Sept. 30, 1969 R. C. FUTTY ET AL 3,469,824

MIXING AND CONVEYING MEANS

Filed Feb. 27, 1968

FIG. 2

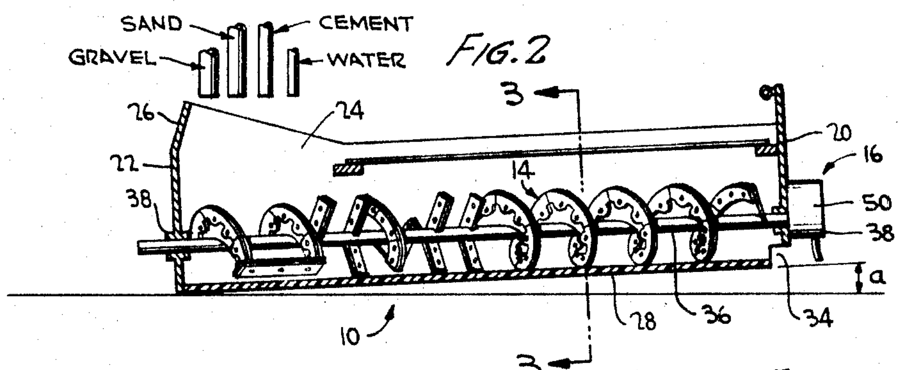


FIG. 1

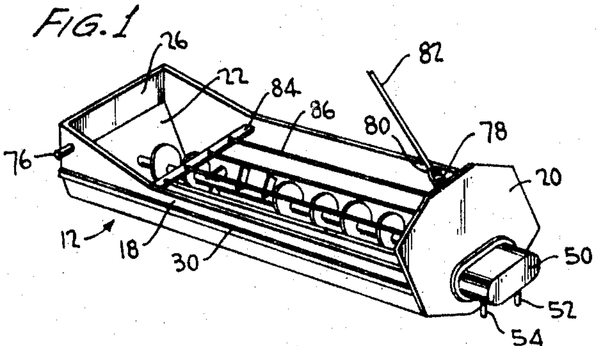


FIG. 9

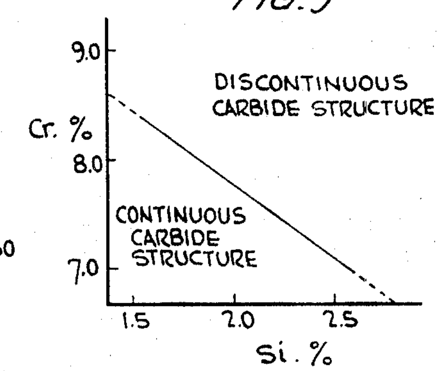


FIG. 3

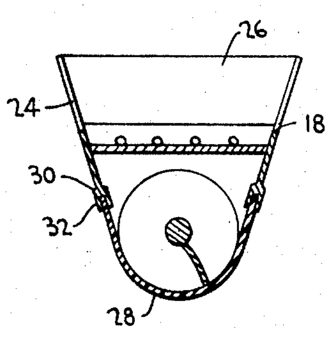


FIG. 5

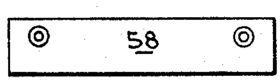


FIG. 6

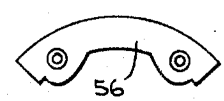


FIG. 7

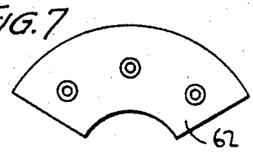


FIG. 8

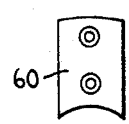
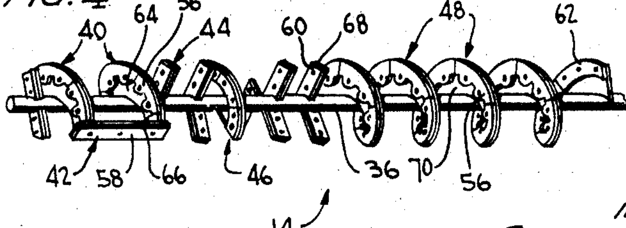


FIG. 4



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1

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MIXING AND CONVEYING MEANS

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U.S. Cl. 259—178 5 Claims

ABSTRACT OF THE DISCLOSURE

A mixing and conveying means of improved wear characteristics, suitable for use in various types of apparatus such as a mixing trough which can be used to mix concrete. A plurality of mixing and conveying elements are disposed along a shaft and include easily removable wear plates, preferably fabricated of an abrasion resistant material such as a nickel-containing cast iron alloy.

This invention relates to mixing devices, and more particularly to an improved concrete mixing and delivery system.

Numerous forms of mixing troughs and associated conveying means have been known and used for a considerable length of time. The majority of such devices have been formed of an elongated chute having a relatively conventional mixing paddle or mixing screw disposed therein. Such prior art systems have suffered from several disadvantages. The first of these has been an inability to withstand the abrasive effect of materials being mixed within the trough, especially when the materials are of a highly abrasive nature, such as concrete. A second such disadvantage in the prior art devices has been that the mixing troughs do not provide a mixing action which fully and completely mixes a liquid and a plurality of varied dry ingredients to obtain a substantially homogeneous composition therefrom. Additionally, the prior art devices are usually designed to perform only a simple mixing operation, and are not adapted to mix a plurality of constituents and to positively feed such constituents outwardly from the mixing trough.

Certain of the disadvantages in the prior art devices were recognized and overcome by the invention defined in Patent No. 3,310,293, for "Concrete Mixing and Delivery System," issued Mar. 21, 1967, in the name of Harold M. Zimmerman. In that patent there is defined and described a system wherein dry concrete constituents or ingredients are stored in separate storage compartments, and are selectively fed in predetermined proportions to a mixing trough wherein they are mixed with water to form concrete of desired properties. It was found that in a system of this type, wherein the dry constituents are of a particularly abrasive nature, there is a tendency for such dry constituents to create an abrasive action on the walls of the mixing trough. It was also found that it was necessary to fully and completely mix the water and the dry ingredients relatively rapidly, in

2

order to obtain fully mixed concrete in a relatively short length mixing trough.

A method and mixing trough construction is later defined and disclosed in Patent No. 3,339,898 for "Mixing Method and Mixing Trough Construction," issued Sept. 5, 1967, in the names of Robert C. Futty and Harold M. Zimmerman, which eliminated these problems. In this latter patent a mixing trough having substantially rigid sidewalls and a flexible and resilient bottom wall which is yieldable during a mixing operation and which is resistant to abrasion from the materials being mixed is described. Disposed within the mixing trough is a combination mixing, agitating and conveying means formed by an elongated shaft having a plurality of specially disposed mixing blades and helical feeding screws disposed thereon. In operation, a plurality of dry particulate ingredients, such as sand, gravel, cement or the like, are introduced into the inlet end of the mixing trough and a liquid, such as water or the like, is likewise introduced at the same location, to be combined with the dry materials to form a somewhat fluent, viscous composition within the mixing trough. As the shaft rotates within the mixing trough, the mixing blades stir and lift the ingredients and combine the same while still directing the same forwardly toward the helical screw portion. The helical screw portion also serves to mix and combine the ingredients, and likewise functions to positively feed such ingredients toward the discharge end of the mixing trough and outwardly therefrom. During all of this mixing and conveying operation, the flexible bottom wall of the trough can yield somewhat, to thus create a form of "kneading" on the ingredients to aid in their combination and to thus enhance the properties of the homogeneous mixture formed within the trough.

It has now been found that the abrasive action of the material being mixed, such as concrete, creates a certain amount of wear on the specially disposed mixing blades and helical feeding screws. Eventually, this abrasive action impairs the efficiency of the combination mixing, agitating and conveying means thereby necessitating periodic inspection and replacement. Further, the wear is not always of an even nature so that a particular section of the combination mixing, agitating and conveying meas may wear before another section whereby the complete assembly must be replaced.

It is, therefore, a primary object of this invention to provide an improved mixing trough free of the foregoing and other such disadventages. In this same regard it is a basic object of this invention to provide an improved mixing trough which includes a combination mixing, agitating and conveying means which is resistant to the abrasive action of the material being mixed and further, to provide an improved mixing trough including a combination mixing, agitating and conveying means certain parts of which are easily replaced without the need for replacing the entire assembly.

Consistent with the foregoing, it is a specific object of this invention to provide a combination mixing, agitating and conveying means formed by an elogated shaft having a plurality of specially disposed mixing paddles and helical feeding screws disposed thereon, wherein said mixing paddles and feeding screws are of such construction that any worn parts thereof may be selectively removed and replaced whenever the need should arise and furthermore, to provide such mixing paddles and helical feeding screws which are constructed of a material, specifically a nickel-containing cast iron alloy, having a unique resistance to the abrasive effects of the material being mixed, e.g., concrete.

Other objects, advantages and salient features of this invention will become apparent from the following detailed description which, taken in connection with the annexed drawings, discloses the preferred embodiment thereof.

In the drawings:

FIGURE 1 is a perspective view of one embodiment of a mixing trough incorporating the basic principles of this invention;

FIGURE 2 is a longitudinal sectional view through the mixing trough shown in FIGURE 1;

FIGURE 3 is a transverse cross-sectional view taken substantially on lines 3—3 of FIGURE 1;

FIGURE 4 is an enlarged perspective view of the mixing, agitating, and conveying means of the mixing trough shown in FIGURE 1;

FIGURE 5 is a front elevational view of one type of wear plate in accordance with the present invention;

FIGURE 6 is a front elevational view of another type of wear plate in accordance with the present invention;

FIGURE 7 is a front elevational view of still another type of wear plate in accordance with the present invention;

FIGURE 8 is a front elevational view of yet another type of wear plate in accordance with the present invention; and

FIGURE 9 is a curve demonstrating the silicon-chromium relationship in a preferred material of construction of the wear plates of FIGURES 5–8.

As will be seen generally from FIGURES 1–3, the novel structure of this invention includes a mixing trough generally designated **10** embodying an elongated chute generally designated **12**, a mixing and conveying means generally designated **14** disposed within the chute, and a means generally designated **16** for operating the mixing and conveying means **14**.

The chute **12** includes a pair of spaced apart longitudinally extending substantially rigid sidewalls **18** and forward and rearward end walls **20** and **22**, respectively, extending between the sidewalls **18**. Forward and rearward end walls **20** and **22** are connected to sidewalls **18** as by welding or the like. The end portion of the chute adjacent the end wall **22** is utilized as the inlet end of the mixing trough **10**, and the end portion of the chute adjacent end wall **20** serves as the discharge end of the same. Accordingly, sidewalls **18** can extend angularly upward as designated **24** and end wall **22** can extend angularly inward as at **26**, thus forming a hood-like portion which serves to assure that the ingredients introduced into the trough will not spill outwardly over the side or end walls thereof, but will remain therein.

A continuous elastomeric sheet **28** forms the bottom wall of the chute **12**. The term "elastomeric" as used herein denotes a material having rubber-like properties of flexibility and resiliency, and desirably a high degree of abrasion resistance. The elastomeric material may comprise natural or synthetic rubbers, synthetic resinous plastic materials, and other such similar materials although it should be understood that it is not limited thereto. The elastomeric sheet **28** is connected to the sidewalls **18** of the chute **12** in any suitable manner. As disclosed in the aforementioned U.S. Patent No. 3,339,-898, and shown in FIGURES 1–3 hereof, one method of connection comprises a pair of metal strips **30** extending longitudinally of the sidewalls **18** with each such strip having either an integral or interconnected depending flange **32**. The side edges of the elastomeric sheet **28** are clamped between the sidewalls **18** and the depending flanges **32**. Additionally, securing means such as nuts and bolts or the like, may be used to insure that the sheet **28** is properly held in place. End wall **20** terminates a short distance above the elastomeric sheet **28** to form an outlet or dispensing opening **34** for the mixed composition.

The improved mixing and conveying means **14** includes an elongated linear shaft **36** disposed within the chute between its sidewalls **18** and above its bottom wall **28**, with the opposite ends of the shaft **36** projecting through the end walls **20** and **22** by means of suitable journal bearings **38** in each of said walls.

Along the shaft **36** are disposed a plurality of mixing elements in spaced relation to one another, with such mixing elements serving to mix the ingredients introduced into the trough. Further, a plurality of conveying elements and/or combination mixing-conveying elements are also disposed along the shaft **36**. Numerous forms and arrangements of such elements can be utilized in the present invention, provided that they perform the necessary function for operation of the mixing trough. Thus, it should be appreciated that the illustrated form and arrangement of such mixing elements is not necessarily the sole arrangement which will prove operative, but that the inventive concepts are concerned with the actual construction and the material of construction of the elements.

However, by way of exemplification, there is illustrated in FIGURE 4 a pair of composite helical screw flight section assemblies **40** affixed to the shaft **36** at the end corresponding to the inlet end of the chute **12**. Since these composite flight section assemblies are disposed directly beneath the ingredients inlet area (FIGURE 2) they receive and initiate mixing of the separate ingredients entering the trough **10**. A composite blade assembly **42** extends between the composite flight section assemblies **40** and creates an interference in flow by agitating the ingredients out of their normal flow path, which, as caused by the composite flight assemblies **40**, is axial of the trough **10**.

Adjacent the composite flight section assemblies **40**, a plurality of composite mixing paddle assemblies **44** extend radially from the shaft **36**. Although each paddle assembly **44** is generally perpendicular to the central axis of the shaft **36**, the flat face of the paddle is disposed angularly to the plane of the end walls **20** and **22**, much in the manner of an impeller blade. The paddle assemblies **44** are individually spaced axially along the shaft **36** and are further circumferentially disposed at spaced angles to one another. Thus, in a preferred configuration the second paddle assembly **44** is advanced some distance along the shaft **36** from the first paddle assembly **44** and is angularly spaced approximately 120° about the periphery of circumference of the shaft. The third mixing paddle assembly **44** is axially advanced further along the shaft **36** and is angularly spaced approximately 120° from the second paddle assembly **44** and 240° from the first paddle assembly **44**. The fourth mixing paddle assembly **44** is axially advanced still further along the shaft **36** and is angularly spaced about the shaft periphery to be in general alignment with the first paddle assembly **44**. Additional paddle assemblies **44** are disposed in a similar arrangement following the same general configuration. A composite arcuate blade section assembly **46** extends across some of the mixing paddle assemblies **44** to scrape the trough walls and, at the same time, provide a lifting and dropping action for materials within the trough. Further along the shaft **36** there is a helical screw means in the form of a plurality of composite spiral flight assemblies **48** extending axially along and helically around the shaft **36**, with such flight assemblies serving to form a sort of feeding screw which conveys material in the trough **10** toward the outlet opening **34**.

Means **16** for operating the mixing and conveying means **14** is in the form of an operating motor which serves to rotate the shaft **36** about its central axis. As illustrated, the means **16** is a hydraulic or pneumatic operating motor **50** connected to the end of the shaft **36** which projects forwardly beyond the front end wall **20**. Such a motor **50** is provided with an inlet conduit **52** and an outlet conduit **54** which enables a fluid flow through the motor **50** to thereby cause the shaft **36** to rotate about its central axis. It will, of course, be understood that the means **16** is not limited to a pneumatic or hydraulic motor **50**, but can equally well include an electric motor, a mechanical motor or the like.

In operation, the mixing and conveying means of a mixing trough used for combining ingredients such as one used to form concrete is subjected to an extreme amount of abrasive action by the materials being mixed. In order to minimize any wear and permit easy replacement of such worn parts the mixing and conveying means **14** of the mixing trough shown in FIGURES 1–3 is preferably constructed as shown in further detail in FIGURES 4–8. Removable wear plates **56**, **58**, **60** and **62** are removably affixed to flight sections **64**, blade **66**, mixing paddles **68**, and spiral flights **70** in such combinations as will provide the necessary wear resistance. Thus, composite flight section assemblies **40** are made up of a pair of helical screw flight sections **64** with wear plates **56** fixed thereto in such a manner that the wear plates **56** relieve helical flight sections **64** of abrasive action. Similarly, wear plate **58** is fixed to blade **66**, thereby making up composite blade assembly **42**. In a like manner, wear blade **60** is fixed to paddles **68** to form composite mixing paddle assemblies **44** and a plurality of wear blades **56** are segmentally fixed to the spiral flights **60** thereby making up the composite spiral flight assemblies **48** which form a helical screw means. At each end of such resulting helical screw means is affixed a wear plate **62** rather than wear plate **56**. The various wear plates **56**, **58**, **60** and **62** are preferably fixed to their respective base members **64**, **66**, **68** and **70** by conventional mounting means such as nuts and bolts. Further, at least one flat washer should be used between those wear plates attached to curved surfaces in order to provide a firm surface at the bolt area. Obviously, the actual size and shape of the various wear plates is dictated by the mixing and conveying elements themselves.

The outer edge of each wear plate is preferably flush with the outer edge of the respective base members **64**, **66**, **68** and **70**, but this is not critical since if the wear plates extend beyond the base members they will eventually wear down to the base level and vice versa. While the wear plates are illustrated as affixed to one side of each member, it should be understood that they can be attached to either the leading face, the trailing face, or both in actual use. The clear advantage of the novel construction is immediately apparent. If any one or several wear plates should wear to the point where replacement is necessary, such worn plates can be removed and replaced by the worker in the field using simple tools and necessitating a minimum of "down time." Instead of replacing a complete mixing and conveying assembly **14** in the shop, taking care that the new unit is properly installed in the bearings **38**, the worker simply replaces the worn plate with another similar piece which does not have to be made to close tolerance.

Since the wear plates **56**, **58**, **60** and **62** will be subjected to extremes of abrasive action they should be constructed of a material which is capable of withstanding the abuse to which they will be put. Hardened steel could be used but even this material has been found to have the minimum acceptable wear and cost characteristics. Actually a material of abrasion resistance characteristics as good as hardened steel, which is defined herein as SAE 1020 annealed steel, can be used. It has been

found that a nickel-containing, martensitic alloy of cast iron possesses excellent abrasion resistance and is, therefore, the preferred material of construction of the wear plates. Such an alloy is that sold as "Ni-Hard" by the International Nickel Company, Inc., New York, N.Y. The Ni-Hard cast irons have been found to possess a microstructure similar to that of a heat-treated steel, but with a relatively larger proportion of carbide which contributes greatly to its abrasion resistance. The Ni-Hard irons can be either chill cast or sand cast, but it has been found that the chill cast alloy has a finer carbide size and, therefore, better abrasion resistance. In Table I can be seen a comparison of different ferritic materials in resisting the abrasive effects of wet silicate sand.

TABLE I.—TYPICAL WET SAND ABRASION FACTORS

Material	BHN	Abrasion Factor [1]
Ingot iron	90	1.40
Gray cast iron	200±	1.00–1.50
SAE 1020 steel, annealed	107	1.00 (Standard)
White cast iron	400±	0.90–1.00
Pearlitic steel	220–350	0.75–0.85
Austenitic Mn steel	200	0.75–0.85
Bainitic steel	512	0.75±
Martensitic steel	715	0.60±
Ni-Hard cast iron	550–750	0.25–0.60

[1] The abrasion factor is the ratio of weight lost by specimen during test to the weight lost by a "standard" specimen. This arbitrarily selected standard was annealed SAE 1020 steel 105–110 Brinell.

Ni-Hard castings come in four types, the choice of which depends on the use to which it will be put. Type 1 is a nickel-chromium white cast iron of good abrasion resistance. Type 2 has less carbon modification than type 1 and, therefore, is stronger and tougher but slightly less abrasion resistant. Type 3 has a high strength modification giving maximum toughness and good abrasion resistance. Type 4, with its higher alloy content, has superior corrosion and abrasion resistant properties. The abrasion factor of type 4 ranges from approximately 0.30 to approximately 0.40 according to the test described in Table I. Table II shows the chemical composition of the four Ni-Hard cast irons.

TABLE II.—CHEMICAL PROPERTIES OF NI-HARD CAST IRONS

Composition, percent	Type 1	Type 2	Type 3	Type 4
Total carbon	3.00–3.60	2.40 (max.)	1.00–1.60	2.80–3.60
Graphitic carbon, max.	0.10	0.10	----------	0.10
Silicon	0.40–0.70	0.40–0.70	0.40–0.70	1.50–2.00
Manganese	0.40–0.70	0.40–0.70	0.40–0.70	0.40–0.70
Nickel	4.00–4.75	4.00–4.75	4.00–4.75	5.50–6.50
Chromium	1.40–3.50	1.40–3.50	1.40–1.60	7.0–10.0
Sulfur, max	0.15	0.15	0.5	0.10
Phosphorous, max	0.40	0.40	0.5	0.25

While the Ni-Hard alloys generally are satisfactory for use as the wear plates in the inventive mixing and conveying means it has been found that Ni-Hard type 4 is preferred due to its extremely high abrasion resistance and other desirable physical properties. The nominal properties of the Ni-Hard alloys are set forth in Table III.

TABLE III.—NOMINAL PROPERTIES OF NI-HARD ALLOYS

	Type 1		Type 2		Type 3		Type 4	
	Sand cast	Chill cast	Sand cast	Chill cast	Sand cast	Chill cast	Sand cast	Chill cast
Brinell hardness, minimum (2 x 6 x 6 test blocks using tungsten carbide Brinell ball)	550	600	525	575	350–500	300–600	550	550
Tensile Strength, p.s.i. (1.20″ diam. test bars)	40,000–50,000	50,000–60,000	45,000–55,000	60,000–75,000	75,000–125,000	90,000–140,000	75,000–85,000	80,000–110,000
Transverse strength, lbs. (1.20″ diam. test bars, 12″ span)	4,000–5,000	4,500–6,800	4,500–5,500	5,500–7,000	6,000–6,400	8,000–10,000	5,000–6,000	5,500–7,000
Transverse deflection, in. (1.20″ diam. test bars, 12″ span)	0.08–0.11	0.08–0.12	0.10–0.12	0.10–0.12	------	------	0.08–0.11	0.10–0...
Izod AB Impact, ft., lb. (1.20″ diam. unnotched bar struck 3″ above support)	20–30	25–40	25–35	35–55	60–70	70–100	35–45	35–45
Pattern shrinkage, in./ft	5/32–1/4		5/32–1/4		------	------	0.25–0.30	
Modulus of Elasticity×10⁶ p.s.i.				24–26		------	------	------
Specific gravity				7.6–7.8		------	------	------
Density, lbs./in.³				0.275–0.280		------	------	------
Coefficient of Thermal Expansion×10⁻⁶ in./° F.:								
50–200° F	4.5–5.0		4.5–5.0		------	------	6.4	------
50–500° F	6.3–6.6		6.3–6.6		------	------	7.3	------
50–800° F	6.8–7.1		6.8–7.1		------	------	7.9	------
Electrical resistivity, microhmcentimeters, 78° F	80		80		------	------	80–100	
Thermal conductivity:								
Cal. cm.⁻¹ sec.⁻¹ ° C.—120° F	0.034		0.034		------	------	0.034	
Cal. cm.⁻¹ sec.⁻¹ ° C.—450° F	0.045		0.045		------	------	0.045	
Magnetic properties				(Fully Magnetic)				
Rockwell C hardness	[1] 53	[1] 56	[1] 52	[1] 55	------	------	------	------
75° F	------	------	------	------	------	------	53.5	------
300° F	------	------	------	------	------	------	53.5	------
500° F	------	------	------	------	------	------	53.0	------
700° F	------	------	------	------	------	------	48.0	------
900° F	------	------	------	------	------	------	40.0	------

[1] Minimum.

While Ni-Hard type 4 cast iron is the preferred material for the wear plates **56, 58, 60** and **62**, it should be clearly understood that this invention is not limited thereto. Type 4 Ni-Hard is characterized by discontinuous carbide with a martensite or martensite-containing austenite continuous phase. The type of carbide present in Ni-Hard type 4, however, is dependent on the chromium and silicon contents. Referring to FIGURE 9 it can be seen that the chromium and silicon must be balanced inversely to produce discontinuous carbide.

As carbon content increases from 2.80 to 3.60 percent, the amount of carbide in the structure increases and abrasion resistance consequently increases. However, tensile strength decreases at a given percent of martensite in the matrix.

Clearly, the mixing and conveying means of this invention is adaptable for use in various forms of mixing apparatus even though the preferred embodiment thereof has been discussed in relation to a mixing trough means of the type described. Turning now, therefore, to the manner of operation of the mixing trough **10** and the novel mixing and conveying means **14**, it will be noted by referring to FIGURE 2 that a plurality of inlet conduits are provided in juxtaposition above the rearward end of the chute **12**. Since the mixing trough **10** is particularly adapted for use in forming concrete, the illustrated inlet conduits are labelled gravel, sand, cement and water. It is again emphasized that the invention is not limited to a trough which will mix these particular ingredients, but rather to one that will accommodate any form of ingredients.

When the ingredients are introduced into the inlet end of the chute **12** they are initially mixed by the composite flight section assemblies **40** and are scraped off the chute walls and bottom by the composite blade assembly **42**. These initially mixed ingredients then feed past the composite mixing paddle assemblies **44** which tend to spin the ingredients about the inside of the chute, while at the same time agitating and forcing the ingredients toward the outlet end of the trough. The composite arcuate blade assembly **46** scrapes the ingredients off the trough walls and bottom, and at the same time tends to lift and drop the mixture into the interior of the trough, thus creating a form of tumbling action which aids in mixing. Next, the composite spiral flight assemblies **48** of the screw receive the mixture, and as they rotate, they feed the mixed ingredients forwardly, while at the same time still further mixing the same. When at last the feeding screw delivers the ingredients to the outlet opening **34** the ingredients have been converted from separate dry and liquid ingredients to a relatively homogeneous, somewhat fluent, viscous composition of concrete.

As an adjunct to the positive action of the composite mixing paddle assemblies and composite blade assemblies, and the feeding screw, an additional mixing and combining action is provided by the elastomeric wall **28** which can freely bulge downwardly and outwardly, to thus create a form of "kneading" action on the materials within the trough. It will be seen that the disposition of the shaft **36** within the trough **10** is such that the mixing paddle assemblies and blade assemblies and the helical screw are in substantial contact with the elastomeric bottom wall **28**, and thus the material being mixed is often forced between these elements and the bottom wall itself. As shown in FIGURE 3, the elastomeric bottom wall **28** contiguously contacts the mixing and conveying means **14**, at least below the level of the shaft **36**. Thus, the combination and coaction between the mixing and conveying means **14** and the elastomeric bottom wall **28** creates a powerful positive agitating, mixing and conveying action which transforms the various separate ingredients into a homogeneously combined composition. Accordingly, when any wear plate wears to the point where there is not substantial contact between the same and the elastomeric bottom wall **28** it should be replaced. For example, in a composite flight section assembly which measures approximately 3⅜ inches from the shaft **36** to the outer edge of the wear plate **56**, if any of the wear plates **56** should wear down to between about 3 inches and 3⅛ inches, it should be replaced.

In a preferred aspect of this invention in a mixing trough the mixing trough **10** is disposed at an angular relationship during the mixing operation so that the mixing and conveying always takes place against the action of gravity. This can be understood by reference to FIGURE 2 wherein the chute is shown disposed at an acute angle α above a horizontal axis H. The exact manner in which the chute is pivoted or pivotally mounted to enable it to assume this position is not necessarily critical, and any suitable pivot mounting means at the inlet end of the chute will be sufficient. For purposes of simplicity of illustration, outwardly extending pivot shafts **76** project from the rear portion of the sidewalls **18**, and it is understood that these pivot shafts can be journaled in any suitable bearing means. Thus, the chute is pivotally mounted about its inlet end. To enable the trough **10** to be maintained in its upward angular disposition, an eye **78** is attached to the upper portion of the forward end wall **20**, and a hook or clamp **80** may be engaged with this eye as shown in FIGURE 1. A cable **82** can extend from the clamp **80** to a winch or other suitable means which when operated, causes the trough to pivot upwardly about its pivot point. The precise value of the angle α is not particularly critical, provided only that such angle be an acute angle. An angle between 15° and 22° has proved useful in practice.

The sidewalls **18** are sloped generally inwardly from their upper to their lower edge as can be seen in FIGURE 3. Thus, the material is generally directed inwardly and downwardly toward the bottom of the trough. Since the trough is disposed at an acute angle α above the horizontal, the force of gravity has a component acting downwardly against the bottom wall **28** and further has a component directed toward the end wall **22** at the inlet of the trough. Thus, when the mixing and conveying action takes place, it must act against the force of gravity. In other words, not only must the mixing paddle assemblies lift the material from the bottom wall of the chute upwardly and back downwardly again, but moreover, the mixing, as well as the conveying, must direct the material in an axial direction toward the outlet opening **34**, against the force of gravity.

As a safety measure to prevent an operator from inadvertently moving his hand into contact with the mixing and conveying means **14**, and additionally, to prevent any large pieces of debris from falling into the chute, a grill-work may be provided above the mixing and conveying means **14**. Such grill-work can take the form of a pair of elements **84** extending transversely of the chute, and a series of rods **86** extending longitudinally of the chute and being mounted upon the elements **84**.

It will be apparent from the foregoing detailed description that the objects set forth at the outset of the specification have been successfully achieved through utilization of the present invention.

Accordingly, what is claimed is:

1. In an elongated mixing trough having an elastomeric bottom portion, a shaft means mounted longitudinally therein, means for rotating said shaft means, and a spirally shaped conveyor mounted on said shaft means to mix and convey material in said trough, the improvement comprising:

(a) a plurality of wear plates, each comprising a fraction of one convolution of said spirally shaped conveyor,

(b) said wear plates being secured on said conveyor in end to end relation to compositely define a wear resistant spiral edge on said conveyor,

(c) said edge cooperating with said elastomeric bottom portion to mix said material while the same is conveyed along said trough,

(d) said wear plates being made of a composition at least as abrasion resistant as hardened steel.

2. The improvement defined in claim **1** wherein said composition has a wet sand abrasion factor of about 0.25 to about 0.60.

3. The improvement defined in claim **2**, wherein said composition has a wet sand abrasion factor of about 0.30 to about 0.40.

4. The improvement defined in claim **1**, wherein said wear plates are fabricated of a cast iron alloy of the following composition:

	Percent
(a) total carbon	1.00–3.60
(b) graphitic carbon, max.	0.10
(c) silicon	0.40–2.00
(d) manganese	0.40–0.70
(e) nickel	4.00–6.50
(f) chromium	1.40–10.00
(g) sulfur, max.	0.10–0.5
(h) phosphorous, max.	0.25–0.40

the remainder being essentially iron.

5. The improvement defined in claim **1**, wherein said alloy is composed of:

	Percent
(a) total carbon	2.80–3.60
(b) graphitic carbon, max.	0.10
(c) silicon	1.50–2.00
(d) manganese	0.40–0.70
(e) nickel	5.50–6.50
(f) chromium	7.0–10
(g) sulfur, max.	0.10
(h) phosphorous, max.	0.25

the remainder being essentially iron.

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