

July 18, 1944.

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2,353,792

COMBINATION DENSITY CONE AND DROP BUCKET

Filed Feb. 10, 1943

3 Sheets-Sheet 1

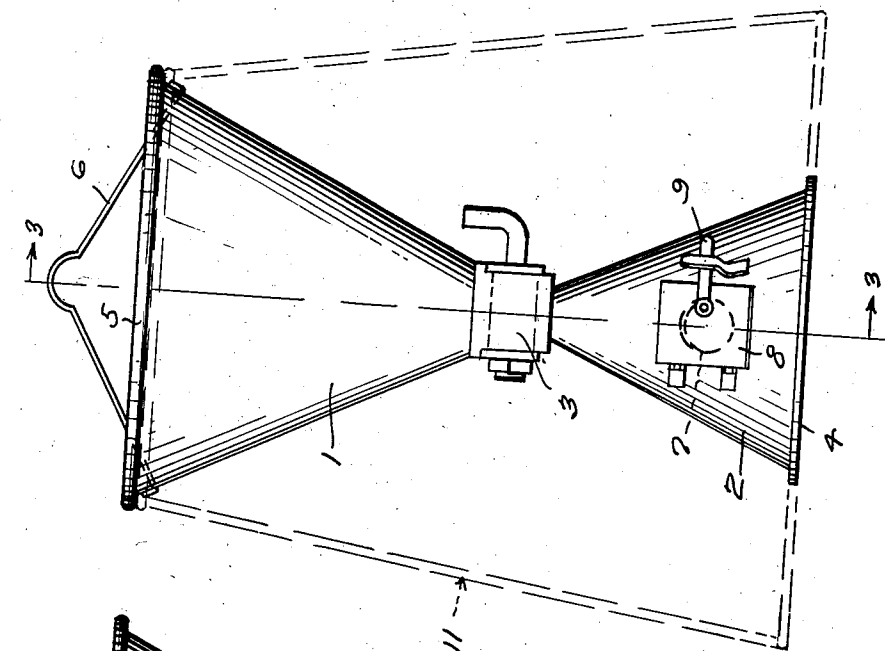


Fig. 2.

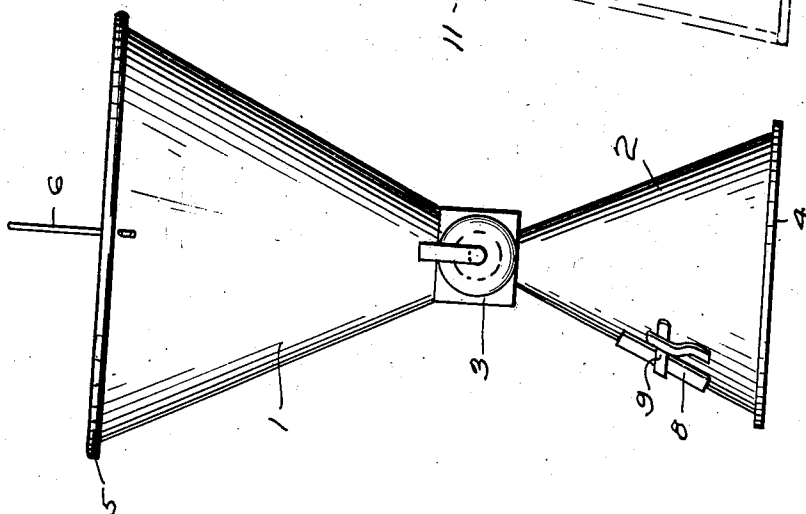


Fig. 1.

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3 Sheets-Sheet 2

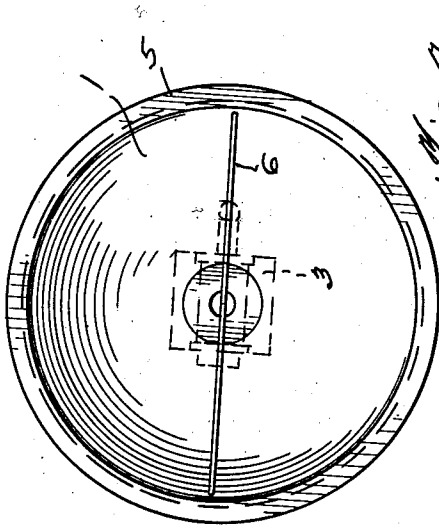


Fig. 4.

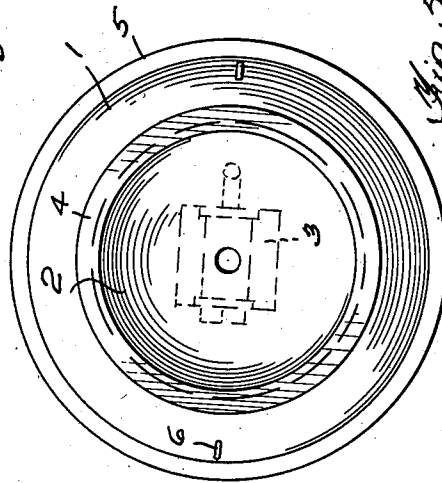


Fig. 5.

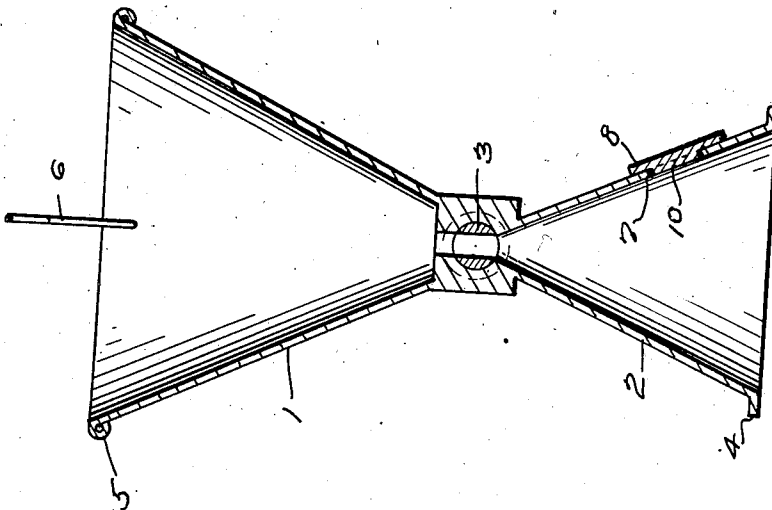


Fig. 3.

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3 Sheets-Sheet 3

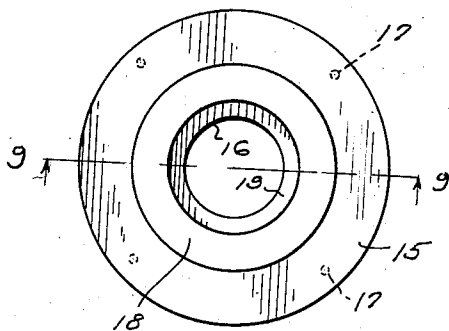


Fig. 6.

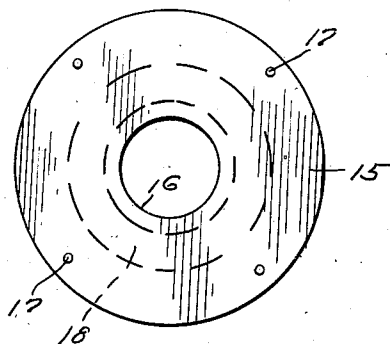


Fig. 7.

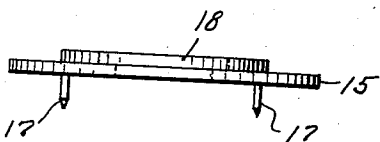


Fig. 8.

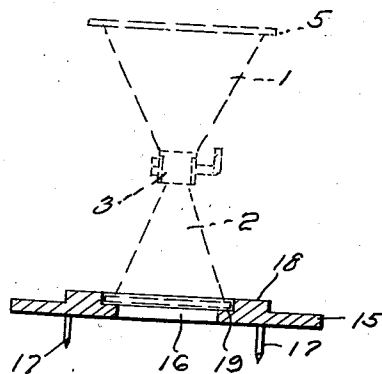


Fig. 9.

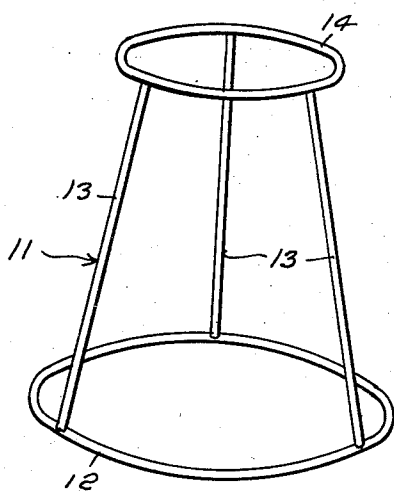


Fig. 10.

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UNITED STATES PATENT OFFICE

2,353,792

COMBINATION DENSITY CONE AND DROP BUCKET

Maurice J. Sowell, Clovis, N. Mex.

Application February 10, 1943, Serial No. 475,417

3 Claims. (Cl. 73—151)

The present invention relates to new and useful improvements in means for aiding in determining the size of a hole, by the sand method, in a base, subgrades, et cetera, or in determining the densities in asphaltic concrete, base course material and subgrade material. The primary object of the present invention is to provide a combination density cone and drop bucket of novel construction for these purposes.

Other objects of the invention are to provide a combination density cone and drop bucket of the aforementioned character which will be comparatively simple in construction, strong, durable, highly efficient and reliable in use, compact, and which may be manufactured at low cost.

All of the foregoing and still further objects and advantages of the invention will become apparent from a study of the following specification, taken in connection with the accompanying drawings wherein like characters of reference designate corresponding parts throughout the several views, and wherein:

Figure 1 is a view in side elevation of a combination density cone and drop bucket constructed in accordance with the present invention.

Figure 2 is a view in front elevation thereof.

Figure 3 is a vertical sectional view, taken substantially on the line 3—3 of Figure 2.

Figure 4 is a top plan view.

Figure 5 is a view in bottom plan of the device.

Figure 6 is a top plan view of one of the guide plates.

Figure 7 is a bottom plan view of one of the guide plates.

Figure 8 is a view in side elevation of one of the guide plates.

Figure 9 is a view in vertical section, taken substantially on the line 9—9 of Figure 6.

Figure 10 is a perspective view of the stand.

Referring now to the drawings in detail, it will be seen that the embodiment of the invention which has been illustrated comprises comparatively large and small upper and lower cones 1 and 2, respectively, of suitable rust-proof metal, the former constituting what may be considered a hopper for the reception of sand. The cones 1 and 2 are joined at their apices, said cone 1 being inverted, and communicate with each other through a quick opening valve 3 of the rotary type. The base of the lower cone 2 is provided with an external flange 4. The top of the upper cone 1 is provided with an external bead or the like 5. The upper cone 1 is further provided

with a ball 6 which is used for handling or weighing.

The lower cone 2 has formed therein, at an intermediate point, a circular opening 7. A hinged closure 8 is provided on the lower cone 2 for the opening 7, said closure comprising a suitable securing latch 9. The closure 8 conforms to the curvature of the cone 2. A circular protuberance 10 on the inner side of the closure 8 is engageable in the opening 7 and flush with the inner periphery of the cone 2 when said closure 8 is in closed position. This is illustrated to advantage in Figure 3 of the drawings.

The invention further comprises a supporting stand 11 of suitable metal for suspending the cones 1 and 2 in elevated position above the hole when the device is to be used as a drop bucket. The stand 11 comprises a base ring 12 having fixed thereon at spaced points upwardly converging legs 13. A relatively small ring 14 is fixed on the upper ends of the legs 13 for engagement beneath the bead 5 of the upper cone 1. This is suggested in broken lines in Figure 2 of the drawings.

The invention still further comprises two circular guide plates of the type shown at 15 of suitable metal, said guide plates having formed centrally therein circular openings 16 of the desired different diameters corresponding to the diameter of the hole to be dug or bored. Anchoring pins 17 depend from the plate 15. Rising from the plate 15 is a coaxial ring 18 which is spaced from the opening 16, thus providing a seat 19.

It is thought that the manner of using the device will be readily apparent from a consideration of the foregoing, particularly to those skilled in the art to which the invention relates. Briefly, a hole of the desired diameter is first dug or bored at an indefinite depth, during which operation a guide plate 15 having an opening 16 of the correct diameter is used. Use of the guide plate 15 facilitates the digging or boring of a smooth, uniform hole. The cone 1 is filled to the desired level with suitable sand and the device, with the sand therein, is weighed and the weight is recorded. If the device is to be used as a drop bucket, the cones are suspended in the stand 11 over the top of the hole. The valve 3 is then opened and enough sand is permitted to flow by gravity into the hole to permit said sand to be leveled off flush with the top of said hole, after which said valve is again closed. The device, with the sand remaining therein, is then weighed and the weight recorded. Deducting the

second weight from the first weight gives the weight of the sand necessary to fill the hole. Then, by dividing the weight of the sand thus used by the weight per cubic foot of the sand gives the volume or capacity of the hole.

If the device is to be used as a density cone, said device is removed from the stand 11, weighed with the sand therein and positioned directly over the hole with the cone 2 lowermost. The valve 3 is then opened for permitting the discharge of sufficient sand to completely fill the hole and the cone 2. The valve 3 is then closed and the device, with the sand remaining therein, is again weighed. The difference in the two weights, minus the weight of the sand necessary to fill the lower cone 2 which has been previously determined, gives the weight of the sand which was actually used to fill the hole. The density cone may be used with or without the guide plate 15. When so used, the flange 4 rests on the seat 19 within the confines of the ring 18. The ring 18 constitutes a guide to facilitate mounting the cone in the same position over the hole each time, said ring also functioning as a retainer for securing the cone against sliding movement on the plate. The pointed pins 17 penetrate the soil for securing the plate 15 in position. By opening the closure 8, rock taken from the hole in the soil may be fed back into said hole through the opening 7 while the sand is flowing, thereby eliminating many computations and saving considerable in time and labor.

We will now consider use of the invention to aid in determination of densities of asphaltic concrete, base course material and subgrade material. Major factors that will determine the density of (hot-mix) asphaltic concrete are heat control, type of aggregate, accuracy of mix, and amount of rolling at proper time. The desirable density ranges from 90 to 95 with a minimum of 86 and a maximum of 96. The asphalt void ratio should be .70 with .03 tolerance.

For density determination with the present combination density cone and drop bucket, the following equipment is used:

1. One combination cone and drop bucket complete with stand.
2. Two 18" guide plates with six and eight inch holes.
3. Two augers, one six and one eight inch.
4. One four pound hammer.
5. One 16" punch with tapered point.
6. One cup.
7. One scales, balance, 2000 grams capacity by 0.1 gram.
8. One scales, 70 pound lever balance by .02 equipped with thumb screw leveling device and under swung for field weighing.
9. One displacement can 8" diameter and 14" deep.
10. Set of density sieves, No. 10, No. 20, 1/4 inch and rocker box.
11. One 1/8 cu. ft. calibrating bucket with wide rim for supporting cone.
12. 7" square point spade.
13. Twelve one pint fruit jars.
14. One bucket approximately .4 cu. ft. volume.

Before the job begins, approximately 300 pounds of density sand should be prepared and a reasonable amount kept on hand thereafter. The sand should be prepared by washing over a No. 10 sieve and retained on a No. 20 sieve. The sand should then be air dried and stored in a dry place. Also, before the job begins, a suffi-

cient number of compaction curves should be run on each type of soil present and at different depths to determine the control to be used for each density test. A compaction curve should be run now and then as the job progresses for a check. To determine the weight of sand to fill the bottom cone without plate, weigh the apparatus filled with prepared sand, then place on a smooth firm surface. Be sure the opening in the bottom cone is securely fastened, then open valve completely and allow sand to run through into bottom cone by gravitational flow. After the sand has stopped running, the valve is carefully closed. The apparatus and remaining sand is then weighed. The difference in weight is the weight of sand used to fill bottom cone. The process is continued until all of the sand in top cone has passed through into bottom cone. Again fill the top cone with sand and repeat above operation. The average of all weights of sand used to fill the bottom cone each time is the weight to use in determining densities. The weight of sand to fill bottom cone and plate is determined in the same manner as above procedure with exception to the fact that a cloth should be placed under the plate. The unit weight of the sand is calibrated by use of the 1/8 cubic foot container with the smooth flange for supporting the density apparatus. An average of the unit weights determined by starting the sand at various levels in the top cone should be used. A unit weight should be run regularly for a check.

Instructions for taking density and operation of equipment

1. An area should be smoothed off large enough for the eighteen inch plate and sufficiently smooth so that the plate will rest firm. The rim of hole in plate should be touching firm ground at all points. In driving spikes on bottom of plate into the ground, the four pound hammer is used and the blows should be delivered directly over spikes so as to avoid warping plate. If a hole of six inches or less depth is desired, the eight inch plate should be used, and for a hole deeper than six inches, the six inch plate should be used.
2. The material taken from hole should be weighed immediately and a moisture sample taken, enough for not less than one hundred grams. The moisture sample should be placed in an air-tight container. The walls of the hole should be smooth, undisturbed and perpendicular as possible. Should there be 12% or less rock present, the material can be passed through a 1/4" sieve and the rock retained weighed and fed back into the hole through the opening in bottom cone. Should there be over 12% rock present, the rock should be taken to laboratory where the weight and volume can be determined.
3. The valve between cones should be closed, the top cone then filled with prepared and calibrated sand. Remove the cones from stand and weigh.
4. This operation can be performed with or without the plate. The apparatus is placed over the hole with bottom cone completely covering hole. The valve between cones is then opened completely allowing sand to pass through. Rock should be fed back into the hole through opening in bottom cone while sand is running. Care should be taken not to jar apparatus while valve is open. After sand has stopped running, the valve should be carefully closed. The apparatus

with remaining sand is then weighed and weight recorded.

5. The sand should be kept clean by passing through a No. 10 sieve and retained on a No. 20 sieve. By doing this a large per cent of the sand
5 with retained sand is then weighed and weight recorded.

6. The scales should be level when weighing.

7. The control density is determined from material passing one-fourth ($\frac{1}{4}$) inch sieve.

8. Moisture sample in rocky material is taken
10 from material passing one-fourth ($\frac{1}{4}$) inch sieve. Care should be taken to insure correct moisture determination.

9. The rock taken to laboratory should be separated from the soil by washing over a one-fourth
15 ($\frac{1}{4}$) inch sieve and air dried before weighing.

The following are examples of densities taken in subgrade and base course material.

(1) Wt. soil+container.....	25.22
(2) Wt. empty container.....	5.87
(3) Net wt. soil+rock (1)-(2).....	19.35
(4) Wt. sand+container.....	40.38
(5) Wt. residue+container.....	19.10
(6) Net wt. sand (used) (4)-(5).....	21.28-7.93 ¹ =13.35 ²
(7) Unit wt. sand.....	89.4
(8) Vol. hole (6).....	1493
(9) Wt. rock (air dried).....	5.07
(10) Vol. rock = $\frac{\text{vol. disp. grams}}{28,317} = \frac{962.3}{28,317}$	.03040
(11) Wt. of soil (3)-(9).....	14.28
(12) Vol. of soil (8)-(10).....	.1153
(13) Wet unit wt. of soil $\frac{(11)}{(12)} \times 100$	123.8
(14) Moisture content of soil.....	11.0
(15) Dry unit wt. of soil $100 - (14) \times 100$	111.5
(16) Maximum dry unit wt. of soil (from curve).....	117.1
(17) Per cent compaction $\frac{(15)}{(16)} \times 100$	95.2

NOTE: Rock is material retained on $\frac{1}{4}$ -inch sieve. Soil is material passing $\frac{1}{4}$ -inch sieve.

¹ Wt. of sand in cone and plate.

² Wt. of sand in hole.

The rock taken from a hole, if 12% or less of the total sample, is fed back into the hole as the sand is flowed therein, so as to not create any voids. To prevent voids being created, it is recommended that not over 12% of rock of the total sample be fed back into the hole. Also, to prevent voids being created, the rock is fed into the hole one at a time, thus giving the sand time to cover each rock before the next is added.

The equation:

$$\text{Vol. rock} = \frac{\text{vol. disp. grams}}{28,317}$$

is used to determine the volume of rock, should the quantity of rock taken from the hole be greater than 12% of the total sample. The meaning of the terms in the equation is as follows: "Vol. of disp. grams" represents the weight or
55

volume of water the rock will displace in grams. 28,317 is the number of grams in a cubic foot of water. In this particular sample, the amount of rock displaced 962.3 grams. 962.3 divided by 28,317 equals .03040 cubic foot, the volume of the rock in said sample. The word "volume" could be left out of the equation if the water displaced by the rock is weighed on gram scales. In this test, however, a graduated cylinder in cubic centimeters was used to measure the water displaced. By all standard practices, one cubic centimeter of water is one gram.

It is believed that the many advantages of density equipment embodying the present invention will be readily understood, and although a preferred form of the apparatus is as illustrated and described, it is to be understood that changes in the details of construction and in the combination and arrangement of parts may be resorted to which will fall within the scope of the invention as claimed.

What is claimed is:

1. Hole size determination equipment of the character described comprising opposed upper
25 and lower cones joined to each other and communicating at their apices, the upper cone for the reception of a supply of sand, the lower cone having a side opening therein at an intermediate point, a closure for said opening, and a valve for controlling the communication between the cones.

2. Hole size determination equipment of the character described comprising opposed upper
30 and lower cones having their apices joined and communicating with each other, the upper cone having an outturned head at the top and being adapted for the reception of a supply of sand, a valve controlling the communication between the cones, and a stand engageable beneath the head of the upper cone for suspending the cones in elevated position above a hole.

3. Hole size determination equipment of the character described comprising a plate for resting on the ground in which a hole is to be formed, said plate having a central opening therein corresponding to the desired diameter of the hole, means for anchoring the plate to the ground, a coaxial ring rigid with and rising from the plate and spaced from the opening, and a pair of opposed, communicating upper and lower cones, a valve placed at the junction of the cones to control communication therebetween, said upper cone for the reception of a supply of sand, the lower cone being engageable on the plate within the confines of the ring.

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