ABSTRACT: The method comprises producing a flow of air at and adjacent and in the same direction of movement of an arcuate path of the buckets toward an outlet, by means of which airflow the divided material carried by the buckets is assisted in the proper path out of the casing. Particles are separated from the air, after passage through the outlet, and this air may be circulated to an upper housing adjacent the arcuate path, or to a lower housing in which the buckets are loaded. The apparatus for carrying out the above method may include a cyclone separator or the like, a blower connected thereto or connected to the lower housing, or connected for discharge of air into the upper housing, such as tangentially to a concave top thereof. The apparatus may also include a discharge chamber having two outlets, one leading to the separator and the other to a discharge conveyor or the like. The blower may also be driven by the shaft of an upper pulley or incorporated in the upper pulley.

The method also includes producing a flow of air at and adjacent and in the same direction of movement of material entering a bucket elevator casing inlet, to enhance the transport of sluggishly flowing materials into said casing.
METHOD OF AND APPARATUS FOR INCREASING THE CAPACITY OF BUCKET ELEVATORS

This invention relates to elevators, and particularly to bucket elevators for handling divided material.

In the operation of elevators which include a series of buckets mounted on a belt or chains, which extend between and around a pulley or sprocket at both the upper and lower ends, it is customary to provide a discharge chute adjacent the top of the elevator and on the descending side of the buckets. When handling relatively granular material, such as sugar, sand, cement and the like, the buckets should be operated at a sufficient speed that, as the buckets move in an arc around the upper pulley or sprockets, the material in each bucket will be discharged by centrifugal force, which assists the gravity flow of material discharged from the bucket, so that all of the material will tend to reach the discharge chute, rather than falling downwardly with the descending buckets. Since the capacity of a bucket elevator is normally proportional to the speed of movement of the buckets, any increase in the speed of the buckets will increase the capacity. However, in attempts to increase the capacity of a bucket elevator handling this type of material, a speed is reached at which the discharge of material from the buckets by centrifugal force, as the buckets move upwardly along an arc around the upper pulley or sprocket, causes an undue amount of material to be thrown upwardly and either fall backwardly down the line of the ascending or descending buckets or, due to air turbulence, move an insufficient distance in a forward direction to reach the discharge chute and thereby fall downwardly along the line of the descending buckets. The capacity of a bucket elevator may also be increased by placing additional material in each bucket, commonly referred to as surcharge loading, but such loading may cause spillage of material at the top of the elevator at normal speeds and increases the probability of spillage of material at increased speeds. The capacity of a bucket elevator may also be increased by installing the buckets more closely to each other, but a point may be reached when the discharge from one bucket impacts the back of the preceding bucket and thereby falls down the upper leg.

Among the objects of this invention are to provide a novel method and apparatus for bucket elevators, particularly those handling granular or other fine material, which will permit the capacity of the bucket elevator to be increased; to provide such a method and apparatus which will permit the capacity to be increased by increasing the speed of movement of the buckets or by surcharge loading, or both, but still obtain an effective and efficient discharge; to provide such a method and apparatus which can be adapted to existing bucket elevators, as well as new constructions; to provide such a method and apparatus in which the feeding of the material to the buckets may also be enhanced; to provide such a method and apparatus which may be applied in several different ways to bucket elevators of various types; to provide such a method and apparatus in which air circulation may be utilized and in which such air circulation may be produced alternatively by suction or pressure; and to provide such a method and apparatus which is efficient and effective in operation.

The foregoing and other objects, as well as the novel features of this invention, will become apparent from the description which follows, taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a condensed side elevation of a bucket elevator and associated parts constructed in accordance with this invention, with certain portions of the elevator housing being broken away to show parts in the interior thereof, such construction including a blower operating through a cyclone separator connected to the discharge chute, to produce the desired air flow in an upper housing of the elevator;

FIG. 2 is a central vertical section of a bucket of the elevator of FIG. 1, with the extent of normal loading of granular or fine material therein indicated;

FIG. 3 is a central vertical section similar to FIG. 2, but showing a modified bucket and with an indication of surcharge loading of the material;

FIG. 4 is a fragmentary side elevation of the upper housing of a bucket elevator similar to that of FIG. 1, but provided with air intake louvers;

FIG. 5 is a fragmentary side elevation similar to FIG. 4, but showing an alternative of the air intake louvers;

FIG. 6 is a condensed side elevation of a bucket elevator also constructed in accordance with this invention, the upper portion of the elevator being similar to that of FIG. 1, but with a cyclone separator only connected to the discharge chute and with a blower or the like provided for introducing air into the lower end of the elevator;

FIG. 7 is a fragmentary side elevation of the lower portion of a bucket elevator similar to that of FIG. 6, but utilizing a modified blower arrangement;

FIG. 8 is a side elevation of a bucket elevator also constructed in accordance with this invention, having a cyclone separator connected to the discharge chute and a blower or other air supply means for discharging air at selected positions and in selected directions into the upper elevator housing;

FIG. 9 is a fragmentary side elevation of a fragment of a bucket elevator similar to that of FIG. 8, but modified so that the blower intake is connected to the cyclone separator and the discharge from the blower is introduced into the upper elevator housing at a different position;

FIG. 10 is a fragmentary side elevation, showing the upper housing of a bucket elevator also constructed in accordance with this invention, but in which air is introduced into the upper housing in a manner similar but not identical to that of FIG. 8, with the blower rotor being mounted on and driven by a shaft for the upper pulley or sprockets of the elevator;

FIG. 11 is a condensed side elevation, partly broken away, of a bucket elevator also constructed in accordance with this invention and similar in many respects to each of FIGS. 1 and 6, but in which suction is produced within the upper housing and discharge chute from a cyclone separator and the air removed from the cyclone separator is introduced into the bucket of the elevator;

FIG. 12 is a fragmentary side elevation, partly broken away, showing the upper portion of a bucket elevator also constructed in accordance with this invention, in which air flow in the discharge area is produced by a blower or fan blades attached to and rotated by the pulley at the upper end of the elevator;

FIG. 13 is a fragmentary vertical section, on an enlarged scale, taken along line 13–13 of FIG. 12;

FIG. 14 is a fragmentary section similar to FIG. 13, but illustrating a modification thereof for use when a chain and sprocket arrangement or other than a belt is utilized for moving the buckets of the elevator.

As illustrated in FIG. 1, the principles of this invention may be applied to a bucket elevator having, as conventional parts, a belt 20 on which is mounted, in spaced positions, a series of buckets B, the belt 20 moving around and being driven by an upper pulley 21 mounted on a shaft 22, which is installed within an upper housing H and is driven by a motor and chain or belt drive and/or gear reducer arrangement 23, as indicated. In the elevator shown, the buckets move upwardly, as indicated by the arrow 24, from a lower pulley 25 through an enclosed housing up leg 26, which connects a lower housing L from the elevator housing H, hence an upper pulley 21. Lower pulley 25 is installed within lower housing L, being mounted for rotation in a conventional manner on a shaft 27. From upper pulley 21, belt 20 and the buckets move downwardly, as indicated by the arrow 24, through an enclosed housing down leg 28 having an inclined portion 29 at the lower end, hence back to lower pulley 25. The inner side of the up leg 26 is split at the position of upper pulley 21, to provide arcuate extensions 30 on each side of the upper pulley.

The upper housing H, which may be supported and stabilized in any suitable manner, as by beams 31, the supports for...
which are conventional and therefore not shown, has parallel sidewalls 32, a lower, angularly disposed plate 33 which extends from up leg 26 to down leg 28 and an arculate top 34 which extends upwardly and then downwardly and past an outlet 35 at the entrance to a discharge chute having a downwardly inclined bottom 36, alongside opposite sides of which sidewalls 32 extend to complete the enclosure of the discharge chute. As will be evident, when operated at an appropriate speed, the material carried by the buckets will be substantially discharged through the outlet 35, with the centrifugal force imparted to the material in each bucket tending to throw the material out of the bucket and into the outlet.

The lower housing L includes a base 38, parallel sidewalls 39, a vertical end wall 40, an outwardly inclined end wall 41 which may be formed as a continuation of the outer wall of the inclined portion 29 of down leg 28 and a normally flat top 42 which extends between the openings to the up leg 26 and to the down leg 28. Down leg 28 is provided, on the inside, with an offset 43 which accommodates a bend pulley 44 engaging belt 20. The lower housing L also includes an inlet chute 45 connected to an inlet opening in the vertical wall 40 and through which bucket to be lifted by the elevator may be supplied by a conventional conveyor, such as a screw 46 operating in a tube 47.

During normal operation of the conventional bucket elevator, as thus far described, the material to be lifted and discharged at a point some distance above, is moved by the screw 46 into the inlet chute 45, some to be lifted into each bucket, in turn, as it moves around the lower pulley 25 and upwardly past the inlet, the rest being scooped up from inside the lower housing by the buckets. When moved at an appropriate speed, the material carried by the buckets, in passing around the upper pulley 21, as indicated, will tend to be discharged by centrifugal force, the impetus of which is in a direction outwardly from the upper pulley. Inasmuch as the bucket movement and the centrifugal force as well as the speed of the bucket, the bucket will tend to fly out toward the top 34 of the upper housing and, instead of falling into the discharge opening 35, will fall down into the down leg 28. Also, any of the material which leaves the bucket before the top center of the upper pulley is reached may tend to impinge on the underside of the housing top 34 and fall back rearwardly into the up leg 26. In either event, the material which does not fall into the discharge chute represents a loss of work and a reduction in efficiency. When the buckets are normally loaded, as in FIG. 2, but the speed of the elevator is increased considerably, in order to increase the capacity of the elevator, the speed of the buckets is such that centrifugal force may become a significant factor before the top center of the upper pulley is reached, with the result that some of the material in each bucket may again tend to fall down the up leg or down leg, particularly the down leg, in this instance.

In accordance with the present invention, a flow of air through the top of the upper housing H, toward the outlet 35 and discharge chute, is produced, in order to carry granular material, fines, or the like into the outlet. This flow of air may be produced by a blower 58 which is connected by a pipe 59 to the top of a conventional cyclone separator C, which is provided with an enclosed but vertically divergent and laterally convergent inlet 60, the bottom and sides of the inlet 60 being essentially a continuation of the discharge chute, and the top being flat and connected to the top 34 of the upper housing H.

The discharge of material from the lower end of the cyclone separator C is preferably through a conventional, rotating air lock 61. Since the suction of the blower 58 through the cyclone separator will produce a considerable flow of air through the upper housing, an air intake 62 is provided at the discharge end of the lower screw conveyor tube 47, so that air will flow along with the material into the inlet chute 45 and thence upwardly through the up leg 26. This flow of air will assist in loading material into the buckets and also maintaining the material in the buckets during upward travel in the up leg, particularly when the load is in transit through FIG. 3, is utilized. Of course, the suction produced at the outlet of the upper housing H by the blower 58 will also pull air from the down leg 28, thus tending to move into the discharge chute any material which may otherwise tend to fall into the down leg. Thus, with the blower suction removing air from the down leg, there will be a tendency for some air to flow from the inlet chute 45 into the down leg 28, but this air will tend to take the shortest path, i.e., around the edges of the belt 20 and upwardly into the down leg along a path beneath the flat top plate 42 of the lower housing. Thus, this diverted air will not materially disturb the loading of the buckets and may even have a tendency to enhance surcharge loading.

For further increased speeds of the elevator, at least a part of the air to be moved by the suction blower, in further accordance with this invention, is introduced into the upper housing at a position and in a direction, to move any granular material or fines along the upper part of the housing, beneath the arculate top 34. For this purpose, a series of upwardly directed louvers 63 may be provided in the back side of the upper housing H, as in FIG. 4. As will be evident, the upward direction of this air will enhance the pickup of any material prematurely discharged by centrifugal force from the buckets, as they pass around the upper pulley 21. A similar but alternative arrangement may be utilized, as illustrated in FIG. 5, in which a set of upwardly directed louvers 63' is installed in each sidewall 32 of the upper housing, again at the rear but substantially directly above the up leg 26. As in FIG. 5, shaft 22 for the upper pulley may be mounted in a bearing 64, in turn mounted atop a bearing support, as shown, which rests on beam 31.

In conventional installations, as described above but without the airflow of this invention, of bucket elevators for conveying sugar, the upper pulley 21 has a diameter of 18 inches to 30 inches and rotates at a speed of 41 to 58 r.p.m. With the directed airflow of this invention, as described above, the speed of rotation of the upper pulley may be increased to up to 100 r.p.m. or more, with a consequent increase in the capacity of the elevator.
In the alternative embodiment illustrated in FIGS. 6 and 7, the conveyor and parts thereof are essentially as illustrated in FIG. 1. The conveyor thus including buckets mounted on a belt, for which a chain or chains may be substituted, passing around a lower pulley enclosed within a lower housing L and an upper pulley enclosed within an upper housing H, with the upward movement of the buckets being within an up leg 26 and the downward movement of the buckets being within a down leg 28. A cyclone separator C has an inlet 60 connected to the upper housing H at the discharge outlet thereof, as before, although the discharge of air from the cyclone separator is through a pipe 65, as indicated by the arrow. The inlet to the lower housing may be slightly modified, utilizing a feed chute 66, as of rectangular cross section, to which the material to be conveyed is supplied through a rotating air lock 67, to which a supply pipe 68 leads from a conventional storage bin or the like (not shown). It will be understood, of course, that a screw feed conveyor, as in FIG. 1, may be utilized for the bucket conveyor of FIG. 6 and vice versa. Each end of shaft 27 for the lower pulley may be mounted in an adjustable bearing 69, by which the position of the lower pulley and the tension of the belt or chain may be adjusted. Other parts having the same reference numerals correspond to those previously described in connection with FIG. 1.

In the apparatus shown in FIG. 6, air is blown into the lower housing L by a blower 70 mounted on the flat top 42 of the lower housing and provided with an air filter 71. As will be evident, the air so blown into the lower housing L will pass upwardly through each of the up leg 26 and down leg 28 and into the upper housing H. The air blown upwardly through the up leg 26 will be directed toward the top of the housing and deflected around into the outlet and into the cyclone separator C, tending to carry with it any fines or small particles which are ejected by centrifugal force in an upward direction, and thereby preventing such material from falling back down the up leg 26. The air blown upwardly through down leg 28 will tend to pick up and carry into inlet 60 of the cyclone separator any material otherwise tending to fall down the down leg. As will be evident, through the circulation of air in the conveyor housings, the speed of movement of the buckets may be increased considerably, using normal loading, as in FIG. 2, without an appreciable waste of material which might fall into the up leg or down leg, rather than moving through the outlet of the upper housing. Similarly, when surcharge loading, as in FIG. 3, is utilized, the above-described air circulation enables such surcharge loading to be used at normal speeds and even permits an increase in the speed of movement of the buckets.

In the modification of the apparatus of FIG. 6 illustrated in FIG. 7, air is supplied to each side 39 of the lower housing L from a conventional motor-driven blower 72, to the outlet of which is attached a fork 73 connected to piping 74 and 75 leading to opposite sides of the lower housing L. The piping 74 and 75 may be connected to the sides of the lower housing L on either side of bearing mounting 69 for shaft 27 of the lower pulley, i.e., adjacent the down leg 28, as shown, or on the opposite side, adjacent the up leg 26. At the connection to the lower housing, inclination of the piping 74 and 75 may be utilized to deflect air toward the up leg 26 or toward the down leg 28, as the case may be. The proportion of air blown through up leg 26 and down leg 28 will depend somewhat on the type of loading and speed of movement of the buckets, which, in turn, will determine whether the greater amount of material tends to fall back down the up leg or fall downwardly into the down leg.

In the embodiment illustrated in FIG. 8, the elevator includes a belt or chains on which buckets are mounted, as before, moving around a lower pulley and upper pulley. The lower housing L' of FIG. 8 is similar to the lower housing L of FIG. 1, except that both ends are vertical, while the up leg 26' and down leg 28' are parallel throughout their height. The upper housing H' of FIG. 8 is similar to the upper housing H of FIG. 1, except that the side plates 32' and top plate 34' extend laterally beyond the upper end of the down leg 28', to provide a horizontal outlet at the entrance to an inclined discharge chute 77, which is connected to inlet 60 of a cyclone separator C, as before, from which air is discharged through a pipe 65, and material is discharged from the lower end through a rotating air lock 61. In accordance with this invention, a blower 78 having an intake pipe 79 connected to an air filter 71, discharges into a manifold 80, from which a pair of distributing pipes 81 and 82 lead to the top and rear, respectively, of housing H'. The pipes 81 and 82 are adapted to blow the air into the upper end of the housing H' in a direction generally toward the outlet and along the underside of the top 34' of the housing. Thus, each pipe 81 and 82 is provided with a pipe section 83 which is disposed at an acute angle to a tangent to the top of the housing H' and is directed generally toward the outlet. As will be evident, in the apparatus of FIG. 8, material thrown upwardly by centrifugal force toward the underside of the top of the housing H' will be picked up or carried by the air discharged through pipe sections 83 and into the outlet, thence into the discharge chute 77, rather than either falling backward into the up leg 26' or downwardly into the down leg 28'.

In the modification of the apparatus of FIG. 8 shown in FIG. 9, the intake pipe 79' of blower 78 is connected directly to discharge pipe 65 of the cyclone separator C, while the blower is driven, as through a belt drive, by a motor 84. Manifold 80' is connected by an orifice 85 to a pair of pipes 86 which discharge into opposite sides of the housing H' directly above the up leg 26'. To provide a slightly greater space at the upper end of the up leg 26', the lower plate 33' of upper housing H' may be constructed angularly, as shown. As will be evident, the air discharged from pipes 86 into the housing H' will travel upwardly and around the inside of housing H', the flow tending to be concentrated just below the top of the housing, to pick up and carry into the discharge chute 77 material thrown upwardly by centrifugal force from the buckets, as they pass around the upper pulley.

In the modification of the apparatus of FIG. 8 illustrated in FIG. 10, a blower 87 having a screened air intake 88 is mounted on one side of housing H and may be driven by the shaft for the upper pulley, or in any other suitable manner. The outlet 89 of blower 87 discharges air into an arcuate manifold 90 which extends from the rear around the housing H' to an appropriate point, such as the top center thereof. From manifold 90, the air is discharged into the upper housing H', as indicated by the arrow, so that again any material discharged by centrifugal force from the buckets moving around the upper pulley and toward the underside of the top of the upper housing will be picked up or carried by the air into the outlet.

In the further alternative embodiment illustrated in FIG. 11, the belt 20, on which are mounted buckets B, passes around an upper pulley 21, which is mounted in an upper housing H", both the upward and downward movement of the belt and buckets being within an intermediate housing I, the upper end of which connects with the upper housing and the lower end of which connects with a lower housing L'. The top 34' of the upper housing may be constructed in an angular manner as shown, rather than arcuately, as before. A vertical baffle 91, placed at a convenient location within the intermediate housing I, such as adjacent the downward leg of the belt movement, extends between the housings, with the upper end 30' of the baffle being forked, each side of the fork being disposed at one side of the upper pulley. One wall 92 of the intermediate housing extends upwardly beyond a discharge chute 36', and is provided with an adjustable lip plate 93, which may be adjusted toward or away from the buckets B. Chute 36' forms the lower end of a discharge chamber D, the upper end of which are formed as continuations of the sides 32' of upper housing H'", but the top wall 94 of which slants downwardly to an end wall 95, in the lower end of which is provided an opening 96 connecting to an inlet duct 97 of a cyclone separator C. Between end wall 95 and chute 36' is an opening 98 to a screw con-
veyor 99, which extends past and is adapted to receive the discharge through an opening 100 from the rotating air lock valve 61 of the cyclone separator. A drive 101, such as a motor and reduction gearing, may be provided for the screw conveyor 99 at the end adjacent an outlet 102. A suction blower 103 is connected to air discharge pipe 59 of the cyclone separator, while a pipe 103 extends downwardly from the outlet of the blower and to the lower housing L' being connected thereto by a tube 104 which directs air into the lower housing, to blow upwardly on each side of the baffle plate 91, as indicated by the dotted arrows 105. The end of tube 104, at the point of connection with a side 39 of the lower housing, may be inclined, if desired, so as to produce a greater flow of air to either side of baffle 92. Other parts similar to those of FIGS. 6 and 8 have corresponding reference numerals.

Air discharged from tube 104 into the lower housing flows upwardly along each of the upward and downward reaches of the conveyor to the upper housing and is drawn through the discharge chamber D into the cyclone separator C for return to the lower housing. As will be evident, any particles thrown upwardly by centrifugal force, as the buckets pass around the upper pulley 21, instead of falling back into the intermediate housing I, as through air turbulence or impact against the underside of top 34") of the upper housing, will be moved into the discharge chamber D. A majority of the material will pass through opening 98 to the screw conveyor 99, for transfer to the discharge pipe 102, but some of the particles will be passed through opening 96 into duct 97 of the cyclone separator and will be separated therein in a conventional manner, to pass downwardly through the rotating air lock valve 61 and through opening 100 for delivery to discharge pipe 102. An advantage of the closed air circuit of FIG. 11 is that any fines which might tend to be entrapped in the air will be returned to the conveyor. The movement of particles into the discharge chamber D from the upper housing is, of course, enhanced by the upward flow of air initially introduced into the lower housing through tube 104. Air moving upwardly past buckets which are moving upwardly assists in maintaining as large a load as possible in each bucket, although some air should be passed upwardly on the opposite side of baffle 91, to ensure that no particles fall downwardly between end wall 92 of the intermediate housing and baffle 91. Lip plate 93 may be adjusted to minimize this space.

In the alternative construction illustrated in FIG. 12, the intermediate housing I and lower housing L', as well as the parts within, are essentially the same as the construction shown in FIG. 11, except that the recirculating air duct 103 may or may not be used, as desired. Thus, upper housing 14 of FIG. 12 is similar to the upper housing of FIG. 11, but the discharge chamber D' is slightly modified in that the end wall 92' of the intermediate housing I extends only to the discharge chute 36', with an adjustable lip plate 93 again being provided and a single outlet 108 being provided between the discharge chute and end wall 95' of the discharge chamber. In this construction, the upper pulley is utilized as the blower for sucking air into the upper housing, carrying with it any particles that may tend to fall downwardly into the intermediate housing. For this purpose, an upwardly concave, arcuate baffle 109 is mounted beneath the upper pulley 110 and extends between the upper ends of baffles 111 and 112, which are respectively disposed adjacent the upwardly moving reach and the downwardly moving reach of belt 20, on which buckets 8 are mounted, as before. To support a bearing 113 for the upper pulley shaft 22, a spider 114 may be attached, as by bolts 115, to each side 32 of the upper housing at a position surrounding the periphery of a screen 116. As in FIG. 13, the upper pulley includes a hub 22 concentric with which ribs 118 extend outwardly to the pulley rim 119. A series of fan blades 120 are attached to the hub and rim and extend laterally therefrom, on each side, to a fan blade ring 121. As will be evident, the fan blades 120 rotate with the upper pulley 110, to suck air in through screens 116 around shaft 22 and hub 117, then discharge the air outwardly at each side of the rim 119. This air will flow around the interior of the upper housing, to pick up any particles which tend to fall back into the space between baffles 111 and 112 and the adjacent walls of the intermediate housing, and blow such particles into the discharge chamber D'. It will be noted that the discharge of air from the fan blades installed on and rotated by the upper pulley is radially outwardly from the periphery of the pulley and that a strong current of air will thus be blown into the discharge chamber from the area immediately above baffle 112, giving additional impetus to the material discharged from the buckets to fall through outlet 108.

The modified construction illustrated in FIG. 14 is adapted for use with a conveyor in which the buckets are mounted on a chain rather than a belt. Thus, the pulley 117, ribs 118, fan blades 120 and fan blade rings 121 are constructed and operate essentially as described above. However, instead of a rim, the pulley is provided with a sprocket 125 having teeth suitably conforming to the chain. As will be evident, the pulley fan of FIG. 14 operates in a manner similar to that described above, in order to prevent particles prematurely discharged by centrifugal force from falling back down the elevator housing.

From the foregoing, it will be evident that the objects and requirements hereinafter set forth are fulfilled to a marked degree. In each embodiment of the invention illustrated and described, the circulation of air through the upper housing in a direction toward the outlet picks up prematurely discharged particles or particulate matter, the trajectory of which would have been otherwise altered by air turbulence, and carries them to the outlet. In addition, a flow of air upwardly into the upper housing, either through the down leg and up leg or on opposite sides of a baffle, assures that a minimum of particles will fall downwardly in the casing. In each of the embodiments, a cyclone separator is shown, but bag filters or expansion chambers may be used to separate air from the discharged particles and return the particles to the elevated point to which they are to be conveyed. As will be evident, the principles of this invention may be applied to several different types of bucket elevators, while the air may be blown into a lower housing or into an upper housing in a desired direction, and the air may also be recirculated from the dust separator.

In addition, the upper pulley itself may be provided with fan blades to blow air into the upper housing.

Although several different embodiments of this invention have been illustrated and described, as well as certain variations thereof, it will be understood that other embodiments may exist and that other variations may be made, all without departing from the spirit and scope of this invention.

I claim:

1. A bucket elevator for handling relatively finely divided material, including:

   a series of buckets for receiving material at a lower position and discharging said material at an upper position while moving around an arcuate path;

   means for moving said buckets upwardly from said lower position to said upper position and downwardly from said upper position to said lower position;

   housing means enclosing said moving means and said buckets;

   means for receiving material discharged from said buckets; and

   means for producing a flow of air in the upper portion of said housing means and towards said receiving means at the position of movement of said buckets around said arcuate path, said flow of air being in the direction of movement of material leaving said buckets and directed so as to produce movement of such material into said receiving means.

2. A bucket elevator as defined in claim 1, including:

   means for separating material from air and connected to said receiving means.

3. A bucket elevator as defined in claim 2, including:

   blower means connected to said separating means.

4. A bucket elevator as defined in claim 3, including:
means for circulating air from said blower means to the lower portion of said housing means.

5. A bucket elevator as defined in claim 1, including:
a blower means having a discharge outlet connected to the lower portion of said housing means.

6. A bucket elevator as defined in claim 5, wherein:
said blower means discharge outlet is connected to opposite sides of said lower portion of said housing means.

7. A bucket elevator as defined in claim 1, including:
a blower means having a discharge outlet connected to said upper housing means.

8. A bucket elevator as defined in claim 7, wherein:
the upper end of the inside of said housing means is concave; and
said blower means discharge outlet includes means for directing said blower discharge generally tangentially toward said arcuate path of movement of said buckets.

9. A bucket elevator as defined in claim 7, wherein:
said blower means discharge outlet is connected to said housing means at a point below said arcuate path of said buckets and generally opposite said receiving means.

10. A bucket elevator as defined in claim 1, including:
blower means within the upper portion of said housing means.

11. A bucket elevator as defined in claim 10, wherein:
said moving means includes a rotatable pulley in the upper portion of said housing means and around which said buckets travel along said arcuate path; and
said blower means includes fan blades mounted on and rotating with said pulley.

12. A bucket elevator as defined in claim 1, wherein:
said means for moving said buckets includes a lower pulley at said material-receiving position and an upper pulley at said material discharge position and means extending around said pulleys and movable therewith, on which said buckets are mounted;
said housing means includes a lower housing enclosing said lower pulley, an upper housing enclosing said upper pulley and provided with an outlet opposite said upper pulley, and an up leg and a down leg connecting said upper and lower housings and through which said buckets are adapted to move upwardly and downwardly, respectively;
a feed device is connected to said lower housing for feeding material to said buckets as they move around said lower pulley;
a separator having an air valve outlet at its lower end for said material is connected by an inlet with said outlet of said upper housing;
a discharge chute extends downwardly from the lower edge of said upper housing outlet and forms a lower wall of said separator inlet; and
a blower for air is connected to said lower housing to force air into said lower housing and thence upwardly through said up leg and said down leg.

16. A bucket elevator as defined in claim 1, wherein:
said means for moving said buckets includes a lower pulley at said material-receiving position and an upper pulley at said material discharge position and means extending around said pulleys and movable therewith, on which said buckets are mounted;
said housing means includes a lower housing enclosing said lower pulley, an upper housing enclosing said upper pulley and provided with an outlet opposite said upper pulley and an up leg and a down leg connecting said upper and lower housings and through which said buckets are adapted to move upwardly and downwardly, respectively;
a feed device is connected to said lower housing for feeding material to said buckets as they move around said lower pulley;
a separator having an air valve outlet at its lower end for said material is connected by an inlet with said outlet of said upper housing;
a discharge chute extends downwardly from said outlet of said upper housing and forms a lower wall of said separator inlet;
a blower for discharging air is disposed adjacent said upper housing, said upper housing having a curved top;
an air manifold is connected to said blower discharge; and
at least one air-distributing pipe is connected between said manifold and said upper housing top for discharging air inside said upper housing in a direction toward said top and toward said outlet.

17. A bucket elevator as defined in claim 1, wherein:
said means for moving said buckets includes a lower pulley at said material-receiving position and an upper pulley at said material discharge position and means extending around said pulleys and movable therewith, on which said buckets are mounted;
said housing means includes a lower housing enclosing said lower pulley, an upper housing enclosing said upper pulley and provided with an outlet opposite said upper pulley, and an up leg and a down leg connecting said upper and lower housings and through which said buckets are adapted to move upwardly and downwardly, respectively;
a feed device having an air inlet is connected to said lower housing for feeding material to said buckets as they move around said lower pulley;
a separator having an air valve outlet at its lower end for said material is connected by an inlet with said outlet of said upper housing;
a discharge chute extends downwardly from said outlet of said upper housing and forms a lower wall of said separator inlet;
a blower for removing air is connected to the upper end of said separator; and
a blower for removing air is connected to the upper end of said separator; and
duct means conducts the discharge of said blower to opposite sides of said upper housing adjacent the upper end of said up leg.

18. A bucket elevator as defined in claim 1, wherein:
said means for moving said buckets includes a lower pulley at said material-receiving position and an upper pulley at said material discharge position and means extending around said pulleys and movable therewith, on which said buckets are mounted;
said housing means includes a lower housing enclosing said lower pulley, an upper housing enclosing said upper pulley and provided with an outlet opposite said upper pulley, and an up leg and a down leg connecting said upper and lower housings and through which said buckets are adapted to move upwardly and downwardly, respectively;
a feed device is connected to said lower housing for feeding material to said buckets as they move around said lower pulley;
a separator having an air valve outlet at its lower end for said material is connected by an inlet with said outlet of said upper housing;
a discharge chute extends downwardly from the lower edge of said upper housing outlet and forms a lower wall of said separator inlet;
a blower for air is mounted on said housing and is driven by a shaft for said upper pulley; and
a discharge duct extends from said blower to an arcuate top of said housing opposite said outlet for directing air into the upper portion of said upper housing and toward said outlet.

19. A bucket elevator as defined in claim 1, wherein:
said means for moving said buckets includes a lower pulley at said material-receiving position and an upper pulley at said material discharge position and means extending around said pulleys and movable therewith, on which said buckets are mounted;
said housing means includes a lower housing enclosing said lower pulley, an upper housing enclosing said upper pulley and provided with an outlet opposite said upper pulley, an intermediate housing connecting said upper and lower housings and through which said buckets are adapted to move upwardly and downwardly, and baffle means in said intermediate housing separating the upward and downward reaches of said buckets and bucket-moving means;
a feed device is connected to said lower housing for feeding material to said buckets as they move around said lower pulley;
a discharge chamber is connected to said upper housing outlet, said discharge chamber having an upper outlet and a lower outlet;
a separator having an air valve outlet at its lower end for said material and is connected by an inlet duct with the upper outlet of said discharge chamber;
a closed screw conveyor is connected at one end to said lower outlet of said discharge chamber and at an inter-

mediate position to said air valve outlet of said separator, said conveyor having an outlet at the opposite end;
a blower for removing air is connected to the upper end of said separator; and
an air recirculating duct extends from said blower to said lower housing, for directing air discharged from said blower into said lower housing.

20. A bucket elevator as defined in claim 1, wherein:
said means for moving said buckets includes a lower pulley at said material-receiving position and an upper pulley at said material discharge position and bucket moving means extending around said pulleys and movable therewith, on which said buckets are mounted;
said housing means includes a lower housing enclosing said lower pulley, an upper housing enclosing said upper pulley and provided with an outlet opposite said upper pulley, and an intermediate housing connecting said upper and lower housings and through which said buckets are adapted to move upwardly and downwardly, respectively;
a feed device is connected to said lower housing for feeding material to said buckets as they move around said lower pulley;
a pair of transverse baffles are disposed in said intermediate housing adjacent the upward and downward reaches, respectively, of said bucket moving means;
an upwardly concave baffle connects the upper ends of said transverse baffles immediately below said upper pulley;
said upper pulley includes a hub, ribs extending from said hub to a rim for engaging said bucket moving means, an annular plate at each side and fan blades extending transversely between said hub, said rim and said plates; and
said upper housing has sides, each provided with an air intake for said fan blades.

21. A method of increasing the capacity of a bucket elevator handling divided material and having a series of buckets moved within a housing having an upper outlet between a lower material-receiving position and an upper discharge position adjacent said outlet, said buckets moving in an arcuate path at said upper position and thereby discharging material at least in part through centrifugal force, which comprises:
producing a flow of air at and adjacent said arcuate path in the same direction as the movement of said buckets and toward said outlet, sufficient to produce movement of material leaving said buckets and directed so as to produce movement of such material into said outlet.

22. A method as defined in claim 21, which includes:
producing said flow of air by suction at said outlet; and
separating particles of said material from said air after passage through said outlet.

23. A method as defined in claim 22, which includes:
recirculating air, after said separation, to said housing, adjacent said arcuate path.

24. A method as defined in claim 22, which includes:
recirculating air, after said separation, to the lower portion of said housing adjacent said receiving position.