Civil Engineering

Study of Concrete Mixers

Corker
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BY

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Recommendation approved

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# A Study of Concrete Mixers

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Chapter I.

Introduction.

The object of this thesis is to present the results of the writer's study of concrete mixers, their history and development, the principles governing their action, the various types, their respective advantages and defects, and to give a more or less detailed account of several representative machines. The writer does not pose as an authority on the subject of concrete mixers, but will present what seems to him to be the salient features of the various mixers as gleaned, not from actual experience with each machine - that would be impossible - but from a careful study of their printed descriptions, specifications, and illustrations, and from such meager literature as could be found on the subject.

A short historical account will be presented, both of concrete and of reinforced concrete and of concrete mixers. The mixing principles now in use will be described, discussed, compared, and criticized with reference to the particular mixers in which they are employed.

All mixers will be divided for purposes of study into three classes: (A) Batch Mixers, (B) Continuous Mixers, (C) Freak Mixers, or those which do not belong to either of the preceding classes or which combine both the continuous and batch types in one machine, or "whose construction embodies totally new ideas. These divisions will be subdivided according to the type of the drum or mixing paddle used. There are numerous attachments without some of which the modern mixer is hardly complete. These, while often built into the machine, will be treated under a separate head.
The writer in ending will attempt to outline the tendencies of modern mixers and to forecast the trend of the mixers of the future.
Chapter II.

Historical.

(A) History of Concrete and Reinforced Concrete.

We of the twentieth century are prone to look upon concrete as an invention of our own time. We can remember the time when a building wholly of concrete was a decided novelty, and our fathers tell us of their wonder at the first cement walks of their young manhood. Certainly the most rapid strides in the use and knowledge of concrete have been taken in our time; but we are apt to forget that concrete was one of the earliest of building materials, and that it was almost as common in ancient times as now.

Probably the use of concrete antedated written history. We do know that the ancient Egyptians were well acquainted with its advantages as a material of construction. Pliny tells us that the columns of the Egyptian labyrinth were molded of concrete. From the archaeologists we learn that at least parts of the pyramids, which have outlasted forty centuries, are of concrete. Among the Romans the use of concrete was quite general. They used it in the great aqueducts, and in the foundations of the great Appian Way, which have outlasted the paving stones which were laid thereon. The Pools of Solomon, near Jerusalem, had concrete curbs; in Mexico are ruins of ancient pyramids built partly of concrete; and the mound builders fashioned their kettles of a similar material.

During the dark ages the use of hydraulic cement gave way to the use of fat lime. It was not until the discovery of portland cement that concrete again came into general use as a trustworthy building material.
The introduction of steel reinforcement was, perhaps, the greatest step toward the generalization of the use of concrete. This is often credited to Lambot who in 1850 constructed a reinforced concrete boat. Monier and Coignet followed in Lambot's footsteps. These men were French. Ways and Bauschinger, two Germans, made the first scientific experiments on reinforced concrete. Americans were late getting into the reinforced concrete field, but have since made such characteristically rapid strides that we are now easily the leaders. Among Americans, E. L. Ransome deserves perhaps the most credit for pioneer work in the reinforced concrete field. At present there are investigations going on in many quarters which are continually diminishing the uncertainties of concrete design. Probably within the next few years safe and economical engineering practice in concrete design will be established.

(B) History of Concrete Mixers.

The history of concrete mixers is indeed recent. Mixing concrete by hand sufficed for our ancestors, but modern economic conditions demand a faster, surer method. Probably the first concrete mixer was but a makeshift—a cubical wooden box, journaled at opposite corners, turned by hand, charging and discharging through a hinged door. It did excellent service and was the direct progenitor of the modern batch machine. But this primitive cube mixer was slow and the labor back breaking. The machine had to be stopped both to charge and to discharge. To eliminate some of these difficulties a long revolving hexagonal tube was tried, depending wholly on rolling contact and the length of the tube for the qual-
ity of the mixture. It was slow and the concrete turned out fell far below the standard set by the cube mixer. Soon screw conveyors were adapted to the mixing of concrete. These were the true forerunners of the modern continuous mixer. Although they were very good conveyors they did very little real mixing. The conveyor was replaced by a series of paddles or spades placed spirally about a central shaft. These still had a tendency to merely convey the material. A set of scraper blades was devised which was fastened to two wheels and which raised the material up the sides of the trough, letting it drop back into the interior of the wheel as they revolved further. The latest and most approved form of the continuous mixer is of the pugmill type, except that a part of its blades are set to kick the material in a reverse direction.

Meanwhile many manufacturers, despairing of ever attaining perfection by the continuous route, returned to improving the old cube batch mixer. There were many faults in the cube mixer - the aggregate tended to ball up if too dry, also there were excessive racking strains set up as the entire load shifted from side to side. This lead to the invention of the cylindrical drum. Inside shelves kept the material from sliding about in the bottom as the drum revolved. Batch mixers were then built of wood; but in many ways they closely approximated the most approved modern machine, being non-tilting and having a discharge chute. Later these were made of cast iron and sheet metal. Someone hit on the idea of sloping the ends of the drum and tilting it for the discharge. For some time many designers of mixers went off on this tangent.

About this time mixers ceased to be designed by guess and became a subject for exact scientific knowledge and calculation.
Manufacturers took intelligent advantage of the experience of their predecessors. Then began the elimination of all unnecessary weight, economizing of power, and standardization and improvement of mechanical details. Nevertheless there are still manufactured and on the market concrete mixers representing each stage of development from the primitive cube, and many of them are built with a fine disregard for the strains which they are destined to resist.

By no means is this march toward perfection finished. Cast iron and semi-steel are being discarded in favor of lighter and less breakable materials. Tilting mixers are constantly being replaced by non-tilting ones except in the smaller sizes. Wood mounting has almost universally given way to steel. Transmission of power is becoming rapidly standardized. Details such as friction clutches, side and end loaders, and watering devices are matters for hot partizanship on the part of various manufacturers. There is a constant call for greater capacity, durability, and economy of power.

The continuous mixer is frowned upon by the best engineers and it seems that they will soon be relegated to the scrap-heap. Mixers built on the cube principle are far too slow to answer the modern demand for capacity. Tilting mixers take too much time and power in dumping to last much longer. Because of the demand for speed batch mixers of suitable construction are sometimes run continuously, not stopping to charge, the spout emitting an almost continuous stream of concrete of a very fair grade.

Some of the batch mixers of today are very near perfection - as near, perhaps, as this type of machine will ever come.
Doubtless there will be improvements, but not in fundamental principles. The future is likely to bring to us a radical departure from concrete mixer precedent. It may be along the line of the compressed air grout mixer. The future of the concrete mixer is very, very hard to forecast.
Chapter III.
Classification and Description.

(A) Introduction.

In presenting the following descriptions of various types of concrete mixers it is not so much the purpose of the writer to describe all of the machines manufactured as it is to give a description of one machine of each type, together with descriptions of those which possess some original feature or which are of especially good design. The items will be very brief and that part which refers to features possessed by several machines in common will be merely touched on in this chapter. Further and more detailed descriptions of such features will be given in Chapter 4. This chapter will be divided into three sections: (B) Batch Mixers, (C) Continuous Mixers, and (D) Freaks. These latter are machines which are constructed along a unique line or which combine both the batch and the continuous principles in the construction of one machine and which therefore could not be conveniently classified as either batch or continuous. In order to show no preference as to location all of the descriptions will be arranged alphabetically according to the names of their makers.
(B) Batch Mixers.

Blystone.


Among the hand power mixers the Blystone is one of great merit. It may be operated with a gasoline engine. Its construction is very simple, consisting of a semi-cylindrical trough with cast iron ends. The trough is of sheet steel, open at the top. It tilts to discharge. The mixing is done by a flight of paddles arranged in a reverse spiral order. The shaft is turned by a geared crank. The discharge is accomplished by means of a rack and pinion at one end of the trough.

Chain Belt.

Chain Belt Co., Milwaukee, Wis.

The Chain Belt Company feature the simplicity of their driving mechanism which they consider, rightly, to be a very important feature. The cast semi-steel drum is driven by a chain and gear about its middle, thus obviating eccentric drive and complex gearing. The blades have a slight spiral twist and are placed on the charging side. They work the material toward the discharge side where scoops or buckets pick it up and pour it into the discharge chute. The material of the drum and chutes is heavier than usual. On the discharge side is a considerable bulge in the drum which increases capacity and insures a better mix. The bearing surfaces are widemaking proper alignment a certainty. Altogether this machine is typical of the best product on the market.
Blystone.

Chain Belt.
Clover Leaf.

Clover Leaf Mixer Co., South Bend, Ind.

The Clover Leaf is a tilting drum batch mixer of very unique shape, the drum being composed of three involute curves much the shape of a clover leaf as the name implies. The smaller end of the involute carries the material up to a suitable height and lets it slide and lap over itself. The ends are slightly cone shaped and are expected to give the material some end to end motion. This action is doubtful as the declivities are exactly opposite each other. However they probably will squeeze the material together as it descends. This mixer is necessarily slow and its ability to mix dry concrete is a doubtful quantity. It should suffice for a sloppy mixture. The drum is of riveted sheet steel, revolved by a radial gear. This company manufactures only tilting mixers.

Cockburn Cube.

Cockburn Co., New York, N. Y.

This is one of a small class of batch mixers which depend on the friction and cohesion of the concrete to the sides of the drum and the mechanical grip of the irregularities of the aggregate to accomplish the mixing. The Cockburn is typical of this class of machines. It is a non-tilting cube, journaled at opposite corners. The fact that it is non-tilting is its most distinguishing feature. Three discharge scoops converge toward a discharge chute, these being the only projections inside the drum. The drum is mounted on rollers and is driven by a heavy gear wheel on the discharge side.
Clover Leaf.

Cockburn Cube.
Foote.

Foote Concrete Machinery Co., Chicago, Ill.

The drum of the Foote mixer is a double truncated cone having angles riveted to the feed end which push the material toward and throw it into the discharge scoops. The outflow of the material is regulated by a rotary door, which when closed keeps the aggregate rolling back and forth inside the drum. The gear is arranged three ways: center, discharge side, and both sides. The weight is carried on wide-faced chilled rollers. The most objectionable feature in this machine is the sharp angle at which the sides of the drum meet, making it very hard to clean. An exceedingly quick delivery of the mixed concrete is claimed for this machine.

Koehring.

Koehring Machine Co., Milwaukee, Wis.

The Koehring embodies much of the best of modern practice in mixer design. Its drum is of the non-tilting type, a cylinder with cast semi-steel ends. Blades deflect the material into buckets which pour it into the discharge spout. This spout pours the material back into the drum until it is thoroughly mixed. The drum heads and gears are cast in one piece. In this machine double-gear drive was adopted because it gave a more equal distribution of the driving force, also it is insurance against stripping of gears. The cast head is objectionable because of its liability to breakage. It would seem better to cast the drum head and the gear separately. The trunnions revolve with their axle - an excellent feature. The large number of buckets insure a quick discharge and a thorough mixture.
Foote.

Koehring.
Northwestern.

The drum of the Northwestern is a double truncated cone of cold rolled sheet steel. The deflectors are adjustable - mounted on six rods which run from end to end of the drum. These throw the material continually toward the discharge end and into a chute which revolves with the drum. The discharge is regulated or cut off by means of a door at the end of a lever. It seems that this mixer with its multiplicity of rods, deflectors, and chutes would be exceedingly hard to clean. The placing of deflectors is a matter for the consideration of a man of wide experience and expert knowledge, and should not be left to the haphazard caprice of an ignorant workman. One point of advantage is that all slopping is prevented by means of the discharge door. This mixer has chain drive. The manufacturers seem to have striven for, and in part attained, simplicity. However the machine is open to the general criticism of all chain driven concrete machinery - the chain is very liable to stretch or wear quickly in the gritty atmosphere.
M. C. Rail Track.

The manufacturers of the M. C. mixer fight perhaps harder than the makers of any other machine to demonstrate its superiority. They especially feature the strength and efficiency of the steel rail track and the trunnions on which the weight is carried. These latter are also on the railroad pattern - the axle revolving with the wheels like a car axle. The drum is cast in two parts and put together with a mortise joint. At each end a seat is carefully milled for the encircling rail bearing. The rack is a segmental casting and is affixed to the center of the drum. The deflectors and buckets are of excellent design and sufficiently plentiful to insure a quick delivery of the mixed material. The rails alone are said to be sufficiently strong to support the entire weight of the drum and charge. Splash plates around the discharge opening prevent useless slopping. The chief objections to this machine are its great weight and the susceptibility of the cast iron drum to breakage. This company also makes a tilting mixer for smaller jobs. The blades of the tilting mixer extend nearly across the drum. The drum of the tilting machine is made of two truncated cones connected by a short cylinder. The larger sizes are equipped with a power dumping device.
M. C. Rail Track.
Milwaukee.

Milwaukee Concrete Mixer and Machinery Co., Milwaukee, Wis.

The Milwaukee is a non-tilting, chain-driven batch mixer. Two cast steel hemispheres, one with a sprocket cast around it, join with a mitered joint to form the drum. The drum is supported on two wide milled tracks which turn on flanged wheels. Deflectors and shovels of large size keep the material agitated. The discharge chute on this mixer is of original design in that it is adjustable to the varying consisting of the concrete handled. The Milwaukee is of necessity a heavy machine and, being of cast steel liable to break. It is sold under a strong guaranty, showing that it has its makers confidence. The larger sizes are of a more cylindrical shape and have a double chain drive.

Chicago Improved.

Municipal Engineering and Contracting Co., Chicago, Ill.

Given time a cube mixer will make good concrete. The Chicago Improved make no claim to building the fastest mixer, but they do claim to make the best concrete. The drum is a sheet steel cubical box, journaled at opposite corners. A cast steel circular rack is bolted to the drum and the whole is carried on trunnions. The weight of the mixer and charge is carried on rollers and tracks at the trunnions. There being no deflectors this is of necessity a tilting machine, and subject to the limitations of a tilting mixer. The mechanical details of this mixer are excellent and very simple.
Milwaukee.

Chicago Improved.
Lakewood.

Ohio Ceramic Engineering Co., Cleveland, Ohio.

There are perhaps half a dozen batch mixers which may be considered standard. They are the ultimate product of years of concrete mixing experience, experiment, and careful engineering calculation. The parts are proportioned to the load, they are standardized. Of such is the Lakewood mixer - it embodies no striking departures from mixing precedent, but is "Built to Last." The mixer is a heavy steel-plate cylinder with rounded corners and inside blades. The drum is rotated by a central rack and pinion. Perfect alignment is insured by rollers at each side of the rack. Four sizes are made - all compact, strong, and economical in operation.
Ransome.

Ransome Concrete Machinery Co., Dunellen, N. J.

The Ransome Company has ever been in the vanguard of the makers of concrete mixing machinery. Mr. Frederick Ransome began the construction of mixers as far back as 1850. Their history parallels that of concrete itself. The Ransome mixer has passed through many stages in the evolution of the present model. In 1903 the essentials of the present Ransome were complete and recent improvements have been in details only. The Ransome drum is a sheet steel cylinder with a multitude of inside cleats extending the full width of the drum and bolted to the shell. The drum is non-tilting and has an independent overhead frame which carries the feed chute. The discharge chute turns the material back into the drum until it is wanted. The chief difficulty is the cleaning of a mixer having so many inside deflectors.

Smith.

T. L. Smith Co., Milwaukee, Wis.

The Smith mixer is admittedly the best in the tilting batch class. The drum is a double cone of sheet steel. The charging end is somewhat flattened to facilitate a quick feed and is reinforced with a removable plate to allow for the unusual wear of the dropping material. The deflectors are large plates placed in V-shaped pairs with ample opening between to prevent clogging. The whole drum is placed in a cradle which supports six rollers on which the drum and the turning mechanism run. The Smith Company features the excellence of their tilting mechanism which dumps the batch without stopping the drum. A great variety of attachments are furnished.
Ransome.

Smith.
Little Wonder.

Waterloo Cement Machinery Co., Waterloo, Ia.

The Little Wonder is a true "Little Brother to the Great". It is an exception among small mixers in that though small it is built as substantially as many of the machines of many times its capacity. The mechanism and drum are exceedingly simple - a hemisphere capped with a truncated cone, - the whole turned on a pivot by a gear and a circular rack. The drum has three deflectors. This is a point usually neglected in these small machines. The top orifice serves both for charging and discharging.

Triumph.

Waterloo Cement Machinery Co., Waterloo, Ia.

In this machine the makers claim to have solved the problem of auxiliary feeding attachments. No staging is required. The wheelbarrows dump directly into a large turbine loader which forms a part of the drum. Large curved scoops throw the material into the drum proper, where it is elevated to the top, falls into the discharge chute only to be returned to the charging side of the mixer. The machine is non-tilting. It has the desirable center drive.
Little Wonder.

Triumph.
Polygon.

Waterloo Cement Machinery Co., Waterloo, Ia.

The shape and arrangement of the mixing drum of this machine is unique and commendable. The drum is composed of two truncated cones connected by a short cylinder. This drum is mounted on trunnions which tilt the axis of the polygon 45 degrees. Inside deflectors insure a thorough mixing process. Thus the material is doubled on itself, thrown from side to side and thoroughly cut up. Of necessity this machine tilts to discharge. The Polygon is built along very simple and substantial lines.

Wetlauffer.

Wetlauffer Bros., Toronto, Can.

The Wetlauffer is a heart-shaped mixer with inside deflectors. The drum is fashioned of riveted steel plates encircled at the charging end by a cast steel rack. This, if any, is the weak point in an otherwise well built machine - the point of application of the power being off center putting eccentric stresses in the drum and unavoidably lowering efficiency. The rollers which support the drum are in turn supported on a tilting platform. The chassis is of heavy structural steel. Both tilting and non-tilting mixers are made by this firm. Automatic loading hoppers and steam power constitute the usual equipment.
Polygon.

Wetlauffer.
(C) Continuous Mixers.

United States Standard.

Ashland Steel Range and Manufacturing Co., Ashland, Ohio.

This mixer is typical of many of the machines at present on the market due to the mushroom-like growth of the use of concrete. It is built more like a washing machine than a piece of concrete machinery. A series of paddles on a shaft are propelled by a complex set of gears and chains. The feed consists of boxes pushed back and forth under the hoppers by a long arm working on an eccentric. There is a great deal of exposed machinery.

Little Giant.


Under the head of the "Elystone" (batch) is a description of a typical hand power batch mixer. As is the "Elystone", so is the Little Giant, typical of a small class of hand power continuous machines. The Little Giant is built along the same lines as her larger sisters; it is complete, mixing drum, cement and gravel hoppers, and watering device. The power may be derived either from a hand crank or a gasoline engine. Each hopper has an adjustable gate by which the proportions may be regulated. Underneath this runs a heavy belt which draws the materials into the drum. Corkscrew agitators insure a continuous feed. The drum is built much on the pattern of a batch mixer drum - a long cylinder with angles riveted to its sides. Gravity conveys the material to the discharge end. This is a novel and efficient machine fitted for smaller work.
United States Standard.

Little Giant.
Besser.


The Besser mixer is built along good lines, but is far too light to stand continuous, hard service. The proportioning device consists of separate plates having a reciprocating motion under the hoppers. The plates dump their loads simultaneously into the mixing trough. The mixer proper is of the pug-mill type. An interesting adjunct to this machine is a set of pulverizing rolls in the cement hopper which mash the lumps in the cement.

Bragstad.

Bragstad Concrete Machinery Co., Canton, S. D.

The elevating feed is the one unusual point in this mixer. The feeding point is lowered a foot or two; but this, in consideration of the extra machinery necessary, is of doubtful value. The proportioning device consists of adjustable gates at the ends of the hoppers. The materials gravitate into separate scraper conveyors, are elevated, and dropped into the mixing trough. The drum or trough is made of two steel cylinders of different diameters fixed end to end, the smaller discharging into the larger. Angles riveted to the sides and the drop from one cylinder to the other do the mixing. The drum is revolved by a chain about its middle. The machine seems to have several mechanical defects, such as uncovered bearings, weak support, etc.
Besser.

Bragstad.
Perfection.

Cement Tile Machinery Co., Waterloo, Ia.

The mixing principle employed in this mixer is a modification of that used in the pug-mill type, in which half of the paddles throw the material forward and the other half throw it half the distance back. The feed mechanism consists of cylindrical boxes of five compartments revolving on horizontal shafts. The proportions are controlled by opening the proper number of these compartments. The trough is semicircular, of ample size, and reinforced in two directions with angles. An attached tank is furnished as usual, but the water supply is not continuous.

Low Down.

Elite Manufacturing Co., Ashland, Ohio.

On careful consideration of this machine very few points of merit can be found. The gearing is complex, the boasted low feed lessens the feeding height only a few inches. The feed is positive-acting - scraper conveyors, running the full length of the hoppers, insure that; but the strike-off gates are inflexible and liable to jam, if a stone of extraordinary size gets in. The sand and stone enter the trough eighteen inches above the cement hopper, thus being agitated for that distance to little purpose. The water is added in one stream. The mixing paddles are multitudinous but so designed as to have little real mixing action.
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Perfection.
Low Down.
Eureka.


The Eureka mixer is simple, efficient and strong. The proportioning device, which is the very heart of a continuous mixer, is a paddle wheel. As it rotates the wheel carries with it an amount of material equal to its cubical capacity. Varying proportion is secured by blanking a portion of these wheels with steel segments provided for this purpose. The mixing paddles are very well designed and placed at the proper intervals. A much heavier construction is used in this machine than is usual in machines of its class.

Hartwick and Grand.


These two machines are essentially the same except that the Hartwick has double mixing flights. The cement is measured by a revolving wheel, while the sand and gravel are proportioned by plates having a reciprocating motion under the hoppers. The double mixing flight is an excellent feature in a continuous mixer. The blades turn toward each other, keeping the material principally in the center of the trough and keeping it constantly agitated. The hoppers on these machines are hardly of sufficient capacity or properly designed to prevent the bridging of wet material.
Eureka.

Hartwick.
The Coultrin mixer has several distinctive features among which is that of being a modern embodiment of one of the oldest mixer ideas in existence. The paddles consist of spirally shaped strips of steel, each extending the whole length of the trough, giving somewhat the action of a batch mixer. The sand and cement are discharged into the trough by the reciprocating action of their separate boxes, this motion being given by a pitman attached to the end of the main shaft. There is an agitator in the cement hopper to prevent clogging. The discharge is regulated by opening a flap door on the end of the barrel. The mechanism of this mixer is somewhat complicated but is reported to give satisfaction.

Northwestern Twin Screw.


This mixer is a great improvement over the old screw conveyor type. In this machine two intermeshing screws of tool steel, working on separate shafts, are geared to the same driving dog. The machine is very simple in operation, the feed being controlled by gates in the two hoppers, through which the material is pushed by paddles. No hopper is provided for coarse material. The watering device, a simple perforated pipe, is placed across the barrel close to the hoppers. This is objectionable because it gives the material no time for a dry mix. Perhaps this machine overcomes some of the objections to the old type of continuous mixer, since one screw pushes the material toward the other; but, the blades being continuous, this action is by no means certain.
Coaltrin.

Northwestern.

The London mixer is manufactured both with single screw, *also* like the "Northwestern", with twin screws. This mixer has the distinction of being one of the very few made in Canada. Both the single and double screw machines have the same feed, a plate sliding under an orifice in the hoppers - the amount being regulated by the height of the opening. All materials discharge simultaneously. This arrangement is likely to clog, especially when handling wet materials, gravity and friction being depended on to deliver the material. The single screw machine is open to the usual objections - as all others of its class - that they tend to cut up and convey the material rather than to mix it. The twin screw machine overcomes at least some of these objections - the material is at least cut oftener.
London.
(D) Freak Mixers.

Arnold.


The Arnold is a small and meritorious example of the traction mixer. The drum is an irregular polygon mounted on a pair of wheels. An axle runs through the drum to which are bolted several small paddles. There are deflectors fixed to the drum. The drum turns with the wheels. The materials are charged and discharged through a hinged door on one side of the drum. The machine is charged at the material piles, and by pulling it to the work the concrete is mixed and may be deposited directly in the forms. A pull of fifty feet is claimed to be sufficient for a thorough mix.

Buffalo.

Buffalo Concrete Mixer Co., Buffalo, N. Y.

This is a semi-continuous mixer with several novel features. The drum is a long sheet steel cylinder driven by a rack and pinion about its center. The cement is automatically measured while the sand and gravel are dumped into a loading skip operated by a rack and pinion. The three chief objections to this machine are: it is not built to withstand hard usage, the drum is very difficult to clean, and the feed is likely to prove unsatisfactory, the feed being but half automatic.
Arnold.

Buffalo.
Automatic.

Automatic Concrete Mixer Co., New York, N. Y.

There are many varieties of concrete mixers, most of them embodying some original idea in their construction, but seldom is the whole principle and construction original. The Automatic is, to the best of our knowledge, of unparalleled design. It is well known that an hour glass will turn its contents inside out, depending on the action of gravity. The hour-glass principle is employed practically and successfully to the mixing of concrete in this machine. In the upper hopper the stone is leveled off in the proper quantity for the batch, then the cement, then the sand, the water being sprinkled on top. The gate of the first hopper is opened, allowing the batch to flow into the second hopper, folding in and grinding on itself. When the whole batch has fallen into the second hopper the second gate is opened, allowing the material to gravitate into the third hopper while another batch is being prepared in the first.

The manufacturers have had to combat the well known prejudice against all departures from precedent, but they seem well equipped with argument and fact. Results have justified its use on many of the largest works in this country. It is used to the best advantage where the materials may be charged at ground level and discharged directly into the forms, as in sewers, basements, etc. But with the use of a derrick or a conveyor its use is almost unrestricted.
Automatic.
S. and S. Elevating Batch.

Cement Tile Machinery Co., Waterloo, Iowa.

The S. and S. is a machine in which both the continuous and batch ideas are combined. The aggregate is proportioned in a rectangular box. This dumps into a revolving cylinder, which, still revolving, is elevated along an inclined track until it automatically dumps, on reaching its highest point, through a hopper into a horizontal pug mill. A dry mix may be had in the revolving cylinder and a wet one in the pug mill. The machine is said to be "a combination of all good mixing principles." Perhaps an application of all the power to one good mixing operation would produce better results.

X-L-All.

X-L-All Manufacturing Co., Chicago, Ill.

This traction mixer is, to say the least, unique. The mixing drum is a sheet steel cylinder four feet long, mounted on an axle between two cart wheels. This axle revolves twelve inside agitators by means of a rachet. After charging the mixer is hauled 75 or 80 feet by a team of horses. After being thus agitated the material can be hauled directly over the forms and dumped. This machine is said to be very economical for street work. As a mixer of the best grade of concrete its efficiency is to be doubted.
Nims.


Of late there have been several departures from precedent in the field of concrete mixing—sometimes a new idea is used, again a new application of an old idea, or a combination of the two. The Nims is an application of the well-known cubical batch mixing principle with an equally well-known principle of continuous feeding. The proportioning machine consists of a long V-shaped trough under which a measuring wheel revolves, dumping the properly proportioned materials onto a conveyor belt. The proportion is governed by the relative positions of partitions in the trough. This material is subdivided into batches at the mixer. The mixer proper is composed of two cast iron cubes which revolve about opposite corners. A shelf in the first cube is so placed that it deflects the material over into the second cube, a shelf there discharges it without tilting. A dry mix may be had in the first cube and a wet one in the second, thus overcoming one of the worst objections to the usual batch mixer.
Chapter IV.

Concrete Mixer Details and Attachments.

In the preceding pages an attempt has been made to give only general descriptions of typical machines, no attempt having been made to describe the mixing action in detail or to describe the agencies by which this action is brought about. These will now be described in as much detail as the scope of this work warrants, together with the various auxiliary attachments, such as batch hoppers, loading skips, etc.

First the details of batch mixers and their attachments will be described, then those of continuous mixers. A more intimate comparison will thus be made possible.

(A) Batch Mixer Details.

The first batch mixer drums were of wood, then sheet steel replaced wood, a little later cast iron came into general use because of its superior wearing qualities, then cast steel being more durable even than cast iron came into vogue. Of late however cast iron or steel has begun to give place again to sheet steel, cast iron being exceedingly liable to breakage. Thus a saving of from 200 to 500 pounds can be made in a single machine. It must not be understood that sheet steel has entirely superseded castings, for many manufacturers of excellent mixers maintain that the superior wearing qualities of cast iron or steel more than justify their increased weight.

In shape concrete mixers afford infinite variety - some makers even seem to have this end in view. Cylinders are most common, double truncated cones placed base to base perhaps come next in
Batch Mixer Drums.
Batch Mixer Drums.
Batch Mixer Drums.
Tilting Mixer Drums.
order of commonness, then cubes or slight modifications thereof, then in order, cylinders having a bulge on the discharge end, irregular polygons, spheres, and single truncated cones.

There is a class which includes most of the cubes and some of the other irregularly shaped figures which have no inside blades or disintegrators. These depend on the adhesion of the concrete to the sides of the drum, the mechanical grip of the drum's irregularities, and its cohesion to lift it up; then as it rolls down, the aggregate doubles and folds upon itself with a grinding and kneading action. These machines are of necessity slow, they are adapted to mixing neither very wet nor very dry concrete. If the material is too dry, it is liable to ball up; if too wet, the lighter materials will simply float about as the mixer revolves. However for a concrete of medium consistency they will, if given time, do the best work.

In most machines the simple action of the cube mixer is considerably complicated by the use of some variety of blade. These blades are of a great variety of shapes and sizes, varying from small angles riveted to the sides of the drum to broad vanes and buckets. These larger sizes are coming more into use these late years, being necessitated by the demand for wetter mixtures and the advent of the non-tilting type of mixer. Usually the blades are flat and affixed perpendicularly to the sides of the drum. In the case of tilting mixers the blades are symmetrical about the center line of the drum. In non-tilting machines some provision must be made for getting the mixed concrete into the discharge chute. This is usually done by sloping the blades nearer the charging side so as to deflect the material into buckets or scoops on the discharge side
which lift and pour it into the discharge chute. In at least one machine the necessity for these scoops is obviated by widening the blade which runs across the entire width of the drum, and bending it into a pocket on the discharge side. The angle at which the blades are attached to the drum and their size are matters for the consideration of the highest grade of skilled experts obtainable, as these things greatly affect the fundamental operations of the machine, such as the speed at which the material undergoes the mixing process, and the thoroughness of the mix. It is evident that a large blade will lift more concrete per revolution than a small one.

Great indeed are the chances for economy or the lack of it in getting the material into and out of the drum. Early mixers were small affairs, and little difficulty was experienced in shoveling the materials directly into the drum. However with the great increase in size and efficiency there have been introduced a great number of labor and time saving devices.

Where the work is large enough to warrant the expenditure, large overhead bins are perhaps the most economical. These may be filled directly from the cars. For this work a "batch" hopper, i.e., a hopper which is of sufficient capacity to hold a whole batch at one time is necessary. A batch hopper can often be used to advantage with an ordinary runway - the next batch being wholly prepared while the previous one is being mixed and discharged. Small hoppers are universally a part of a concrete mixer's equipment.

Low feed is one of the important points to be considered about a mixer - the lower the feed level the less expensive and laborious the work. The only practical way of obtaining a ground level feed on a batch mixer is by means of a power loading skip. This
is a sheet steel box one side of which is formed into a long slender spout. The material is dumped directly into this from the wheelbarrows, it is then elevated and dumped into the drum without stopping the drum. The skip is sometimes simply pivoted at the proper height to a frame; but in the case of an elevating loader it is attached to a set of wheels which run on a vertical guide or track automatically dumping its load when it reaches the proper height, thus enabling materials to be lifted from several feet below the level of the mixer. The skip should be so designed that when elevated the material will flow freely and without aid into the drum. In the best machines the nose of the skip is entirely covered over. The skip is usually operated by means of two steel cables, one attached to each side of the skip, which wind about a drum or hoisting mechanism near the motor. In some machines one cable, attached to a bail on the skip, is used instead of two. At least one machine operates the skip by means of a rack and pinion.

Every non-tilting mixer must have some kind of a discharge chute. Chutes may be divided into two classes: those which remain inside the drum whether discharging or not, and those which are attached to a pivoted lever on the outside of the drum and which are only shoved in when a discharge is desired. Those of the first class require a stationary secondary spout outside the drum. When not discharging, the chute pours the concrete back into the drum; and when a discharge is desired, the spout is tilted down until the required amount is poured out. Chutes of the second class are little more than curved sheets of steel attached to a frame which is hinged at the bottom. The chute is set at such an angle that when shoved into the drum the concrete will flow out freely until the spout is with-
Power Loading Skip

and Supplementary Distributor.
drawn. Neither of these arrangements has a very decided advantage over the other.

For special work, such as paving, a supplementary spout or distributor is a great economy. This is a long sheet steel chute hinged under the discharge chute and so hung that it can be swung through an arc of 180 degrees, thus delivering the material without the aid of wheelbarrows.

Semi-automatic tanks are a part of the equipment of many of the best machines. The desired amount of water is allowed to run into the tank, the amount being gauged by a float or some similar device, then at the will of the operator the water for the batch can be let into the drum by pulling a lever.

The importance of the relative position of the driving gears is a matter often given too little consideration in the design of a mixer. In tilting mixers the driving gears are of necessity kept in the center of the drum. However in non-tilting machines the gears are likely to be found at almost any place on or at the side of the drum. The racking strains set up in a drum are unavoidably great, but by placing the gears symmetrically about the center of the drum stresses due to this cause may be reduced to a minimum.

(B) Continuous Mixer Details

There are two points to be most carefully considered in every continuous mixer: the mixing flights or paddles, and the proportioning device. Considering the fact that continuous mixers have been in use almost as long as have batch machines, there has been comparatively little improvement since their inception. There are still in use machines built after the pattern of those of fifty
Continuous mixers may be divided into two classes: those having blades attached to a revolving shaft, and those having a revolving cylinder or drum. The latter of these are of little importance.

There is comparatively little difference in the design of the paddles. They have two functions, that of conveyors and of agitators or mixers. Sometimes the blades are such good conveyors that they are of little use as mixers. Usually the blades are of cast iron or steel, wide and thin, with a round or square socket which fits over the shaft. In shape they vary somewhat; they may be rectangular and flat, slightly curved, narrow near the shaft and wider at the end, or curved two ways like a screw propeller blade. Some are designed with a short side making an angle with the blade proper so that they kick the material back toward the feed end. In others this end is accomplished by turning a part of the blades to kick the concrete in the reverse direction. In some machines the blades are formed by bolting square plates to long arms which are attached to the shaft.

The mixing flights revolve in an open semi-circular trough. There is a slight clearance between the paddles and the trough enough to prevent the rock from jamming. The trough should be somewhat flared at the top to prevent slopping. As the wear on this trough is very great it should be made of thick material.

A few of the less important mixers have a revolving drum, set at a slight angle, into which the aggregate drops. Gravity conveys the material from the feed end to the discharge end. Angles riveted to the sides of the drum carry the concrete part way up the
Cat No. 1 showing Mixing Cylinder in all Coltrons except Nos. 1 and 18.

Paddles.
side and let it roll over itself. This system can not be said to be very satisfactory.

Next to the paddles in importance comes the proportioning mechanism. Here there is infinite variety - almost as many kinds as there are machines. The most common are of the reciprocating plate type. In these the hopper bottom consists of a reciprocating plate which, as it slides forward, carries with it an amount of material guaged by the height of a strike-off brush or plate. The material in the hopper above takes the place thus vacated. As the plate returns, the material outside the hopper is pushed off into the trough. In many machines some form of the scraper conveyor performs the functions of a proportioning device. The scraper passes over a plate which forms the bottom of the hopper dragging with it a portion of the contents of the hopper. Here again the amount is guaged by an adjustable strike-off. Another popular device is a revolving paddle wheel, into the compartments of which the material drops, and as it revolves a little farther discharges the material into the trough. Here the proportions are controlled by blanking a portion of the compartments either wholly or in part with quarter round segments which are made in the correct sizes and screwed into the wheel. One or two mixers have a modification of the reciprocating plate - a bottomless box which has a reciprocating motion under the hoppers. The material drops into the box when it is in one position, and out into the trough when it passes to the opposite position. All of these devices will work fairly well if there is no arching or bridging of the material in the hopper; but this can not be made certain, especially if the material is slightly wet. To lessen the chance of this bridging agitators are sometimes provided - usually in the form of
Proportioning Devices.
Proportioning Devices.
spiral "ire springs attached to a rotating shaft. The efficiency of these contrivances is doubtful in a damp material, for they are very apt to clog.

In two or three machines an attempt is made to lower the feeding level by placing the hoppers close to the ground and connecting them to the mixer proper by a system of scraper conveyors. This undoubtedly does lower the feed somewhat, but it is a question if the increased complication of the machinery and the decreased portability does not more than offset the advantage gained.

In every mixer there should be some arrangement made to take care of the concrete after it has undergone the mixing process until it can be conveniently gotten rid of. This end is usually accomplished by hinging a hood on the end of the trough. The hood may be but an elongation of the trough itself, or it may be a curved sheet of steel turned up at considerable angle with the trough proper. In either case it is operated by means of a long lever. An operator stationed on top of the machine tends to the loading of the barrows. Some of the lesser machines omit this hood; but this practice is to be condemned, for then the material falls to the ground and requires extra labor to get it into the barrows.

A few mixers have double-mixing flights which turn toward each other. In these the mixing flights themselves are very little different from those in machines having but one mixing flight. However this arrangement should greatly increase the mixing efficiency of the machine, since the material is much more constantly agitated than in the usual type of continuous mixer. The tendency is for the material to be thrown toward the center, and always to remain on top of the paddles, thus being thoroughly lifted up and cut through.
Chapter V.
An Ideal Mixer.

The ideal mixer is, of course, of the batch type. At least in its present state the continuous mixer is far too uncertain in its operation to even aspire to ideality. A machine which might be perfect for mixing small amounts of material would produce very poor results if used for larger batches. For this reason this description will be of a machine of one half cubic yard capacity or thereabouts. The writer makes no pretence to originality in this description, it being but a compilation of the ideas employed in the construction of seven or eight of the standard mixers.

The drum should be of metal of at least 3/16" thickness, 1/4" would be better. The blades should be of the same thickness. Sheet steel should be used because of its less weight. All gearing should be cast of semi-steel. The main gear (around the drum) should be cast in several equal and interchangable segments, at least six, and should be bolted to the drum in such a way as to be readily removable in case of breakage. The main gear should be placed in the center of the drum to prevent the eccentric stresses unavoidably set up if the drive is off center. The gear ring should be at least 2\(\frac{3}{4}\)" wide, the teeth being deep enough to give a little extra clearance.

The drum should be about sixty inches in diameter except at the discharge end, where it should be enlarged to about sixty four inches, as this enlargement will greatly increase the capacity of the drum and also provides a suitable seat for the buckets, helping to fill them and to keep them full. The drum should be 40" to 42" in width, all corners to be rounded to 3" radius to prevent the
concrete from sticking in them. The blades should be flat or curved slightly in the direction of the motion. They should be fastened perpendicularly to the sides of the drum at an angle of about 25 degrees with the horizontal by means of cast or malleable iron brackets. All fastenings should be made with round headed bolts so that worn or broken parts may be replaced with the least possible labor. There should be eight of these blades and a similar number of buckets. The blades should be so placed that their discharge-end empties the material directly into the buckets. Thus far this is practically a description of the Chain Belt mixer with the exception of the material of which the drum is made and the number of the paddles and buckets.

As to trunnions the standard railroad rail rerolled to fit snugly about the perimeter of the drum and running on flanged wheels is to be preferred. This arrangement reinforces the drum and takes practically all of the wear which would otherwise come on the drum proper. The flanged wheels should be turned true. They should be of the proper size to make up for the difference in diameter of the different ends of the drum (14" and 12") and have at least a 6" bearing on the axle. Roller bearings with forced feed grease cups will effect a great saving in power.

The drum could be most easily made in three sections - two heads and a cylindrical center section - these to be riveted together. The charging and discharging and discharge holes should be 24" and 22" in diameter respectively, and both should be flared outward around the edge to prevent splashing.

The charging hopper should be 42" long by 18" or 20" wide, and make an angle of not less than 45 degrees with the horizontal
to prevent its clogging. If possible the feeding height should not be more than 60" from the ground. The nose of the hopper should extend slightly into the drum.

The discharge chute should be pivoted on a frame as near the discharge opening as possible and be as wide as the size of that opening will permit. Its inner end should protrude two or three inches past the edge of the buckets. It should be rounded to a diameter two inches less than that of the opening. When discharging this chute should easily clear the highest wheelbarrow or cart likely to be used.
Chapter VI.

Trend of Modern Practice.

There are perhaps half a dozen concrete mixers on the market which are recognized as standard. There is little choice between them, either as to product or construction. They are of course batch machines. Modern engineering requirements will not approve of any but a batch machine except on works of small importance.

The standard mixer of today seems very near perfection - at least as near as the possibilities of the present type will permit. Not that there is no room for improvement, but the improvements will be in details. The time is ripe for a fundamental invention which will change the whole course of mixer construction. What form this will take it is impossible to tell. It is to be doubted if its forerunner has yet appeared. By some - its makers especially - the pneumatic grout mixer is hailed as the type of the concrete mixer of the future. It has already been used for this purpose to a limited extent. A great need mothers a great invention; the steamboat, the cotton gin, the printing press, and the aeroplane came each at its psychological moment, and so will come the new concrete mixer.

The machine of yesterday was not designed - it was cut and fitted. Then if a part failed it was replaced by a stronger one. If the concrete seemed too little mixed, a few more blades or blades of a different shape were put in. Even today we know very little of the real science of concrete mixing. We are but reaping the results of the mistakes of our predecessors. No one has yet attempted to evolve a formula for the most effective form of the concrete mixer blade. Nor is there a table in existence giving the proper speed
for machines of different sizes to produce the best result. It is true that we have progressed a little toward that knowledge.

In view of the importance of concrete as a building material in the future, here lies a great field of endeavor - a field worthy of the effort of the greatest genius.

However the competition among manufacturers today is not along such lines. Driving mechanism, weight, power-loading skips, clutches, and other mechanical details now form the bone of contention. This is perhaps good on the whole, for it leads to greater economy of power and to a higher degree of perfection in the machine as a whole.

Cast iron and steel drums are rapidly being discarded in favor of sheet steel on account of its less weight. Fewer and fewer freak shapes make their appearance year by year. All or nearly all of the standard machines are now of cylindrical shape. The tilting mixer, at least for the larger sizes, is almost a thing of the past.

The manufacture of concrete mixers is getting to be less and less a side line in this country. It is becoming recognized as a business worthy of the highest grade of engineering skill. Concrete seems destined to go hand in hand with progress, and the path traveled by concrete must be closely paralleled by that of the machine which makes it.