

April 25, 1961

B. G. MARSHALL
APPARATUS FOR MECHANICALLY COMPACTING
PAVING MIXTURES AND OTHER MATERIALS

2,980,978

Filed May 8, 1956

3 Sheets-Sheet 1

Fig. 1

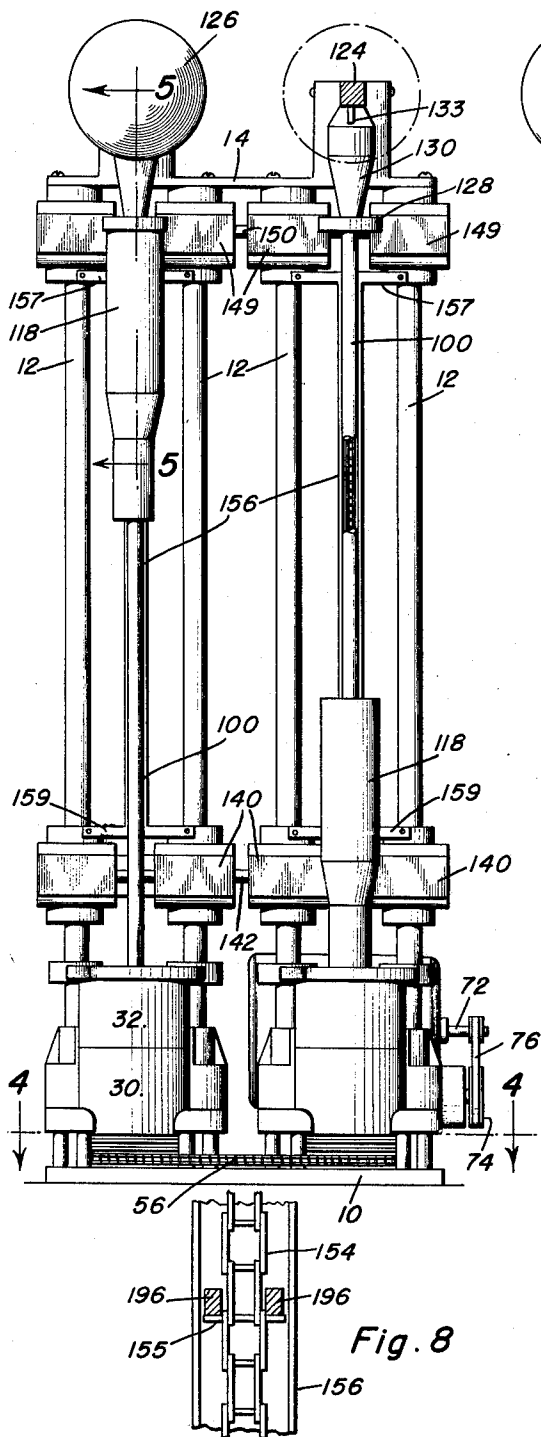
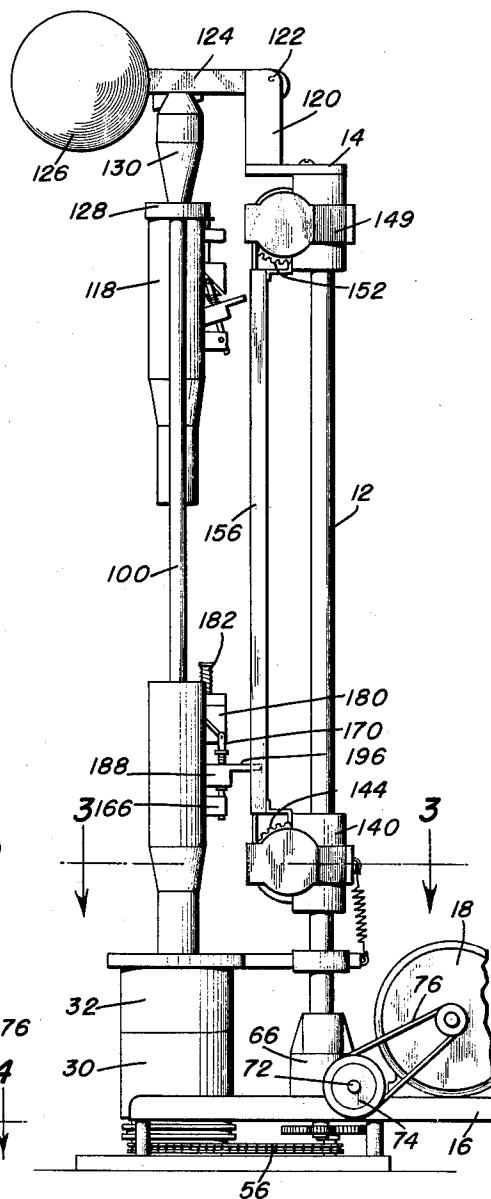


Fig. 2



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Fig. 8

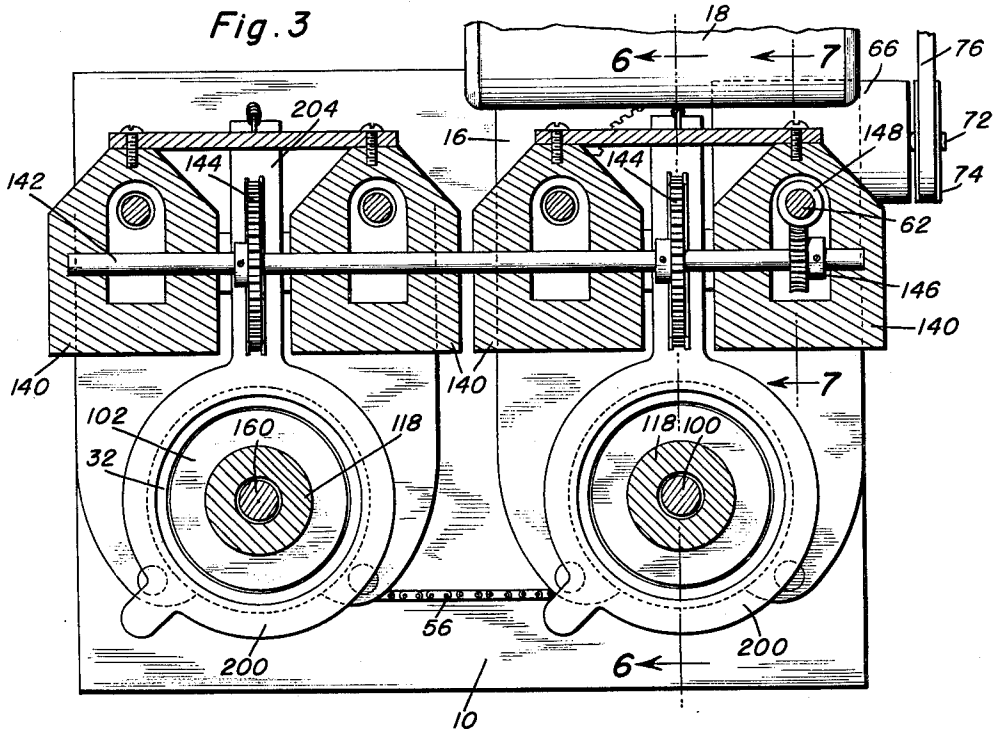
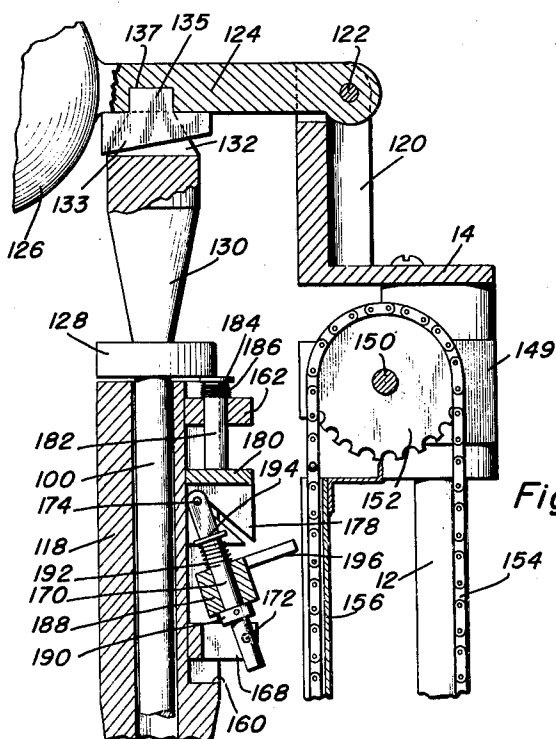
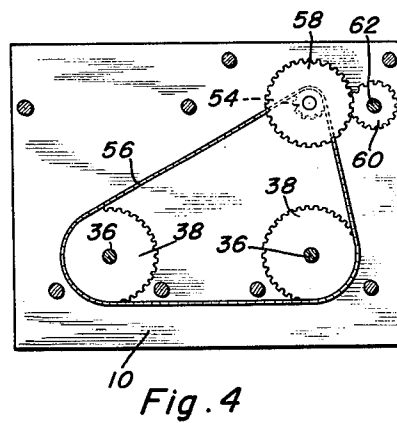
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3 Sheets-Sheet 2



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Fig. 10

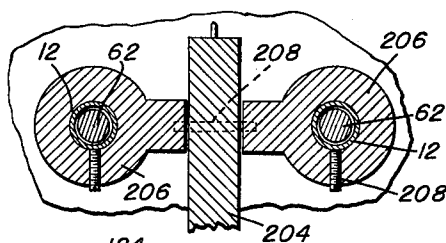
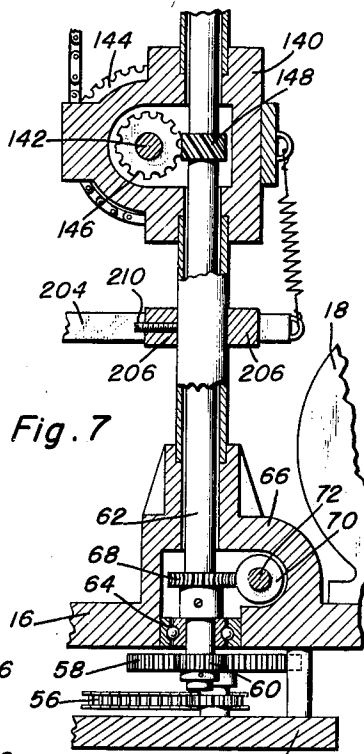


Fig. 7

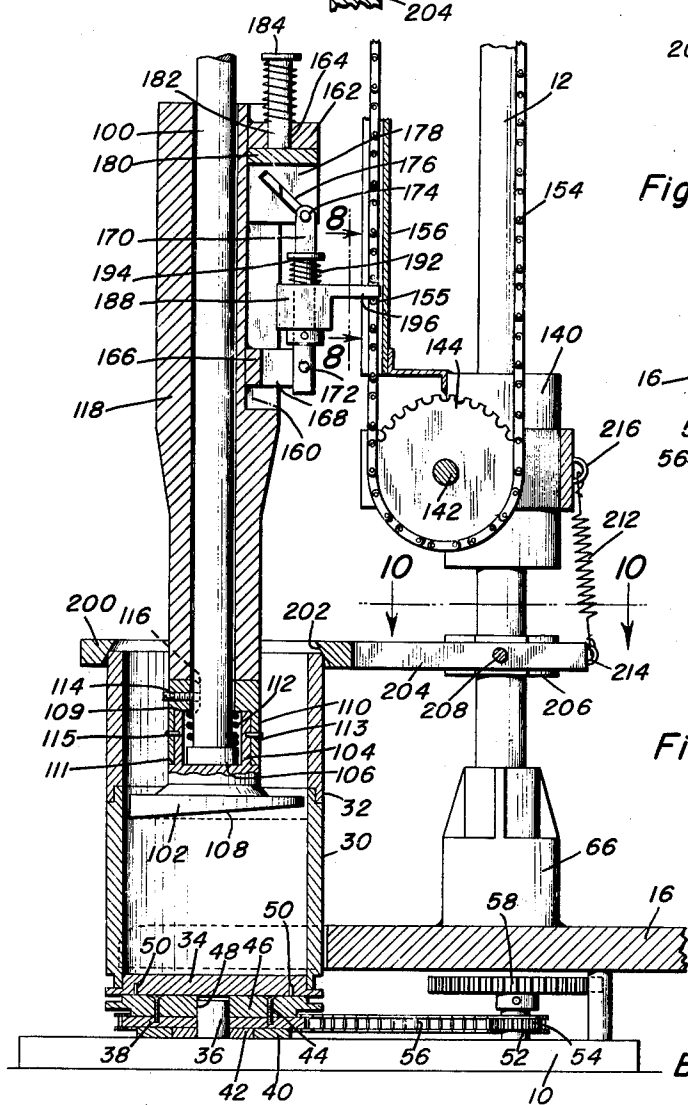


Fig. 6

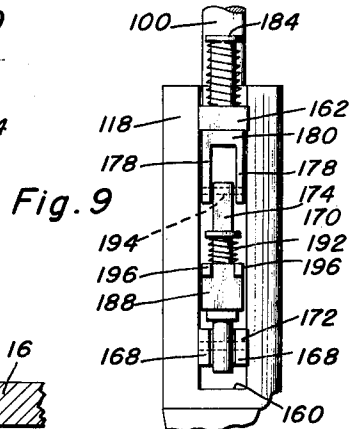


Fig. 9

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2,980,978

APPARATUS FOR MECHANICALLY COMPACTING PAVING MIXTURES AND OTHER MATERIALS

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3 Claims. (Cl. 25—41)

This invention comprises a novel and useful apparatus for mechanically compacting paving mixtures and other materials and more particularly relates to an improved mechanism for producing uniformly compacted test samples of mixtures of paving material in order that uniform and reproducible results will be reflected in succeeding tests.

The principal objects of this invention are to provide a novel apparatus whereby mixtures of paving materials may be compacted into test samples having densities which are capable of being precisely controlled as desired.

A further object of the invention is to provide apparatus for forming the above mentioned testing samples with a great saving in time and labor.

Yet another object of the invention is to provide an apparatus capable of forming simultaneously and by a completely automatic operation a plurality of test samples of a uniform density.

A still further important object of the invention is to provide an apparatus whereby test samples of paving material mixtures may be quickly and precisely formed even by unskilled operators.

An additional important object of the invention is to provide an apparatus for compacting mixtures of paving materials in a mold and whereby the major portion of the impacting force is effectively applied adjacent the rim of the mold to overcome the resistance between the interior mold surface and the material being compacted, which resistance, unless compensated for, causes a variation in the compactness of the material being formed as a test sample.

Yet another object of the invention is to provide an apparatus for compacting mixtures of paving materials in a mold to form test samples thereof, and whereby a timed rotation of the mold is simultaneous with a timing of the impacting member upon the material in the mold.

Still another important object of the invention is to provide a testing apparatus having a highly effective means for delivering periodically a series of controlled impacts upon the material in the mold, together with a novel and effective means for lifting an impact member and releasing the same for impact upon the material in the mold.

Another important object of the invention is to provide a means effecting a kneading action between the surface of the materials being compacted and the face of the impacting member thereby orienting the particles of the material in the mold to the position of least value of the resulting test sample being produced.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

Figure 1 is a front elevational view of one suitable form of apparatus for carrying out the principles of

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this invention, the apparatus being designed for compacting two mixtures of paving materials in two molds, portions of one unit of the apparatus being broken away and shown in vertical section, the two units being shown in different phases in their cycles of operation;

Figure 2 is an end elevational view taken from the right end of Figure 1;

Figure 3 is a horizontal sectional view taken upon an enlarged scale substantially upon the plane indicated by the section line 3—3 of Figure 2;

Figure 4 is a horizontal sectional view taken substantially upon the plane indicated by the section line 4—4 of Figure 1 and showing the common driving means for rotating the two molds of the apparatus;

Figure 5 is a view taken in vertical section upon an enlarged scale substantially upon the plane indicated by the section line 5—5 of Figure 1 and showing certain details of the hammer release mechanism of the invention;

Figure 6 is a fragmentary view in vertical section taken substantially upon the plane indicated by the section line 6—6 of Figure 3 and showing the manner in which the impacting element bears against the mixture of paving materials in a mold together with the latch and lifting mechanism whereby the impact weight of the unit is lifted;

Figure 7 is a detail view taken upon an enlarged scale substantially upon the plane indicated by the section line 7—7 of Figure 3 and showing some of the driving mechanism of the apparatus;

Figure 8 is a detail view taken upon an enlarged scale substantially upon the plane indicated by the section line 8—8 of Figure 6 and showing the manner in which the lifting mechanism of one of the units engages the latch mechanism for lifting the weight of that unit;

Figure 9 is a fragmentary elevational view of a portion of the latch mechanism of one of the units; and

Figure 10 is a horizontal sectional view taken substantially upon the plane indicated by the section line 10—10 of Figure 6.

The present invention consists of a mechanical device and a method for producing a high and/or uniform degree of consolidation, density or compaction in specimens of asphalt paving mixtures, soils, or other granular materials or mixtures composed of such materials and any additives thereto.

In order that reliable and dependable results of subsequent tests can be obtained on such specimens, it is essential that the test specimen conform to the following characteristics and conditions of production:

(1) The degree of compaction or densification must be uniform throughout the mass of the specimen.

(2) Each specimen of identical mixtures must be compacted to the same degree of densification and the results must be reproducible with certainty and precision.

(3) The degree of densification must be obtained by the same mechanical means and under the same conditions.

The present invention relates to the same general subject matter but presents improvement over the inventions patented in my prior Patents No. 2,447,586, of August 24, 1948, and No. 2,471,227 of May 24, 1949.

The novel principles embodied in the concept of this invention may be performed by various forms of apparatus and also may be practiced by various methods. In order to understand a suitable manner in which the principles of the invention may be satisfactorily practiced, there has been illustrated in the accompanying drawings one form of apparatus, although it will be understood that other forms of apparatus and other methods may be employed.

In the apparatus illustrated there is provided a general supporting framework, a mold assembly for receiving the mixtures to be compacted into test samples or specimens, and a hammer assembly together with its actuating mechanism.

These portions of the apparatus will be now dwelt with specifically under their respective headings.

General supporting framework

The apparatus, in order to be portable in nature, may consist of a plate-like supporting base 10 above which are supported pairs of supports or standards 12, there being one pair of standards for each unit of the apparatus. It will be understood that although the drawings disclose an apparatus consisting of two units, any desired number of units, one or more, may be employed.

Carried by the top of the standards 12 is a cross beam assembly 14 for a purpose to be later set forth.

Supported above the base 10 is a suitable platform 16 upon which is mounted an electric motor 18 for supplying power to operate the various elements of this apparatus.

In a manner to be referred to hereinafter, a portion of the mold driving mechanism is located below the platform while the above mentioned standards 12 are directly supported thereon.

Mold assembly

Each unit of the apparatus includes a mold assembly consisting of a mold adapted to receive the mixture of materials to be formed into a test specimen together with means for holding the mold in place and further means for imparting rotation to the mold in timed relation to the impacts of the hammer assembly.

As will be best apparent from Figure 6, each mold consists of a cylindrical lower section 30 comprising the molding chamber and which has its external circumference diametrically reduced at its ends for engagement in the internally diametrically reduced end portion of an upper mold section 32. Thus, the mold section 32 can be placed upon either end of the section 30, that is, the latter can be reversed as set forth hereinafter.

A mold case plate 34 is provided for engagement in either end of the lower mold section 30, and by means of any suitable fastening means, either end of the mold chamber section 30 can be placed upon the base 34 in relatively non-rotatable engagement therewith.

As shown in Figures 4 and 6, a pair of vertical pins or axles 36 rise from the base 10 and a driven sprocket wheel 38 is journaled for rotation upon each of these axles. Suitable spacing rings 40 together with adapter rings 42 encircle the axles 36 and form a support and wear resistant bearing for the sprocket 38. Secured to each sprocket as by fastening screws 44 is a plate or disk 46, apertured as at 48 for reception upon the axle 36. Rising from the top surface of the disk 46 is a pair of dowel pins 50 which are adapted to be received in corresponding recesses or apertures on the bottom surface of the mold base 34, whereby the mold base may be placed upon the member 46 and thus may be rotated by the driven sprocket 38.

A further vertical axle 52 is journaled on the base 10 and is provided with a sprocket wheel 54, a sprocket chain 56 being entrained about the sprocket 54 and the two driven sprockets 38. Also secured to the axle 52 is a gear wheel 58 which as shown in Figures 4 and 7 is meshed with a pinion 60 carried by the shaft 62.

Referring now especially to Figure 7 it will be seen that the shaft 62 is journaled in the platform or shelf 16 as by the bearing assembly 64, the lower end of the shaft having the above mentioned pinion 60 for driving the gear 58. The platform 16 is provided with an enlargement forming a gear casing 66 and within this casing the shaft 62 is provided with a gear 68 in mesh with a worm gear 70 on a driving shaft 72. As will be apparent from Figure 2, the shaft 72 is in turn provided with a pulley 74 operatively connected to the electric motor 18 as by

a belt drive 76. It will be seen that the operation of the motor serves to impart rotation to the vertical axle or shaft 62 for a purpose to be subsequently set forth, and from this shaft imparts rotation to the sprocket gears, thereby causing rotation of the molds 30.

The shaft 62, shown in Figures 3 and 7 is housed within one of the tubular standards 12, and in a manner to be subsequently set forth, imparts power to the mechanism effecting actuation of the hammer assembly.

Hammer assembly and actuating mechanism

Cooperating with the mold assembly of each unit for compacting therein a mixture of paving materials is a hammer assembly and its actuating mechanism. Each hammer assembly comprises a hammer rod 100, the latter having an enlarged end 106, which slidably fits into sleeve 104 of an impact member or hammer foot 102. A sleeve 110 encircles sleeve 104 of impact member 102 and abuts against the impact member at the annular surfaces 109, 111. Sleeve 110 is secured to sleeve 104 of impact member 102 by pins 113. Snap ring 115 retains pins 113 in place. A shock absorbing spring 112 encircling lower end of hammer rod 100 shoulders against sleeve 110 and enlarged end 106 of hammer rod 100. Pin 114 engaging in an elongated slot 116 in the rod 100, prevents rotation of rod 100 and permits limited vertical movement of sleeve 110. As will be apparent from Figure 6, the lower or impact surface of the hammer foot 102 is inclined as at 103 in such a manner that when the hammer impact member is received within the mold chamber section 30 the major portion of the impact blow of the vertically descending hammer will be applied at the circumference or periphery of the mold chamber. This arrangement is important for the purpose of this invention since by placing the greater force of the blow at the circumference of the mold chamber, the frictional resistance to compacting of the material against the wall of the chamber is overcome, thereby tending to produce a uniform densification of the material throughout the mold chamber. Since the hammer rod 100 is held stationary against rotation as set forth hereinafter, and since the mold chamber rotates, it is obvious that a uniform compaction of the material within the chamber will be secured.

Freely slidable upon the rod 100 is an elongated hammer weight 118 which is adapted to be lifted and dropped through a definite height as set forth hereinafter, to produce repetitive and timed impacts upon sleeve 110 which abuts against impact member, to thereby cause the latter to strike against the material within the mold chamber 30.

Referring now primarily to Figures 2 and 5 it will be seen that the upper cross member 14 of the supporting frame is provided with upstanding mounting brackets 120 upon which are pivoted as by pivot pins 122 horizontally extending, vertically swingable loading beams 124, each being provided with a weight 126 at its outer end. The upper end of the hammer rod 100 is provided with a laterally enlarged shoulder or collar 128 and has a handle portion 130 extending upwardly therefrom, the upper end of this handle being slotted or bifurcated at 132 to receive the depending rib 133 having an inclined lower edge, a stem 135 of the rib being secured in the recess 137 provided in the lower side of the beam 124. Thus, the weight 126 upon the beam 124, causes the latter to press downwardly on the handle 130 of the hammer rod 100, to thereby apply a predetermined weight and load to the impact member to hold the same firmly upon the top surface of the mixture of paving material received within the mold chamber 30 of each unit. Obviously, by lifting the beam 124 about its pivot 122, the rib 133 will be withdrawn from the slot 132 and the hammer assembly may be lifted from the mold chamber, to permit the latter to be filled, emptied, or replaced as desired.

It will thus be seen, that the hammer rod 100 with its impact member 102 may be lowered into the mold as-

sembly into contact with the material therein to be compacted, and will be held firmly against this material by means of the weight 126. Thereafter, the hammer weight 118 will be lifted and dropped as set forth hereinafter to impart a series of impacting blows to the sleeve 110, and through the latter directly to the hammer foot or impact member 102.

Reference is now made more particularly to the elevating means for raising repeatedly the hammer weight, from its dropped position shown at the right of Figure 1 to its elevated position ready for dropping as shown at the left of Figure 1.

Interposed in all of the tubular columns 12 adjacent the lower end of the same are housing members 140, see in particular Figure 3, in which is journaled a transverse shaft 142. Between the housings of each of the units the shaft 142 is provided with a sprocket 144 and in that housing member 140 which is adjacent to the vertical shaft 62, see Figure 7, the shaft 142 is provided with a helical gear 146 which meshes with and is driven by a gear 148 upon the shaft 62. Thus, the shaft 62 driven by the electric motor 18 as previously described, is also utilized to impart rotation of the shaft 142.

Extending horizontally through housing units 149, each surrounding one of the standards 12, and forming part of the upper cross member assembly 14 is a shaft 150 likewise carrying sprockets 152, each disposed above one of the sprockets 144. A pair of chains 154 are provided, one for each unit, each chain being entrained over a sprocket 144 and a sprocket 152.

Each of the chains is associated preferably with a vertical channel member 156 constituting a guideway, which channel member extends between the upper housing 149 and the lower housing 140, as will be best apparent from Figures 1, 2, 5 and 6. Each guideway 156 has upper and lower support brackets 157 and 159 respectively secured to the upper and lower housings 149, 140 of each unit for supporting the guideways. Referring to Figure 8, it will be seen that each of the chains 154 is provided with a transversely, laterally extending pin 155 for periodically elevating the hammer weight.

Mounted upon the hammer weight 118 is a latch assembly whereby the weight may be coupled to the chain 154 for elevation of the weight preparatory to dropping of the same for delivering the impact to the hammer foot 102. As will be best apparent from Figures 5 and 6, the weight 118 is provided with a vertical channel or recess 160 therein to receive the latching mechanism. At the upper end of this recess there is provided an overlying lug or bracket 162, secured as by welding or the like, and which is apertured as at 164. Adjacent the lower end of the recess there is provided a further laterally extending lug 166 having furcations or arms 168.

Referring also to Figure 9 it will be seen that a latch pin 170 has its lower end positioned between the furcations 168, being pivoted thereto as by a latch pivot pin 172. It will thus be seen that the latch pin can swing in an arc about the horizontal pivot 172, as will be apparent by comparing the positions of the latch pin in Figures 5 and 6.

The upper end of the latch pin is provided with a transverse pin 174 which is slidably retained in the inclined slots 176 formed in the parallel side walls 178 of a slide 180. The latter is provided with an upstanding pin 182 which is slidably received in the aperture 164 of the lug 162, the pin having a headed portion 184 while a compression spring 186 surrounds the pin and is received between the lug 162 and the headed portion 184. The slide 180 is thus guided for vertical sliding movement relative to the weight 118, the spring 186 tending to retain the slide in its raised position as shown in Figure 6. As will be apparent from Figure 5, the headed extremity 184 of the pin 182 is positioned to engage the enlargement 128 on the hammer rod 100 when the weight is in its raised or elevated position.

The operation of the latch mechanism, as so far described is as follows: When the weight has reached its raised position, and the headed extremity 184 abuts against the enlargement 128 of the relatively stationary hammer rod 100, the slide will be depressed, thus causing the latch pin 174 to travel inwardly relative to the hammer weight 118, thus causing the latch pin to move into an inclined position shown in Figure 5. However, after the weight has dropped, and until the weight is again lifted in order to move the latch mechanism into the position shown in Figure 5, the latch mechanism will remain in the position shown in Figure 6, with the latch pin 174 at the outer and lower end of the slots 176, and the latch pin 170 in its substantially vertical position.

A latch body 188 is slidably received upon the latch pin, between a retaining collar 190 and a compression spring 192 whose upper end abuts against a shoulder or annular enlargement 194 carried by the latch pin. Extending from the body 188 are a pair of latch fingers 196, which in the position of the latch mechanism shown in Figure 6 are adapted to straddle and embrace the upwardly travelling flight of the weight elevating chain 154, and are adapted to rest upon the lifting pin 155 on the chain 154, as shown in Figure 8. It will thus be apparent that each time the pin 155 travels upwardly, it will engage the latch fingers 196, when the weight and latch are in their lowered position as in Figures 2 and 6, and through the latch mechanism will lift the weight 118, the tension of the spring 186 being sufficient for this purpose. When the weight has reached the upper end of its travel, the stem 182 will be depressed by engagement with the stationary abutment element 128 and will be urged thereby to the position shown in Figure 5, pivoting the latch pin away from the chain and disengaging the latch fingers 196 therefrom, thereby permitting the weight to drop and deliver its impact to the hammer foot 102 as previously mentioned. When the chain completes its cycle of rotation, the pin 155 will again lift the latch finger and weight and repeat the cycle of operation.

It is intended that the movement of the molds 30 through their driving chain 56 and the frequency of the vertical reciprocations of the weight shall be such as to cause the descending hammer foot to strike the material in the mold at circumferentially spaced locations, whereby to cause even compacting of the material within the molds.

In order to facilitate the placing of the mold section 30 in place upon the device, and the mounting of the mold upper section 32 thereon, there is provided for each unit a retaining ring 200 having a beveled surface 202 adapted to engage the center itself upon the upper mold section 32. The ring 200 is carried by a support arm 204 which is positioned between a pair of collars 206, being pivoted thereto as by pivot pins 208. Each collar in turn is secured as by a set screw 210 to one of the above mentioned tubular member or standard 12, as will be apparent from Figures 7 and 10. A tension spring 212 is secured as at 214 and 216 to one end of the support arm 204 and to one of the housings 140, to thereby yieldingly urge each of the rings 200 into its lowered position. As will be apparent, a ring is provided for each of the mold assemblies.

Method of operation

In accordance with this method, a mixture of the various ingredients desired to be tested are placed in a mold section 30 which is mounted upon a base 34. Preferably two such samples are prepared, although the apparatus can be utilized to prepare a single sample. In any event, the mold section 30 with its base 34 is then attached to the plate 46, and the mold section 32 is then placed upon the section 30, with the retaining ring 200 being then lowered into place to lock these parts into position. The loaded beam 124 is then lowered, thereby lowering the hammer foot 102 through the open ring 200 and into the

mold section 32, and into contact with the top of the material placed in the section 30. Thereafter, the electric motor is started, causing cyclic raising and dropping of the weight 118 to deliver intermittent timed impacts to the material within the mold section. Simultaneously, the mold section is rotated in synchronization with the vertical reciprocation of the hammer element. After a given number of strokes, the device is stopped, the ring 200 is raised, the section 32 is removed, and the mold 30 and its base 34 are removed. The base is then replaced upon the other end of the section 30, whereby the mold is reversed, the parts are reassembled and a given number of strokes are delivered to the other side of the mixture of material placed in the mold. Thus a test specimen or sample is prepared for subsequent testing as to various characteristics.

It should be noted that in accordance with this method and apparatus, the entire forming of the sample is performed automatically and with complete precision. Thus exactly the same number of strokes, of exactly the same force are delivered to a sample, in exactly the same manner, to thereby ensure a uniform compressing or compacting of the ingredients of the specimen in the compacting mold.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. An apparatus for producing from paving material test samples of uniform and controlled density comprising: a mold for receiving and confining material for a sample, an impact member for compacting material in said mold, mounting means for retaining said impact member in continuous uninterrupted contact with the top surface of the material in said mold, a hammer weight for striking said impact member, lift means for raising said hammer weight and means for releasing said hammer weight from said lift means, said impact member having its surface which is in contact with said material inclined relative to the path of travel of said hammer weight, the lowermost portion of the inclined surface of the impact member being disposed in closest proximity to the wall of said mold whereby to exert greater compacting force adjacent said wall and thereby overcome resistance to compaction and obtain more uniform densification of said material, means for rotating said mold about an axis displaced from the path of travel of said hammer weight

whereby said impact member will successively progress over the entire surface of the material in said mold and thereby effect uniform compaction therein, connecting means operatively connected to said lifting means and said mold rotating means for effecting a fixed timed relation of operation thereof.

2. An apparatus for producing from paving material test samples of uniform and controlled density comprising: a mold for receiving and confining material for a sample, an impact member for compacting material in said mold, mounting means for retaining said impact member in continuous uninterrupted contact with the top surface of the material in said mold, a hammer weight for striking said impact member, lift means for raising said hammer weight and means for releasing said hammer weight from said lift means, a support for said mold, means for rotating said support, means interconnecting said rotating means and said lifting means for timed operation.

3. An apparatus for producing from paving material test samples of uniform and controlled density comprising: a mold for receiving and confining material for a sample, an impact member for compacting material in said mold, mounting means for retaining said impact member in continuous uninterrupted contact with the top surface of the material in said mold, a hammer weight for striking said impact member, lift means for raising said hammer weight and means for releasing said hammer weight from said lift means, a support for said mold, means for rotating said support, means interconnecting said rotating means and said lifting means for timed operation, means engaging said mold for retaining it upon said support, resilient means urging the last named means upon said mold.

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