1° the stream of aggregate slowly slides over the smooth interior of the first split ring 2 and

tially fills the chamber, heating the aggregate; with means whereby the air passing over the hot aggregate, cools the aggregate and transfers some of the heat back to the heating chamber; with means for stationarily supporting in a rotating cylinder the burners and tubes for heating and spraying the aggregate with such liquids as may be used in making of widely varying paving materials with bituminous and oil binders, and with means for introducing near the end of the coating treatment, finely divided material to increase the thickness, toughness, and water resisting properties of the coating material. The aggregate, which may come directly from the sand pit or gravel pit or quarry and which is delivered directly into one end of the apparatus, issues from the other end thereof as a completely coated aggregate ready for placement or storage.

While the mechanism above described is primarily intended to be used to heat, dust, waterproof and coat aggregate with a bituminous or oily binding material by flowing a stream of aggregate therethrough, the mechanism is also designed for and is capable of being used as a drying and dusting apparatus in the treatment of aggregate or a drying and dusting and waterproofing apparatus.

When it is desired to obtain merely clean dry aggregate, the split ring 2 is removed, thereby leaving a substantial gap between the lower end of the heater section 1^a and the upper end of the intermediate section 1^b.

When new aggregate is delivered from the elevator 10, hopper 20 and chute 21 into the section 1^a, which is rotated by the chain 23 and through which a blast of air from the fan 17 and the flame from the burner 28 are projected said section will operate as it did when coupled with the other two sections and the aggregate will be lifted by the lifting troughs 40, dropped through the blast of air and progressed slowly longitudinally of the section until it falls from the lower end of the section 1^a in the gap between the two sections 1^a and 1^b.

When it is desired to prepare an aggregate by cleaning it and drying it and coating it or impregnating it with a waterproofing or other liquid, as for instance, in the laying of a penetration pavement, then the split ring 2' is removed while the split ring 2 unites the two sections 1^a and 1^b as first above described. In this arrangement the driving of the chain 23 affects the rotation of the two sections 1^a and 1^b and after leaving the section 1^a the aggregate flows under the perforations in the spray or pipe 32 and any suitable liquid, such as a liquefier for asphalt or latex, or solutions of waterproofing material, are discharged onto the stream of aggregate passing therethrough. When the aggregate leaves the section 1^b gravitationally, it falls through

the gap between the sections 1^b and 1^c caused by the removal of the ring 2'.

When the split ring 2 is removed, the section 1^a is supported on the rollers 5 and 8, while the combined sections 1^b and 1^c remain in position supported on the rollers 10, 12 and 14.

When the split ring 2' is removed, then the sections 1^a and 1^b rotatively rest upon the rollers 5 and 8 and 10, while the section 1^c remains in alinement therewith supported on the rollers 12 and 14, and the flanges on the rings 6, 7, 9, 11 and 13 hold these sections from longitudinal movement when they are disconnected by the removal of either of the split rings 2 or 2'.

It is to be understood that although for the purposes above described a construction is illustrated wherein the cylinder 1 consists of three unitary and separable sections united into a unitary cylinder by the split rings 2 and 2', the terms "section" and "chamber" are not to be construed as limited to a separate or removable section unless so expressly stated, for when the three parts are clamped together by the split rings 2, 2' the cylinder 1 itself is a unitary structure, the full equivalent of a one-piece cylinder, in which the sections are not separable, for it is believed that in the general use of this apparatus, when it shall have been once set up and put into operation with the three sections unitarily connected together, only on rare occasions will either of the split rings 2, 2' be removed and parts of the machine operated alone.

Having thus described my invention, what I claim and desire to protect by Letters Patent of the United States is:

1. In a machine for making paving material, the combination of a hollow casing mounted for rotation with its longitudinal axis inclined slightly to the horizontal and providing at its upper end a heating section and at its lower end a mixing section, of means to continuously deliver aggregate into the upper end of said casing, means to continually rotate said casing about the longitudinal axis thereof to impart a slow gravitational travel to the aggregate through said casing, means to impel a current of air over said aggregate after it leaves said heating section to cool the aggregate during its travel from said heating section to the lower end of said casing, a burner adjacent the lower end of said heating section, means to conduct fuel and air to said burner to produce a flame of burning fuel well filling said heating section, means extending into said mixing section to continuously discharge hot binding material over the aggregate as it travels through said mixing section, and means within said mixing section to thoroughly agitate said aggregate.

2. In a machine for making a paving material, the combination with a hollow casing

into the upper end of the intermediate section 1^b and on through the spaces between the arms of the spider 24.

When the material which is being used to
 5 coat or cover the aggregate is asphalt and is
 of a consistency which requires a liquefier,
 such as kerosene or other light relatively
 volatile oils, such liquefier is continuously
 supplied to the stream of aggregate while it
 10 is passing under the upper end of the pipe
 32, where said pipe is provided with the per-
 forations 34 through which said liquefier is
 delivered to the aggregate from the pipe 32.
 When binding material, which does not have
 15 to be thinned or liquefied in order to thor-
 oughly mix it with the aggregate, is used,
 the pipe 32 is not employed and the valve
 33 is closed or the pipe 32 may be used to
 spray any other liquid such for instance as a
 20 solution of rubber or rubber latex or a soap
 solution over the aggregate.

After the stream of aggregate has passed
 from under the perforations 34 in the pipe
 32, it slides over the smooth inner surface of
 25 the second split ring 2' at the upper end of
 the mixer chamber 1^c.

Air from the fan 17 enters the lower end
 of the mixer section 1^c at atmospheric tem-
 perature and is impelled toward the burner
 30 28 and during its travel it substantially re-
 duces the temperature of the aggregate
 traveling through the sections 1^b and 1^a ab-
 sorbing heat from the hot aggregate and
 transferring said heat back to the heating
 35 chamber 1^c thereby substantially increasing
 the efficiency of the apparatus. In this man-
 ner the aggregate is cooled to a temperature
 below that of the binding material delivered
 to the aggregate in the chamber 1^c and there-
 40 fore somewhat chills the binding material
 causing the binding material to adhere firm-
 ly to the aggregate and to form a thick coat-
 ing thereof thereon.

In the general use of the machine the ag-
 45 gregate will have a temperature of about
 250° F. when it enters the mixer section 1^c
 and the coating and binding material a
 temperature of about 300° F.

The spraying of the aggregate with the
 50 liquefier from the pipe 32 (when a liquefier
 is used) also substantially assists in the cool-
 ing of the aggregate in the intermediate sec-
 tion 1^b after it leaves the heating chamber
 1^a. If, however, the pipe 35 is not used, then
 55 the only special treatment which the aggre-
 gate receives within the section 1^b is that
 of being chilled or cooled to the desired ex-
 tent or degree by the air at substantially at-
 mospheric temperature blown thereover from
 60 the fan 17.

Upon leaving the intermediate section 1^b
 the aggregate passes under the upper end of
 the spray or jet pipe 35 which is supplied
 with the hot liquid binding material, the
 65 temperature being approximately from 250

to 460° F. depending upon the particular
 binding material used. Throughout its
 travel through the mixing chamber 1 a suit-
 able quantity of the coating material is con-
 tinually sprayed upon the stream of aggre-
 70 gate and as soon as the aggregate meets the
 stirrer blades 42 it is lifted higher up on the
 side of the cylinder than it was in traversing
 the smooth surface of the intermediate por-
 tion 1^b and of the split rings 2 and 2'. 75

On the side of the cylinder which is rising,
 as the cylinder rotates, the aggregate slides
 from the stirrer blades of one circular series
 to the stirrer blades of the adjacent series
 slowly working toward the discharge end of
 80 the section 1^c due to the incline of the axis of
 the cylinder.

Shortly prior to the time when the treat-
 ment of the aggregate in the mixing or coat-
 ing chamber 1^c has been completed, there is
 85 introduced into the chamber a relatively
 small quantity of "fines" or sands either alone
 or mixed with other materials (when the ag-
 gregate under treatment is substantially
 coarser or larger than sand or "fines") for the
 90 purpose of obtaining a thicker coating and a
 more even distribution of the coating mate-
 rial on the individual pieces of aggregate.
 This fine material, which may contain pow-
 dered sulphur or lime or other suitable ma-
 95 terials, is continuously added to the stream
 flowing through the lower end of the mixing
 chamber 1^c, the screw 46 delivering the same
 in a continuous stream flowing down through
 the chute 49. The blast of air at atmospheric
 100 temperature from the fan 17 will prevent the
 material falling from the lower end of the
 chute 49, from being deposited directly be-
 neath the lower end of the chute. Because it
 is finely comminuted and dust-like small par-
 105 ticles will be blown by the blast of air some
 distance upwardly toward the upper end of
 the mixing chamber 1^c before it comes to rest
 on the surface of the aggregate being agi-
 tated therein, particularly if the lower end of
 110 the chute 49 be spaced a substantial distance
 above the upper surfaces of the stream of ag-
 gregate under treatment.

When the coated aggregate leaves the
 lower end of the mixing chamber 1^c it falls
 115 into the chute 18 and may be carried away
 for storage by a continuous conveyer or it
 may be delivered into cars or trucks for trans-
 portation to the place where a roadway is
 being made. 120

The machine, above described, constitutes
 an apparatus in which aggregate may be con-
 tinuously treated as a stream of aggregate
 continuously moving by gravity in a direc-
 125 tion opposite to that of a blast of air driven
 through the machine, said apparatus being
 provided with means extending into a rotat-
 able cylinder for supporting the upper end,
 forming a heating chamber; with means for
 forming a large jet of flame which substan-

mounted for rotation with its longitudinal axis inclined slightly to the horizontal and providing at its upper end a heating section and at its lower end a mixing section, of means to continuously deliver aggregate into the upper end of said casing, means to continually rotate said casing about the longitudinal axis thereof to impart a slow gravitational travel to the aggregate through said casing to the lower end thereof, a burner at the lower end of said heating section, means to conduct fuel to said burner to produce a blast flame of burning fuel well filling said heating section, and operable to continuously impel a current of air from the atmosphere throughout the length of said casing over said aggregate in a direction opposite to the travel of said aggregate to cool the aggregate after it leaves said heating section and to remove the dust and products of combustion in the heating section out through the upper end of said casing, means to continuously discharge hot binding material over the cooling aggregate as it travels through said mixing section, and means within said mixing section to continuously thoroughly agitate said aggregate.

3. In a machine for making paving material, the combination with a hollow casing mounted for rotation with its longitudinal axis inclined slightly to the horizontal and providing at its upper end a heating section, at its lower end a mixing section and between them an intermediate section, means to continuously deliver aggregate into the upper end of said casing, means to continuously rotate said casing about the longitudinal axis thereof to impart a slow gravitational travel to the aggregate through said casing to and out of the lower end thereof, a burner at the lower end of said heating section, means to conduct fuel and air to said burner to produce a blast flame of burning fuel well filling said heating section and operable to produce a current of air over said aggregate after it leaves said heating section and in a direction opposite to the travel of said aggregate, means to cool said aggregate during its travel through said mixing and intermediate sections, means to discharge a liquid on said aggregate as it flows through said intermediate section, means to continuously discharge hot binding material over the aggregate as it travels through said mixing section, and means within said mixing section to continually thoroughly agitate said aggregate as it travels through said mixing section.

4. In a machine for making paving material, the combination with a hollow casing mounted for rotation with its longitudinal axis slightly inclined to the horizontal and providing a heating section at its upper end, a mixing section at its lower end and an intermediate section between them, of means to continuously deliver aggregate into the

upper end of said casing, means to continuously rotate said casing about the longitudinal axis thereof to impart a slow gravitational travel or flow to said aggregate throughout said casing to the lower end thereof; a burner adjacent the lower end of said heating section, operative to produce a blast flame of burning fuel well filling said heating section, means to conduct the products of combustion directly out of said heating section through the upper end of said casing, means to continually impel a strong current of air from the atmosphere through said casing over said aggregate after it leaves said heating section, means within said mixing section to continuously discharge hot liquid binding material over the aggregate in said mixing section, means for discharging a liquid over the aggregate as it travels through said intermediate section, and means within said mixing section to continuously thoroughly agitate said aggregate therein.

5. In a machine for making paving material; the combination of a hollow casing mounted for rotation with its longitudinal axis inclined slightly to the horizontal and providing at its upper end a heating section and at its lower end a mixing section, of means to continuously deliver aggregate into the upper end of said casing, means to continually rotate said casing about the longitudinal axis thereof to impart a slow gravitational travel to the aggregate through said casing, a burner adjacent the lower end of said heating section, means to conduct fuel and air to said burner to produce a flame of burning fuel well filling said heating section, means extending into said mixing section to continuously discharge hot binding material over the aggregate as it travels through said mixing section, means within said mixing section to thoroughly agitate said cooling aggregate, and means projecting into the lower end of said casing to continuously feed finely powdered mineral material to said aggregate at a point in said mixing chamber where said aggregate has been partly but not completely coated with said binding material.

6. In a machine for making paving material, the combination with a hollow casing mounted for rotation with its longitudinal axis inclined slightly to the horizontal and providing at its upper end a heating section and at its lower end a mixing section, of means to continuously deliver aggregate into the upper end of said casing, means to continually rotate said casing about the longitudinal axis thereof to impart a slow gravitational travel to the aggregate through said casing, a burner adjacent the lower end of said heating section, means to conduct fuel to said burner to produce a blast flame of burning fuel well filling said heating section, means to continuously impel a strong current

of air from the atmosphere through said casing from the lower to the upper end thereof, means to continuously discharge hot binding material over the aggregate as it travels through said mixing section, means within said mixing section to continuously thoroughly agitate said aggregate, and means projecting into the lower end of said casing to continuously feed finely powdered mineral material to said aggregate at a point in said mixing chamber where said aggregate has been partly but not completely coated with said binding material.

7. In a machine for making paving material, the combination with a rigid hollow casing mounted for rotation with its longitudinal axis inclined slightly to the horizontal and providing at its upper end a heating section, of means to continuously deliver aggregate into the upper end of said casing, means to continuously rotate said casing about the longitudinal axis thereof to impart slow gravitational travel to the aggregate therethrough, a burner at the lower end of said heating section to produce a blast flame of burning fuel well filling said heating section, means to drive atmospheric air through said casing in a direction contrary to the travel of the aggregate therethrough, lifting troughs secured to the inside of said casing within said heating section, whereby aggregate in said heating section is carried by the rotation of said casing in said troughs to the upper side of said cylinder and then falls to the lower side thereof transversely through said flame and transverse to said current of air, said current of air being operative to abstract heat from the aggregate leaving said heating section and to transfer it back to said heater section.

8. In a machine for making paving material, the combination with a hollow casing mounted for rotation with its longitudinal axis inclined slightly to the horizontal and providing at its upper end a heating section, at its lower end a mixing section and between them an intermediate section, of means to continuously deliver aggregate into the upper end of said heating section, means to continually rotate said casing about the longitudinal axis thereof to impart a gravitational travel to the aggregate through said casing, means to discharge hot liquid binding material over the aggregate as it travels through said mixing section and to thoroughly agitate the aggregate therein, and means to discharge a liquid over said aggregate as it travels through said intermediate section.

9. In a machine for making paving material, the combination of a relatively long hollow casing, of a plurality of pairs of spaced rollers having their axes parallel to the axis of the cylinder and upon which said cylinder is supported for rotation about its longitudinal axis, which is slightly inclined to

the horizontal, said casing comprising a heating section at the upper or highest end thereof, a mixing section at the opposite or lower end thereof and an intermediate section, the ends of which are spaced from the adjacent ends of said heating and mixing sections respectively, removable means surrounding the adjacent ends of the heating section and said intermediate section for unitarily rigidly connecting said sections and closing the space therebetween, means for preventing said sections from sliding longitudinally on said rollers, means for applying power to said heater section to rotate said casing, whereby when said removable means are removed said heater section may be operated alone and independently of the other sections of said casing, means to supply aggregate continuously to the upper end of said heater section, a burner at the lower end of said heating section and within said casing, and means to supply fuel and air thereto to produce a blast flame well filling said heating section.

10. In a machine for making paving material, the combination of a relatively long hollow casing, a plurality of pairs of spaced rollers having their axes parallel to the axis of said casing and upon which said casing is supported for rotation about its longitudinal axis which is slightly inclined to the horizontal, said casing comprising a heating section at the upper or highest end thereof, a mixing section at the opposite and lower end thereof and an intermediate section, the ends of which are spaced from the adjacent ends of the said heating and mixing sections respectively, removable means surrounding the adjacent ends of said heating section and said intermediate section for unitarily rigidly connecting said sections and closing the space therebetween, like removable means rigidly connecting together the adjacent ends of said intermediate section and said mixing section and closing the space therebetween, means for preventing said sections from sliding longitudinally on said rollers, means for applying power to said heating section to rotate said casing, whereby when said removable means between said heating section and said intermediate section are removed said heating section may be operated alone and independently of said other sections and whereby when said second removable means are removed, said heating section and said intermediate section may be continually operated independently of said mixing section, means to supply aggregate continuously into the upper end of said heating section, a burner at the lower end of said heating section and within said casing, means to supply fuel thereto to produce a blast flame well filling said heating section, and means to spray a liquid over the aggregate as it travels through said intermediate section after leaving said heating section.

11. In a machine for making paving material, the combination of a rigid hollow casing mounted with its longitudinal axis inclined to the horizontal and providing a heating section at its upper end, a mixing section at its lower end and an intermediate section therebetween, means to deliver aggregate continuously into the upper end of said casing, means to continuously rotate said casing, a burner within said casing and positioned at substantially the lower end of said heating section, a fuel pipe and an air pipe both entering said casing at the lower end thereof and extending to said burner, a third pipe entering said casing at the lower end thereof and extending substantially as far as said burner and provided with perforations at the upper end thereof for the delivery of a liquid therefrom to the aggregate in said intermediate section, a pipe for conducting hot coating material also entering said casing at the lower end thereof and provided with a longitudinal series of openings for the continuous discharge of said coating material over a substantial part of the entire length of said mixing section, means to support said pipes rigidly and stationarily with respect to each other within said rotatable casing and including spaced supports rigid with said casing and extending inwardly from the inner surface of said casing to the center thereof and provided with a cylindrical opening adjacent and to the rear of said burner and concentric with the axis of said casing, and a disk smoothly fitting within said opening and provided with openings through which at least two of said pipes extend.

12. In a machine for making paving material, the combination of a rigid hollow casing mounted with its longitudinal axis inclined to the horizontal and providing a heating section at its upper end, a mixing section at its lower end and an intermediate section therebetween, means to deliver aggregate continuously into the upper end of said casing, means to continuously rotate said casing, a burner within said casing and positioned at substantially the lower end of said heating section, a plurality of pipes for supplying fuel to said burner and for continuously delivering liquid material to the aggregate being treated in said casing between said burner and the lower end of said casing, means to support said pipes rigidly and stationarily with respect to each other within said rotatable casing and including spaced supports rigid with said casing and extending inwardly from the inner surface of said casing to the center thereof and provided with a cylindrical opening adjacent and to the rear of said burner and concentric with the axis of said casing, and a disk smoothly fitting within said opening and provided

with openings through which at least two of said pipes extend.

13. In a machine for making paving material, the combination of a rigid hollow casing mounted with its longitudinal axis inclined to the horizontal and providing a heating section at its upper end, a mixing section at its lower end and an intermediate section therebetween, means to deliver aggregate continuously into the upper end of said casing, means to continuously rotate said casing, a burner within said casing and positioned at substantially the lower end of said heating section; a plurality of pipes for supplying fuel to said burner and for continuously delivering liquid material to the aggregate being treated in said casing between said burner and the lower end of said casing, means to support said pipes rigidly and stationarily with respect to each other within said rotatable casing and including spaced supports rigid with said casing and extending inwardly from the inner surface of said casing to the center thereof and provided with a cylindrical opening adjacent and to the rear of said burner and concentric with the axis of said casing, a disk smoothly fitting within said opening and provided with openings through which at least two of said pipes extend, and a roof-shaped shield stationarily supported over said pipes to prevent any coated aggregate falling thereon from sticking to and accumulating on said pipes and roof.

14. In a machine for making paving material, the combination of a rigid hollow casing mounted with its longitudinal axis inclined to the horizontal and providing a heating section at its upper end, a mixing section at its lower end and an intermediate section therebetween, means to deliver aggregate continuously into the upper end of said casing, means to continuously rotate said casing, a burner within said casing and positioned at substantially the lower end of said heating section, a fuel pipe and an air pipe both entering said casing at the lower end thereof and extending to said burner, a pipe for conducting hot coating material also entering said casing at the lower end thereof and provided with a longitudinal series of openings for the continuous discharge of said coating material over a substantial part of the entire length of said mixing section, means to support said pipes rigidly and stationarily with respect to each other within said rotatable casing and including spaced supports rigid with said cylinder and extending inwardly from the inner surface of said casing to the center thereof and provided with a cylindrical opening adjacent and to the rear of said burner and concentric with the axis of said casing, and a disk smoothly fitting within said opening and provided

with openings through which at least two of said pipes extend.

15. In a machine for making paving material, the combination with a hollow casing mounted for rotation with its longitudinal axis inclined to the horizontal and providing at its upper end a heating section and at its lower end a mixing section, of means to continuously deliver mineral aggregate into the upper end of said casing, means to continuously rotate said casing about its longitudinal axis to impart a slow gravitational flow or travel to the aggregate throughout said casing, means to impel a current of air through said casing over said aggregate to cool said aggregate throughout its travel through said casing after it leaves said heating section and to remove dust from said aggregate through the upper end of said casing, means within said casing for quickly drying aggregate in said heating section, means extending into the mixing section to continuously discharge hot binding material over the aggregate as it travels through said mixing section, and means within said mixing section to thoroughly agitate said aggregate.

16. In a machine for making paving material, the combination with a hollow casing mounted for rotation with its longitudinal axis inclined slightly to the horizontal and providing at its upper end a heating section and at its lower end a mixing section, means at the lower end of said heating section to heat said heating section, the upper end of said heating section being open to the atmosphere to permit of the passage of products of combustion directly out of the upper end of said heating section, means to continuously deliver aggregate into the upper end of said heating section of said cylinder, means to continually rotate said casing on its longitudinal axis to impart a gravitational travel to the aggregate throughout said casing, means to cool said aggregate after it leaves said heating section and throughout the balance of its travel through said casing, and means to discharge bituminous binding material, in a fluid condition over said cooling aggregate and to thoroughly agitate said aggregate as it travels through said mixing section.

17. In a machine for making paving material, the combination with a hollow casing mounted for rotation with its longitudinal axis inclined to the horizontal and providing at its upper end a heating section and at its lower end a mixing section, of means to continuously deliver mineral aggregate into the upper end of said casing, means to continuously rotate said casing about its longitudinal axis to impart a slow gravitational flow or travel to the aggregate throughout said casing, a burner at the lower end of said heating section for quickly drying said aggregate in said heater section and arranged to

discharge its products of combustion directly from said heating section out through the upper end of said casing, means extending into the mixing section to continuously discharge hot binding material over the cooling aggregate as it travels through said mixing section, means to impel cool air into the lower end of said casing and to cause said air to travel the length of said casing first over the aggregate in said mixing section and thence through said heating section and out of the upper end of said casing to cool said aggregate after it leaves said heating section and to force the products of combustion and dust in said heating section out through the upper end of said casing, and means within said mixing section to thoroughly agitate said aggregate.

In witness whereof, I have hereunto set my hand this eighth day of August, 1929.

DONALD McKNIGHT HEPBURN.