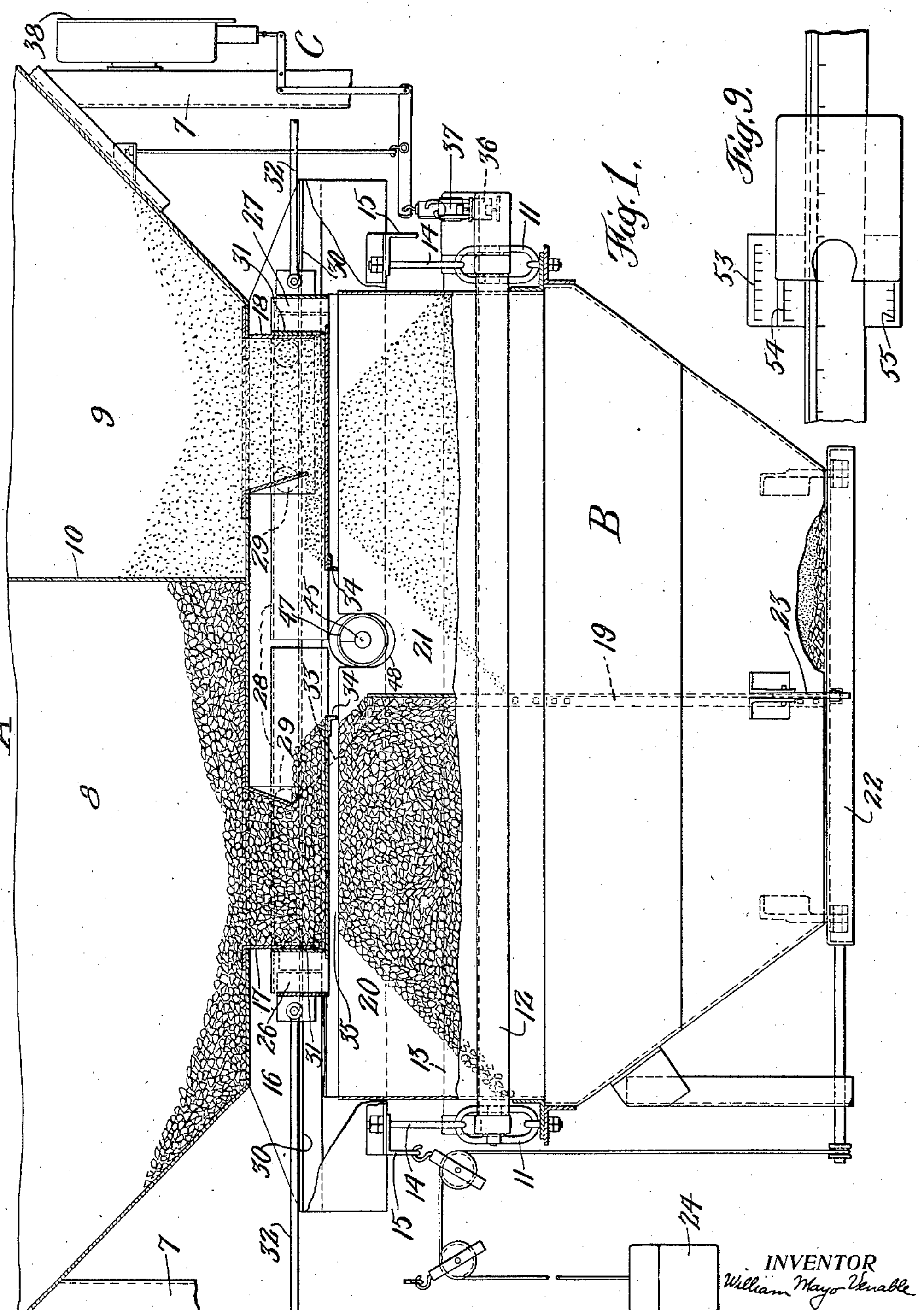
Sept. 9, 1930. W. M. VENABLE 1,775,609

APPARATUS FOR APPORTIONING THE INGREDIENTS OF MIXTURES

Filed April 12, 1924 3 Sheets-Sheet 1



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APPARATUS FOR APPORTIONING THE INGREDIENTS OF MIXTURES

Filed April 12, 1924 3 Sheets-Sheet 2

Fig. 2.

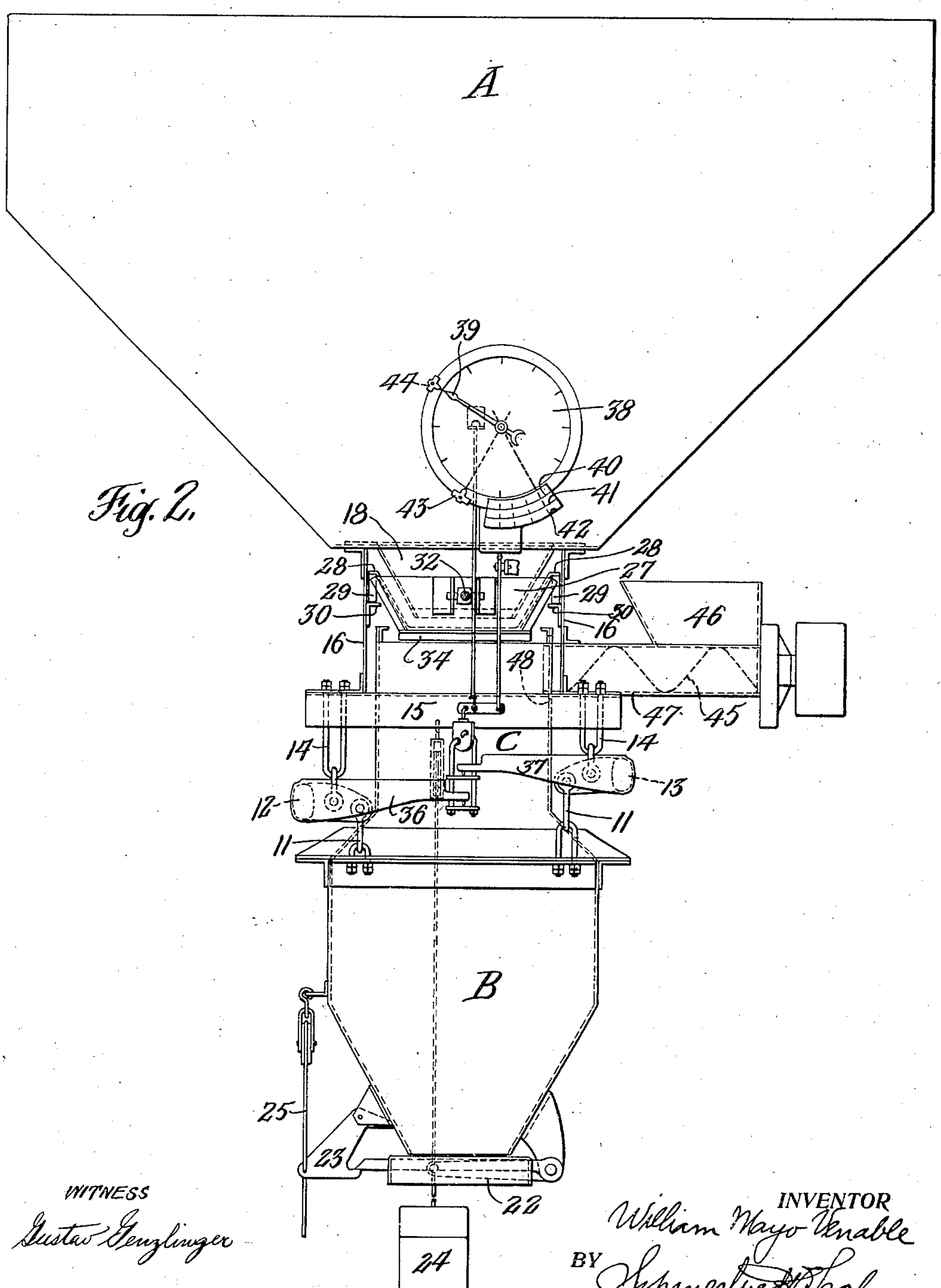

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Fig. 3.

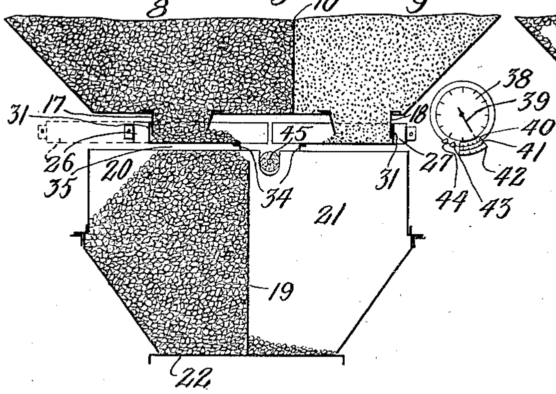


Fig. 4.

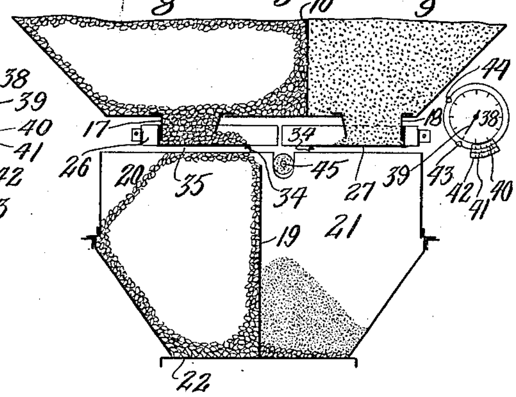


Fig. 5.

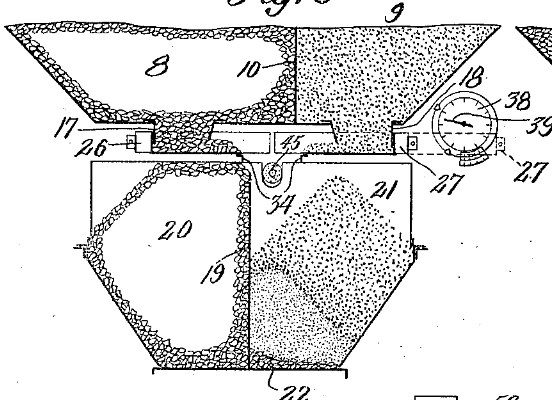


Fig. 6.

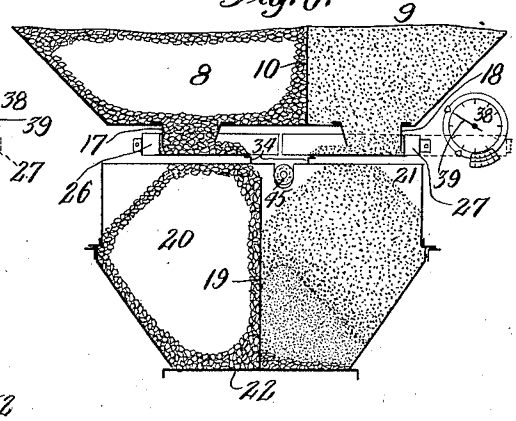


Fig. 7.

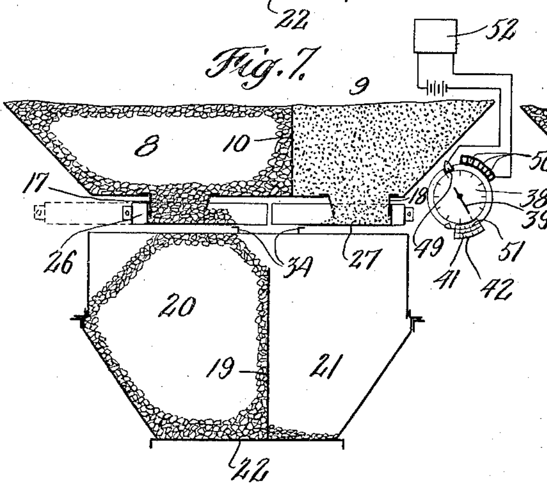
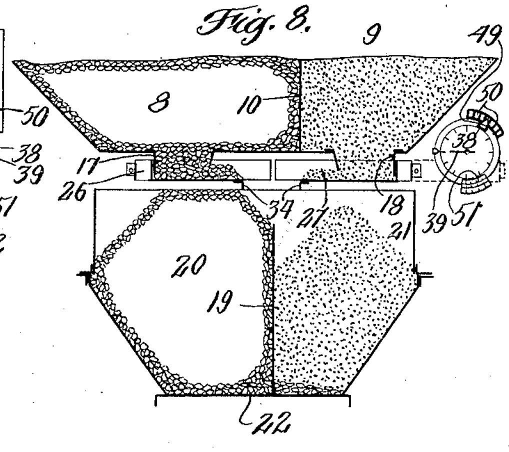


Fig. 8.



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Patented Sept. 9, 1930

1,775,609

UNITED STATES PATENT OFFICE

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APPARATUS FOR APPORTIONING THE INGREDIENTS OF MIXTURES

Application filed April 12, 1924. Serial No. 706,139.

This invention relates to the apportioning of materials such as stone, sand and cement for making concrete mixtures and the like and it has for one of its primary objects, the maintaining of the mixture uniform throughout successive batches, so as to maintain uniformity throughout the structure built from the mixture.

The nature, objects and advantages of my invention will be best understood from the following brief statement of the standard practice now being followed in the specification and preparation of concrete mixtures.

It has been customary for cement to be delivered in sacks which are assumed to hold a bulk of one cubic foot of cement weighing about 95 lbs. In specifying a mixture of certain proportions, a sack of cement has been used as a unit of measurement, that is to say, in a mixture of one part cement, two parts sand and four parts stone, a bag of cement would be used to two cubic feet of sand and four cubic feet of stone. The cleanness and fineness of the sand is also specified, and the stone specifications usually provide that the fragments shall pass thru a certain screen, say of 2 inch mesh, and should be rejected by another screen, say of 1/4-inch mesh. However, even if great care is exercised in the preparation and handling of the stone, it is found that the particles become more or less segregated in screening, piling and rehandling, so that the proportion of void spaces in the interstices between the fragments to the total volume of crushed stone in a batch of definite volume varies, requiring either more or less mortar as the case may be to fill the voids. The total weight of sand measured by volume in a container of definite size also varies with its moisture content as much as 26 to 30%.

As a step toward overcoming these difficulties it has been proposed to substitute weighing for the bulk measurements described. This is effective so far as sand alone is concerned, since the variation in the moisture content seldom exceeds 2% or 3% and may be either neglected or allowed for to sufficiently close approximation; but to substitute a fixed weight of stone for a fixed volume is a step in the wrong direction. The larger the voids in the stone, the less the weight per cubic foot and also the less the number of cubic feet that should be used, if the sand is kept constant in quantity.

In fact because of these variable factors and the deficiency of the methods followed, a practice has grown up in the art, of permitting the inspector to exercise some measure of discretion, as dictated by observation of conditions on the ground, to depart from the actual specifications. This, however, is also unsatisfactory, as its effectiveness is directly proportional to the skill of the inspector.

I propose to overcome the difficulties above mentioned and to make it possible to reliably, accurately, and economically, ascertain the actual amount of stone, sand, cement and water to be mixed in batches of concrete, so as to obtain a concrete of uniform quality even though the ratio of void spaces in the stone to the total volume of stone may vary considerably.

By my method, the quantities of various materials required in each batch are fixed, not by a certain quantity of the finest material to be used—cement—but by the ascertained volume and weight of each batch of crushed stone or gravel.

Before passing to a detailed description of the apparatus, I shall first illustrate the principles of my invention by the following examples:—

Let us assume that an engineer has been specifying a mixture of one bag of cement to 2 cubic feet of dry sand and 4 cubic feet of crushed stone, basing this upon the expectation of securing 95 pounds of cement to the bag, perfectly dry sand with 31% of voids and stone screened over a 1/4-inch mesh screen, with 45% voids. He desires to specify a proportioning that will make correction for the inequalities of bulk measurement of sand measured when moist and of voids in stone.

Let a=weight of one cubic foot of solid stone of the kind specified, as taken from the quarry.
x=weight of one cubic foot of crushed stone entering any batch, this varying from batch to batch with the percentage of voids.
n=number of cubic feet of crushed stone in a batch.
b=weight of one cubic foot of dry sand, of the quality specified.
c=specified weight of cement to be considered as equal in volume to one cubic foot.
v=percentage of void spaces to total volume in any batch of crushed stone.
$w=nx$=weight of a batch of stone.

In stone with 45% voids, x= $.55\,a$
The sand to go with this will then weigh $.5\,b$
and the total weight will be $.55\,a$ plus $.5\,b$

The proportion of sand to void spaces is $\frac{.5}{.45}=1.11$.
The volume of mortar to go with each cubic foot of stone (neglecting water) is $\frac{1}{2}$ (1−.31 plus .5)=.595 cu. ft.
The proportion of mortar to voids in the stone is $\frac{.595}{.45}=1.32$.

To maintain this proportion of excess mortar, in order to secure concrete of uniform quality, the weight of sand and of cement used in a batch must vary as the voids vary.

The ratio of void space to volume of stone is:

$$v=\frac{a-x}{a}$$

The volume of sand required per cubic foot of stone is $1.11\,\frac{a-x}{a}$ and the weight thereof $1.11\,b\,\frac{a-x}{a}$.

The total weight of any batch, therefore, should be—

$$W=nx+1.11\,nb\left(1-\frac{x}{a}\right)=1.11\,nb+w\left(\frac{a-1.11\,b}{a}\right)$$

$=K+kw$, K and k being constants.

Thus we may measure out a certain volume of stone, and by weighing it, very easily determine how much sand to add, and the total weight of sand and stone that should be taken, it then being a very simple matter to add sand until the total weight required is secured. The cement required may be determined in a similar manner, and it is optional in carrying out the invention whether cement or sand be added first, or whether the cement be weighed in a separate container.

By way of specific illustration, let us assume that the stone is trap rock, weighing 185 lbs. per cubic foot, the sand weighing, dry, 100 lbs. per cubic foot, the cement weighing 95 lbs. per cubic foot, and that a 21 E paving mixer is to be used, capable of handling a batch with 18 cubic feet of stone. 18 cu. ft. of stone is, therefore, to be measured out for each batch.

The actual weight of stone in any batch, indicated by the scale, is w. The weight of sand required is—

$$18\times1.11\times100-\frac{111}{185}\,w=(1998-.6\,w)\text{ lbs.}$$

The weight of cement required is:

$$\tfrac{1}{2}\,(1998-.6\,w)\,\frac{95}{100}=(949-.285\,w)\text{ lbs.}$$

Therefore, the weight of stone plus cement required is:

$$949+.715\,w$$

and the weight of stone plus sand plus cement required is:

$$1998+949+.715w-.6w=(2947+.115w)\text{ lbs.}$$

while the weight of stone and sand, necessary to determine in case the cement is separately weighed, is:

$$1998+.4\,w.$$

The actual weights of the several materials with different void spaces in the stone are indicated in the following schedule:

WEIGHTS

Per cent voids	Stone	Sand	Cement	Stone and cement	Stone and sand	Stone, sand and cement
40	1998	799	380	2378	2797	3177
45	1831.5	900	427	2258.5	2731.5	3158.5
50	1665	999	475	2140	2664	3139

If, instead of requiring that the mortar volume bear a certain ratio to the void spaces, it be required that the mortar exceed the void spaces by a fixed amount per volume of stone, the formulæ expressing the proportion will be of the same character, but the constants slightly different.

The actual weight of sand required increases as the weight of stone diminishes, the increase in the illustration used amounting to 25% more with 50% voids than with 40% voids,—a range somewhat wider than ordinarily occurs. A variation of 10% to 15% in sand and cement requirements, however, would be encountered in practice, if considerable care were not exercised in providing stone of uniform gradation, unless the specifications were drawn to require more cement than necessary in the average batch, as by specifying a mix of one of cement, two of sand to three of stone, instead of four of stone. Moreover, weighing the sand secures more nearly the proper quantity than measuring by volume, because packing does not affect weight as it does volume.

My invention provides for proportioning stone, sand, and cement as indicated to be highly desirable in the foregoing exposition of the requirements of the problem, eliminating as far as possible the human element of computation by the use of indicators or automatic devices, insuring accuracy, expedition and convenience. It may be used to proportion materials according to any law of mixture the engineer may decide upon, insuring the filling up of the voids and the provision of any excess of mortar that may be deemed sufficient for the work in hand. With this invention available it is practicable to carry out work under specifications that hitherto, if proposed at all, would have been regarded as impractical; and to effect a saving in cement when the stone is suitably graded while requiring an excess over the average in those batches where the stone is unduly coarse.

In some cases all of the materials are not measured at the same place, therefore it is another object of my invention to indicate, at points remote from the place where the amount of additional material to be added is determined, the amount of material to be so added.

The foregoing together with such other objects as may hereinafter appear, or are incident to my invention, I obtain by means of a construction which I have illustrated in preferred form in the accompanying drawings wherein:

Fig. 1 is a partial longitudinal elevation of and section thru an apparatus utilized in carrying out my invention;

Fig. 2 is an end view of Fig. 1;

Figs. 3, 4, 5 and 6 are sectional views showing successive steps in the operation of the apparatus;

Figs. 7 and 8 are similar views showing successive steps in a modified form of my invention; and

Fig. 9 is a fragmentary view of a beam scale with one of the features of my invention applied thereto.

Referring now to Figs. 1 to 6, inclusive, it will be seen that the apparatus in general, comprises a bin A, mounted on the structure 7, which bin is divided into two compartments 8 and 9 by the wall or bulkhead 10; a hopper B; and scales C. The hopper B is floatingly supported by means of U bolts 11 from the scales levers 12 and 13 which are hung by U bolts 14 from angles 15, 15 secured to the parallel gate hangers 16 extending longitudinally of the apparatus. The gate hangers 16 are secured to the underside of bin A at either side of the throat or neck portions 17 and 18 thereof.

An adjustable partition or bulkhead 19 is provided in the hopper B which may be adjusted to change the volumetric capacity of the compartments 20 and 21 of the hopper formed by such bulkhead. Of course this partition is set at the beginning of a job so that the bin 20 will hold a definite quantity of material determined by the capacity of the truck conveying the mixture or by the capacity of the mixing machine to be used for the particular job at hand.

At its lower end the hopper B is provided with a door 22 which is held in closed position, by the latch 23 and counterweight 24. In order to empty the contents of the hopper the latch 23 is tripped by pulling on the cable 25, the weight of material acting against the counterweight to open the door, and the counterweight again closing the door after the material has been discharged.

In the particular embodiment shown I fill the compartment 8, of the bin A with the coarser aggregate, in this case broken stone, and the compartment 9 with the finer aggregate, in this case sand. The gate 26, registering with neck 17 of compartment 8, and the gate 27 registering with the neck 18 of compartment 9, are of trough like construction (see Fig. 2), and have laterally extending upper flanges 28 engaging the rollers 29, which are guided on the tracks 30 carried by the hangers 16. The necks, are at one end fitted to the gate troughs by the baffle plates 31, so as to allow small clearance, but at the opposite ends they provide liberal clearance above the gate bottoms. The bottom of the gates are open for a portion of their length at the end opposite the baffle plate 31 as are also the ends of the gates. These gates are manipulated through the medium of rods 32 which may either be operated by hand or some suitable operating mechanism. The necks 17 and 18 extend well into the trough like gates thereby preventing material from working onto the tracks, thus preventing jamming or undue friction.

Referring particularly to the gate controlling the compartment which contains the coarser aggregate, it will be seen that when this gate is opened wide, the aggregate runs into the compartment 20 of the hopper B until it will take no more by gravity feed. The upper part of the aggregate assumes its natural slope as indicated by the dotted line 33 in Fig. 1. The gate is then closed striking off the top of the pile, by means of the strike off angle 34, and pushing the surplus material so as to fill the upper right hand corner portion of the compartment, as indicated in full lines, and throwing the balance of the surplus material into the adjacent compartment. The space 35 between the bottom of the gates 26 and 27, and the top of the hopper B is of a size so that a definite volume of coarse aggregate is pushed over the partition 19 into the adjacent compartment. The top of this partition is a sufficient distance below the top of the hopper B to insure clearance of the pusher angle 34, from the material in the hopper. It will thus be seen that the hopper with its contents is entirely clear of the gate and bin and may be said to float on the levers 12 and 13 of the scales. The purpose of pushing a portion of the material into the compartment 21 is to cover the door 22 with such material to prevent adhesion of cement which is next to be introduced as will be hereinafter described.

In the scale arrangement shown the scales levers 12 and 13 are connected to the beams 36 and 37 in the usual manner and thence through beams and links to the indicating part of the scale, in this case a dial scale 38. This arrangement of the intervening mechanism may be as best suits the particular location and construction of the scale.

I will now describe the way in which the apparatus operates to carry out my invention.

It will be apparent that the compartment 20 is a bulk measure which measures out the same bulk of stone for each successive batch; in which connection it is pointed out that the unfilled space at the upper left hand corner of the compartment will always be the same since the material fed in will always assume its natural angle of repose. Each batch of stone is of course weighed since the hopper is carried by the scales and the weight is indicated by the pointer 39 and the graduation on the dial 38. The relation of the weight of the bulk measured out to the specific weight of the stone will determine the amount of voids and therefore the amount of additional material to be added. If now this relation and the specification be considered, scales may be worked out, in the manner indicated by the examples, to indicate the precise amounts of each material to be added to any batch of stone. The graduations 40, 41 and 42 on the scales are calibrated in this fashion and the pointer in indicating the weight of any batch of stone will automatically indicate the amounts of each of the other materials. The specially prepared graduations 40, 41 and 42 need only extend over a sufficient range of the dial to cover the maximum weight of stone in any batch. This stage in the operation of the apparatus is shown in Fig. 3. The operator having observed these readings sets the indicator 43 which is movably mounted on the frame of the dial scale, to the graduation on the dial 38 corresponding to the reading on scale 40, giving the total weight of stone and cement. He likewise sets the movable indicator 44 to the graduation on the dial 38 corresponding to the reading on scale 41, giving the total weight of stone cement and sand; and notes the amount of water to be added by the reading on the scale 42.

The operator now admits cement into compartment 21 until the pointer 39 comes opposite the adjusted indicator 43 at which time he will have the proper amount of cement. This stage in the operation of the apparatus is shown in Fig. 4. The cement may be introduced by means of the conveyor screw 45 which receives material from the hopper 46 and conveys it through the tubular casing 47 into the compartment 21. The conveyor casing is mounted on one of the gate hangers 16 and extends into the hopper B, clearance being provided in the side of the hopper by means of slot 48 to allow freedom of movement of the hopper with respect to the conveyor when weighing.

The operator now admits sand into the compartment 21 until the pointer 39 comes opposite the adjusted indicator 44 at which time he will have the proper amount of sand. This is accomplished by opening the gate 27 and leaving it open until the pointer 39 begins to approach the adjusted indicator 44, and then closing it as shown in Fig. 5. The gate is then manipulated back and forth until the pointer comes opposite the indicator 44, as shown in Fig. 6. The size of the compartment 21 is such as will always insure clearance of the gate and the contents of the compartment.

Having thus measured out quantities of the various materials going to make up the mix, in proper proportion, they may be discharged from the hopper B by means of the door 22 previously described.

The calibration of the computing scales is made to suit the particular kind of material and proportions specified, owing to the variance of the unit weights of different kinds of stone and sand and to different grades of concrete requiring different mixtures of ingredients. Stone for instance, varies from 135 lbs. to 200 lbs. per cubic foot in the solid, depending upon its chemical and crystalline structure. The stone most commonly used in masonry varies from 160 to 185 lbs., while dry sand varies from 90 to 110 lbs.

The arrangement just described is suitable for a central proportioning plant where the materials composing the mixture are to be dumped directly into the mixer, or into a truck for hauling to the mixer, if sufficiently close to make the moistening of the cement by the sand during hauling unobjectionable.

In case the cement must be kept separate from the sand during hauling, or should it be desired to measure out the cement at a distant point, I omit the provision made for introducing cement to the hopper and provide an indicator 49 (see Figs. 7 and 8) which is movably mounted on the frame of the dial scale and insulated therefrom, and a series of insulated contacts 50 one of which is selected as indicated by the reading on the graduated scale 51 to which the pointer 39 points when a batch of stone has been supplied to the compartment 20 of the hopper B. By moving the insulated indicator 49 to the selected segment or contact 50, as shown in Fig. 8, a circuit is completed which records on the recorder 52 (see Fig. 7) the amount of cement to be measured out on a suitable weighing device. This recorder of course can be located at any point where the additional material is to be added.

I contemplate the use of automatic devices for controlling the gates and water supply by the use of similar contacts on the scales 40, 41 and 42 but I am not here claiming or describing their details.

While I have shown the bin and hopper divided into only two compartments with gates for controlling the bin compartments I wish it to be understood that I might employ any number of compartments or gates as the particular mixture being prepared may necessitate.

If a beam scale is substituted for the dial scale it is only necessary to provide special calibration of the beam as indicated in Fig. 9, in which 53, 54 and 55 correspond to the graduated scales 40, 41 and 42 of Fig. 2. The weight on the beam is moved by hand instead of moving the indicators 43 and 44.

I claim:

1. In a device for proportioning materials in concrete mixtures and the like, the combination of a bulk measure, and weighing means constructed to translate the weight of the bulk measured as compared to the specific weight of the material into an indication of the amount of additional material to be added.

2. In a device for proportioning materials in concrete mixtures and the like, the combination of a bulk measure, and a computing scale having associated graduations, one indicating the weight of the bulk which is measured and the remainder indicating the amount of additional material to be added, said remainder being laid out according to the relation of the weight of the bulk measured to the specific weight of the material.

3. In a device for proportioning materials in concrete mixtures and the like, the combination of a bulk measure, and a computing scale having associated graduations, one indicating the weight of the bulk which is measured and the remainder indicating the amount of additional material to be added, said remainder being laid out according to the relation of the weight of the bulk measured to the specific weight of the material and the proportions of various materials specified for the mixtures.

4. In a device for proportioning materials in concrete mixtures and the like, the combination of a bin, a hopper therebelow, having two compartments, one of which is in registry with the discharge opening for the supply of material from the bin to said compartment, and a gate for said opening operating when moved to closed position to discharge material from said compartment into the next compartment.

5. In a device for proportioning materials in concrete mixtures and the like, the combination of a bin, a hopper therebelow, having two compartments one of which is in registry with the discharge opening for controlling the supply of material from the bin to said compartment, together with means for discharging some of the material in said compartment into the adjoining compartment.

6. A device for apportioning ingredients of mixtures comprising, a bin, a gate controlled opening in the bin, a hopper for bulk measurement, and a scales supporting the hopper independent of the bin and for weighing the material in the hopper, said scales having associated therewith means whereby the voids may be translated into indication of material to be added by the relation of said weight to the specific weight of the material.

7. A device for apportioning ingredients of mixtures comprising a bin, a hopper for receiving a definite bulk of material from the bin, means disassociating the material in the bin from that in the hopper, a scales for supporting the hopper and for weighing its contents and a computed chart co-operable with the scales to show, in proportion to the percentage of voids in said material, the amount of other ingredients to be added.

8. A device for apportioning ingredients of mixtures comprising a bin, a hopper for receiving a definite bulk of material from the bin, means disassociating the material in the bin from that in the hopper, a scales for supporting the hopper and for weighing its contents and a computed chart, adapted to co-operate with said scales, and having readings showing the amount of other ingredients to be added, together with registering means indicating at a distant point the amounts of some of the materials to be added.

9. In a device for apportioning materials for concrete mixtures and the like in varying quantities determined by the condition of the coarser material, the combination of a bulk apportioning hopper supported by a weighing device, and a computed chart giving the weights of the other materials to be added mounted on the scale of the weighing device, so that, the scale pointer indicating the weight of the coarser material will point to the reading on the chart giving the weights of such other materials.

10. A device for apportioning material for concrete mixtures and the like, comprising a bin having a discharge opening, a hopper of definite volume registering with said opening, means for introducing material into the hopper from the bin, means for disassociating the material in the bin from that in the hopper, a scales for supporting the hopper and weighing its contents, together with means indicating, from the scales reading, the amount of other materials to

be added, in accordance with the volume of voids in said first material.

11. A device for apportioning materials for concrete mixtures and the like comprising, a divided bin, a discharge opening for each compartment of the bin, a scales, a hopper floatingly supported by the scales and registering with the discharge openings, means for introducing and cutting off materials from said compartments to the hopper, said means disassociating the materials in the bin from those in the hopper, the amount of coarser material to be fed to the hopper being determined by bulk, and a computed scale showing the weight of other materials to be added.

12. A device for apportioning materials for concrete mixtures and the like comprising, a divided bin for coarse and fine aggregates, a scales, a divided hopper floatingly supported on the scales, one portion of the hopper being adapted for bulk measurement of the coarse aggregate, a gate for each division of the bin, means for controlling the amount of materials fed to the hopper and means for discharging the contents of the hopper after weighing.

13. A device for apportioning materials for concrete mixtures and the like comprising, a divided bin for coarse and fine aggregates, a scales, a divided hopper floatingly supported on the scales, one portion of the hopper being adapted for bulk measurement of the coarse aggregate, the division wall being of such height to allow a portion of the coarse aggregate to enter the other compartment, a gate for each division of the bin, and means for controlling the amount of materials fed from the bin to the hopper, together with mechanism for introducing still another material to the hopper.

14. In a device for apportioning material into batches, a bin, an opening therein, a gate, and a hopper for bulk measurement so positioned with relation to the gate that a predetermined volume is always measured, in combination with a scales by which said hopper is carried in such manner as to permit measurement by weight after measurement by bulk, while the material is in the same hopper.

15. In a batching device for concrete materials, a bin, a gate beneath said bin, and a hopper for both bulk and weight measurement beneath said gate, in combination with a strike-off member movable with said gate for the purpose of striking off material in said hopper so as to provide clearance beneath the gate when the latter is closed, in order not to interfere with free weighing of material within the hopper.

16. In a device for batching concrete materials by combining bulk measurement with measurement by weight, a bulk measuring device in combination with a hopper scales with computing dial or beam, by means of which the weighing of a given bulk of one material automatically indicates the required quantities of other materials to be added.

17. In a device for batching materials in variable proportions depending upon the void spaces in the coarser material; the combination of a bulk apportioning device, a weighing device and a computing scale, which scale indicates when actuated by the weight of the apportioned bulk of coarser material, the desired quantities of other materials to be used therewith.

18. In a device for apportioning concrete materials, a bin divided into compartments for coarse and fine aggregates, a hopper scales therebelow, the hopper thereof divided into compartments by a partition, one of said compartments being suitable for bulk measurement; separate gates to admit different materials from the bin to said hopper, and means for discharging the contents of said hopper after weighing.

19. In a device for apportioning concrete materials, the combination of a bin divided into compartments for coarse and fine aggregates, a hopper scales therebelow, the hopper thereof being divided into compartments by a partition not extending to the top thereof, one of said compartments being of size suitable for apportioning the coarse material by bulk, separate gates to admit different materials from the bin to the hopper, and means for discharging the contents of the hopper.

20. In a device for apportioning concrete materials, the combination of a bin divided into compartments for coarse and fine aggregates, a hopper scales therebelow, the hopper thereof being divided into compartments, a partition not extending to the top thereof, one of said compartments being of size suitable for apportioning the coarse material by bulk, separate gates to admit different materials from the bin to the hopper, means for discharging the contents of the hopper and feed mechanism for introducing another material into the hopper.

21. In a device for apportioning materials to be mixed, the combination of means for apportioning one of the materials into batches of equal bulk, a scales for weighing the material so apportioned by bulk, and a computing chart whereon the proper quantities of other materials to add, are designated by reference to the weight of the material apportioned by bulk.

22. In a device for apportioning concrete materials, a bin divided into compartments for containing coarse and fine aggregates; bottom openings in said compartments; necks extending below said openings; longitudinally operating gates disposed endwise of one another intercepting the flow from said necks, and separately opened or closed; in combination with a hopper scales below said gates, the hopper of said scales being adapted

for bulk measurement as well as for weight measurement.

23. Apparatus for apportioning different materials for mixtures in proportion to the void space in one of said materials, comprising in combination a divided bin having discharge openings, gates for said openings, a weighing scales, a measuring hopper in registry with said openings and supported by said scales, and computing mechanism in cooperative relation with said scales adapted to indicate directly, in proportion to the void space in one material, amounts of other material to be used.

In testimony whereof, I have hereunto signed my name.

WILLIAM M. VENABLE.