THESIS

CONTINUOUS CONVEYORS FOR HANDLING MATERIALS

FOR DEGREE OF M. E.

C. C. FORD

1912

THESIS

Conveying machinery

C O N T I N U O U S C O N V E Y O R S

-FOR-

H A N D L I N G M A T E R I A L S.

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NINETEEN HUNDRED TWELVE.

CLEM C. FORD.

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THESIS

Continuous Conveyors for Handling Materials.

The manufacture of conveying machinery in this country and its development to meet the demands of possible applications began about 1880. The first steps taken in response to requests for such machinery was by manufacturers of the detachable link belt and was due to requests for a chain with attachments to which pans, flights, etc., could be fastened.

There is very little published information regarding elevating and conveying machinery aside from the meager accounts of its use and adaptability, in specific instances, given in the trade journals as advertising matter by the various manufacturers. And as far as the writer has been able to learn, there are no text books devoted to this subject, nor any schools in which definite instruction regarding it is given, although it is playing a very important role in the present tendency toward "conservation of energy", "labor saving appliances", etc.

Really reliable data as to economies effected by the use of continuous conveyors is lacking even among their manufacturers, however, there is no doubt that the managers of many concerns have been able to show their directors where savings have been made by their use. But they are careful not to make such information public for competitors to profit by their ideas and the expense of testing them out.

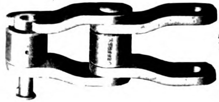
Especially have the large manufacturing plants, together with large producers of raw or finished products, found the use of continuous conveyors to be most profitable. Further, it would be practically impossible to manufacture many products on a commercial scale were it not possible to handle same during the process of manufacture with continuous conveyors. There is practically no material used in quantities sufficient to insure the installation of conveying machinery to which it is not adaptable. Even small factories or institutions which handle a given article in quantities find various uses for conveyors.

Chains.

A short history or description of the chains used in the development of elevating and conveying machinery will be of interest in leading up to the various styles of conveyors in use as well as their adaptation to specific machines.

The detachable chain (Fig. 1) was the first to be invented and developed. As stated above this was about 1880. This chain is still very popular for light, simple elevators

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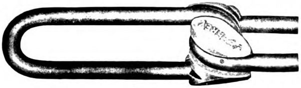
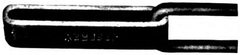
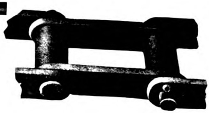
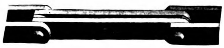


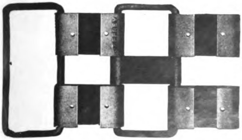
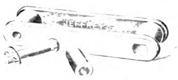
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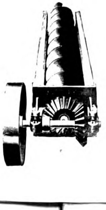
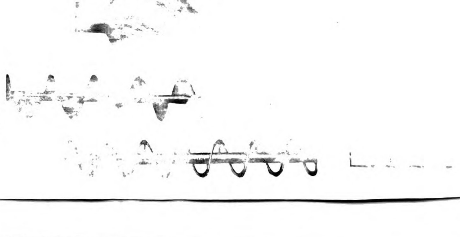

and conveyors.

Two or three years later a chain with solid ends and steel pins was developed (Fig. 2).

About the same time a roller chain was patented. Of this type there are now three styles in use, the malleable roller chain, the steel thimble roller chain, and the steel roller chain (Figs. 3 and 4).

The Malleable Roller Chain has malleable iron side bars made in two pieces, with a projection at one end, on which the roller fits. The bars are held together with a steel rivet pin.

The Steel Thimble Roller Chain is made of steel side bars. It has casehardened bushings or thimbles over the pins on which the rollers fit. The thimble is pressed into the two inside bars and locked so it can not turn. The pins are locked in the two outer bars. The articulation takes place between the pin and thimble where there is a large wearing surface, thus making a very durable chain.

The Steel Roller Chain is of the same general construction as the steel thimble roller chain, except it is not provided with thimbles and the pin is not locked in the side bars. The articulation is between the links and the pins on a comparatively small surface. The pin being free to turn allowsit to take the wear around its entire circum-

ference.

The rollers on these chains reduce the wear on the sprockets very materially. They also reduce the friction on the conveyor runways, especially in conveyors which carry their load, thus prolonging the life of an equipment as well as reducing the amount of power necessary for driving the conveyor.

The short pitch steel thimble roller chains are used for transmitting power.

The drag or sawdust chain (Fig. 5) is allowed to run in the bottom of a trough thus acting as a conveyor by itself. The chain is covered with the material handled, moving it along bodily, often of a depth up to a point where the friction on the sides of the trough is so great that the chain drags thru the material instead of moving it along. These chains are made of malleable iron or forged steel bars. They are also made with projections from the side bars to increase the width of the chain, thus giving them greater carrying capacity. These chains are used for handling sawdust, sand, ashes, etc.

The transfer chain (Fig. 6) is used in two or more strands side by side for handling lumber, boxes, etc. The chains slide on runways and are spaced the proper distance apart so that the articles handled can extend across them.

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For conveyors of long span the coil chain (Fig. 7) is often used. It is forged from round stock and drawn to pitch so that the links will fit the teeth in the driving sprockets. Malleable iron blocks are inserted at the articulation points to give a large wearing surface for the links, also to take the wear from the sprocket teeth. When attachments are required they are cast integral with these blocks. This chain is adaptable to conveyors which make either horizontal or vertical turns or both.

The flat and round link chain (Fig. 8) is adaptable to conveyors for which the flights, buckets, spurs, etc., are bolted directly to the links. An ordinary blacksmith can forge links for repairs in case of emergency.

The steel or bronze bushed chain (Fig. 9) is used where gritty material is to be handled. The articulation takes place between the pin and the bushing. These parts can be quickly replaced at little expense when necessary.

The combination steel and malleable chain (Fig. 10) is a great favorite for elevators and conveyors of medium size. It is easily assembled and dismantled. The pins are locked in the steel links, thus giving a large surface between the head of the malleable link and pin, for wear due to articulation. With this chain it is also possible to use traction wheels at heads of elevators. These cause less wear than sprockets. Attachments are cast integral with the malleable links.

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The steel link chain (Fig. 11) is of simple construction and inexpensive. It is often used for light scraper conveyors by forging a bar so it will extend across between the strands of chain and also form the inner bars of the two chains. Steel scrapers are then bolted to these cross bars. Hard iron wearing blocks are spaced at intervals on the chain to take the wear due to the friction on the runways.

The Patnoe chain (Fig. 12) is used for heavy continuous bucket elevators for handling stone, gravel, etc. The buckets are bolted, with their backs flat against the chain without the use of attachments.

The forged steel chain (Fig. 13) is made with the inner links of drop forgings and the outer links of steel bars. The pin is of large diameter with a flat extension milled on each end for locking it in the outer bars. The head of the inner link furnishes a large wearing surface for the pin to take wear due to articulation. The pins and forged links are casehardened. This chain is especially adapted to heavy work.

Ch. 7.

Continuous Conveyors for Handling Materials.

Conveyors.

Continuous conveyors may be divided into two classes:- namely,

1. Those which push or pull the load, and

2. Those which actually carry the load.

The style of conveyor to be used in a given case is usually determined by the physical properties of the material to be handled. The amount of material to be conveyed, together with the local conditions under which it is to be handled must also be given consideration. Such consideration will suggest the many different possible arrangements of conveyors to suit the various conditions under which they must be operated.

Conveyors which Push their Loads-Class #1.

Of the conveyors which push or pull their load, the spiral conveyor (Figs.14 and15) is no doubt the most widely used. It is made up of spiral steel plates mounted on a hollow shaft of 10'-0" to 12'-0" in length. The sections of conveyor are coupled together with pieces of shafting which extend into the hollow shafts and are bolted in place- with a space between the ends of the conveyor for a bearing on the coupling shaft. The bearings are carried by hangers from the top of the conveyor trough. These conveyors are very compact and are especially suitable where available space is very limited. They are not usually used for lengths over 100'-0" or 125'-0", due to the tortional strain on the

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hollow shafts.

For certain materials some engineers prefer to have the conveyors lie on the bottom of the trough and do away with the hangers. The writer has recently constructed a conveyor of this type 16" in diameter on 4" extra heavy pipe 175'-0" long for handling soda powder. This particular conveyor required 6 H. P. to operate empty, as measured in current consumed by a motor. This, however, was with a very thin coat of heavy grease on the trough bottom.

Spiral conveyors are usually allowed to carry material of a depth equal to 1/3 the diameter of the spiral and are driven at 60 to 80 r.p.m. For light unabrasive material, however, such as grain, seeds, etc., they are often speeded up to 100 or 125 r.p.m. The friction of the material in the trough and on the conveyor or flights causes rapid wear and consumes a great deal of power, hence it is preferable to operate at the lower speeds. These conveyors are made by manufacturers in all sizes from 4" to 18" diameter with the pitch of the flights equal to the diameter of the conveyor.

For handling sand, ashes or other gritty materials, the flights are often made of cast iron and mounted on a solid shaft. The cast iron flights will wear better than the steel flights. However, the iron flights are so heavy for the size shaft it is possible to use, that these conveyors do not always give perfect satisfaction. Consequently, a heavy steel flight is usually more preferable than the cast

FIG 18A

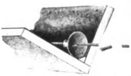

FIG 18

FIG 22

FIG 19

FIG 20

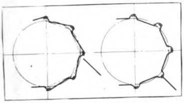

FIG 23A

FIG 23

FIG 21

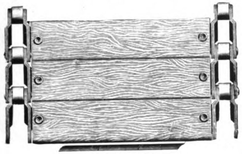

FIG 27

FIG 25

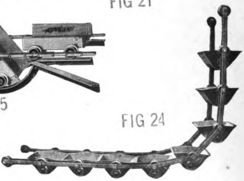

FIG 24

FIG 26

FIG 28

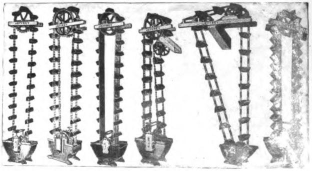

FIG 29

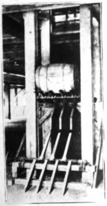

FIG 32

FIG 31

FIG 30

bolted together about the cable at regular intervals to match the spacing of the gaps in the sheaves used for driving the conveyor. The cable is driven by the end of the flight engaging against the face of the gaps in the sheave and not due to friction between the rope and sheave as in the case of a transmission rope drive (Fig. 18a). Sheaves are made with adjustable rims so that as the cable wears and stretches, the pitch diameter of the sheaves may be increased to keep the distance face to face of gaps equal to the distance face to face of clamps and flights. Flexible teeth are also provided to reduce the wear on the clamps and to prevent the cable running with a jerky motion. In good practice the pitch diameter of the sheaves should not be less than sixty diameters of the rope. The two strands of conveyor may be made to operate one above the other or side by side in a horizontal plane as the available space and local conditions may require. The cable is suitable for conveyors which turn in either vertical or horizontal planes. It is adaptable to retarding conveyors for bringing coal, etc. down mountain sides and is also used on long car hauls and conveyors for handling lumber, pulpwood, etc. The cables used for this purpose are so woven as not to twist or rotate when used in a conveyor. Those used in best practice are woven about a steel center, although ropes with a hemp center are often used. With ropes on hemp centers it is difficult to hold the flights and clamps in place due to the fact that the rope will crush out of shape, thus making it difficult

to maintain the proper bearing surface between the clamp and the rope. The weak point in a cable conveyor is usually due to the fact that the cables have a tendency to crack and break at the ends of the clamps due to the continuous bending about this point as the cable turns about the head and foot wheels.

Log conveyors (Fig. 19) are made up of a strand of chain with steel spurs running in timber guides. The spurs are arranged at intervals with a spacing somewhat greater than the length of the logs to be handled. The logs are rolled into the guides on top of the chain and are thus pulled along lengthwise by the spurs.

Refuse conveyors (Fig. 20) used for handling the refuse from saw mills or woodworking machinery, are of the same general construction as the log haul except that the wood flights are used instead of steel spurs and are spaced much closer together, usually 2'-0" to 4'-0" centers.

Trolley conveyors are made up of a single strand of rope or chain which is carried by roller attachments on one runway and provided with a finger or projecting attachment extending over an adjacent runway on which is a trolley with a sling or hook for carrying the material to be handled. As the conveyor moves along, the projecting finger engages the trolley and pushes it along on its runway. These conveyors are used extensively in packing houses for handling carcasses of dressed meats. They are also used for handling large cans of milk, packages, bundles, etc.

Conveyors Which Carry Their Load-Class #2.

Of this class the belt conveyor is probably the oldest and most commonly used. Fig. 21 will give an idea of how the conveyor is arranged and how troughing idlers are made. The conveyor consists simply of a heavy belt driven over pulleys on head and foot shaft and supported between pulleys by troughing idlers. When handling light material the belt is often carried in a flat bottom trough. Conveyors are made with belts from 16" to 48" in width and up to 1000'-0" in length, that is, center of head shaft to center of foot shaft. Experience has shown that it is a very difficult matter to train a belt less than 16" in width so that it will run straight and smooth, consequently, manufacturers do not generally recommend using a belt less than 16" wide. The belts used are either of heavy canvas closely stitched or of canvas ducking with a rubber binder and rubber cover to protect the canvas from wear and moisture. The rubber covering varies from 1/16" to 1/4" in thickness. For handling hot material there is a closely stitched canvas belt on the market which is guaranteed to handle material up to a temperature of 350 degrees Fahrenheit. For handling materials which tend to stick to the belt, a small revolving brush is placed just under the discharge pulley and driven from its shaft so as to rotate in the opposite direction of the travel of the belt. The brush shaft is carried in adjustable bearings so as to make it possible to shift the brush in order to keep it in contact with the belt.

The limiting angle for inclined conveyors is about 20 degrees, however, conveyors handling wet sand have been installed with an incline of 30 degrees.

For handling small packages, paper boxes, etc., a flat belt is used with supporting idlers of 2" and 3" dia. rollers mounted with ball bearings and spaced from one to three feet apart.

For handling bulky material such as coal, ore, etc., troughing idlers are used. These are made with inclined pulleys to hold the edges of the belt above the center and causing it to assume a troughed shape. This gives it a greater carrying capacity than in the case of a flat belt and also prevents material spilling off along the conveyor. The first troughing idlers used were made in one solid piece either of wood or iron and of greater diameter at the ends than at the middle of the rollers. Thus the peripheral travel of the ends of the rollers was greater than that of the middle portion and consequently wore the belts very rapidly. This style was later replaced with an idler made with horizontal pulleys in the middle and inclined pulleys at either end of the horizontal pulleys mounted on independent shafts so that each could revolve independently of the other. The most up-to-date idlers are of this type with ball bearings for the pulleys. Troughing idlers should be spaced as follows, depending upon the weight of material to be handled:- for 16" belts- 4½ ft. to 5 ft. apart and 18" to 22" belts and over- 3 ft. to 3½ ft. apart. The return belt is carried on straight face idlers spaced 10 ft. to 12 ft. apart.

The lubrication of idlers is a very important item especially when a rubber belt is used, as oil or grease causes the rubber to deteriorate very rapidly. Oil should not be used as it will run down over the bearings, shaft, etc., cause dirt and dust to collect, and produce excessive wear. It is also apt to run out over the pulleys when they are standing still, coat the pulley face and thus finally cover the belt. Grease is much more preferable and when applied near the middle of the bearing or pulley hub thru a hollow shaft it will work out towards the ends of the bearings and carry out any dirt or dust which may get into them. It will also collect in a ring on the shaft at the end of the bearing and form a very efficient dust collar.

Endless belts are often used, however, steel lacings have been found to give good satisfaction for connecting the ends of the belts and are more commonly used.

For long wide belt conveyors it is often found necessary to use a snubbing pulley to get a large arc of contact on the driving pulley. It may also be found necessary

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to use rubber covered pulleys to increase the friction of belt on pulley to secure the necessary tractive power. Pulleys should always be crown faced and two inches wider than the belt. Diameter of driving pulley should be not less than five inches per ply of belt used. Diameter of tail pulley, four inches per ply of belt used. For very long conveyors it may be found necessary to insert intermediate driving pulleys. A belt travel of 200 ft. per minute is considered good practice; however, speeds up to 500 ft. travel per minute are often used. A good quality belt properly installed for rough work, such as handling coal in a coaling station, should give about three year's satisfactory service.

The simplest form of belt conveyor discharges its load over the head pulley. However, when handling material in bulk, it is possible to discharge at any point along the conveyor by use of a tripper. It is also possible to arrange a series of fixed discharge points by arranging pulleys similar to those in a tripper.

Trippers are made to be either hand propelled or power driven. The power is obtained from the belt itself in such a way as to cause the tripper to operate automatically back and forth over the entire length of the conveyor or over any portion of it.

The formula on the attached blue prints will give the approximate amount of horse power necessary to drive a belt conveyor under ordinary conditions when properly installed. They also show the capacities of different width belts in different styles of troughing idlers in tons per hour.

BELT CONVEYOR DATA.

Formulae for computing Horse Power required to drive B

L = Length of Conveyor between centers in feet.

T = Load in Tons per Hour. Use Maximum capacity of Be chosen, unless conditions are such as to guarantee smaller capacity will not be exceeded.

S = Speed of Belt in Feet per Minute.

H = Vertical Height in Feet that material is lifted.

C = Power Constant varying with the width of belt. Se

Under ordinary conditions:-

For Horizontal Conveyors:- $H.P. = \frac{(CS + 2.33T)L}{33000}$

For Inclined Conveyors:- $HP = \frac{(CS + 2.33T)L}{33000} + \frac{T}{99}$

For Conveyors under 50 feet in length add 20% to Horse Power above.

For conveyors over 50 feet and under 100 feet in length ad

For conveyors over 100 feet and under 150 feet in length ad

For each fixed or movable tripper add the Horse Pow the following table:-

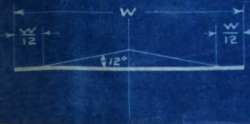
Width of Belt	C Power Constant	HP for Each Tripper	Width of Belt	C. Power Constant	HP for Each Tripper	Width of Belt	C Power
10"	.55	$\frac{3}{4}$	24"	2.00	$1\frac{1}{2}$	38"	3.
12"	.65	$\frac{3}{4}$	26"	2.15	2	40"	3.
14"	.75	1	28"	2.30	2	42"	4.
16"	1.05	1	30"	2.45	2	44"	4.
18"	1.35	$1\frac{1}{2}$	32"	3.15	2	46"	4.
20"	1.70	$1\frac{1}{2}$	34"	3.35	2	48"	4.
22"	1.85	$1\frac{1}{2}$	36"	3.55	2		

To the Horse Power at the Head Shaft as obtained above, there s added an additional 5% for each reduction through Chain or Cut Gears and 10% for each reduction through Rough

Conclusions

CAPACITIES OF FLAT BELT CONVEYO

WIDTH OF BELT	CROSS SECTION OF LOAD SQ. FT.	CU. FT. PER HR. AT 100 F.P.M.	CU. YDS. PER HR. AT 100 F.P.M.	BU. PER HR. AT 100 F.P.M.	TONS PER HR. AT 10		
					WT. OF MATERIAL IN LB		
					25	50	75
10"	.025	150.	5.5	121.	1.9	3.8	5.7
12"	.036	216.	8.	174.	2.7	5.4	8.1
14"	.049	294.	10.9	236.	3.7	7.4	11.1
16"	.064	384.	14.2	309.	4.8	9.6	14.4
18"	.081	486.	18.	391.	6.1	12.2	18.3
20"	.100	600.	22.2	482.	7.5	15.	22.5
22"	.121	726.	26.9	584.	9.1	18.2	27.3
24"	.144	864.	32.	694.	10.8	21.6	32.4
26"	.169	1014.	37.5	815.	12.7	25.4	38.1
28"	.196	1176.	43.5	945.	14.7	29.4	44.1
30"	.225	1350.	50.	1085.	16.9	33.8	50.7
32"	.256	1536.	56.9	1235.	19.2	38.4	57.6
34"	.289	1734.	64.3	1393.	21.7	43.4	65.1
36"	.324	1944.	72.	1562.	24.3	48.6	72.9
38"	.361	2166.	80.2	1741.	27.1	54.2	81.3
40"	.400	2400.	89.	1928.	30.	60.	90.
42"	.441	2646.	98.	2126.	33.1	66.2	99.3
44"	.484	2904.	107.5	2334.	36.3	72.6	108.9
46"	.529	3174.	117.5	2551.	39.7	79.4	119.1
48"	.576	3456.	128	2777.	43.2	86.4	129.6



ABOVE TABLE BASED ON CROSS

FORMULA:- CU. FT. PER HR. AT

WHERE W = WIDTH OF BELT

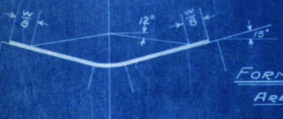
S-15

...aded flight (Fig. 36) is used because of the fact that

CAPACITIES OF BELT CONVEYORS
WITH TWO PULLEY TROUGHING IDLER

WIDTH OF BELT	CROSS SECTION OF LOAD IN SQ. FT.	CU. FT. PER HR. AT 100 F.P.M.	CU. YDS. PER HR. AT 100 F.P.M.	BU. PER HR. AT 100 F.P.M.	TONS PER HR. AT 10		
					WT. OF MATERIAL		
					25	50	75
10"	.042	250.	9.3	201.	3.13	6.3	9.4
12"	.060	360.	13.3	289.	4.5	9.0	13.5
14"	.082	490.	18.1	394.	6.1	12.2	18.3
16"	.107	640.	23.7	514.	8.0	16.0	24.0
18"	.135	810.	30.0	651.	10.1	20.2	30.3
20"	.167	1000.	37.0	804.	12.5	25.0	37.5
22"	.202	1210.	44.8	972.	15.2	30.4	45.6
24"	.240	1440.	53.3	1157.	18.0	36.0	54.0

ABOVE TABLE BASED ON FOLLOWING CROSS SEC



W = WIDTH OF BE

FORMULAE

AREA OF CROSS-SECTION OF LO

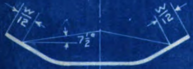
CU. FT. PER HR. AT 100 F.P.

S-15

Capacities of Belt Conveyors.
With Three Pulley Troughing Idle

Width of Belt.	Cross Section of Load in Sq. Ft.	Cu. Ft. per Hr. at 100 F.P.M.	Cu. Yds. per Hr. at 100 F.P.M.	Bu. per Hr. at 100 F.P.M.	Tons per Hr.		
					Wt. of Materia		
					25	50	7
10"	.058	350.	12.9	281.	4.4	8.8	
12"	.084	504.	18.7	405.	6.3	12.6	
14"	.114	686.	25.4	551.	8.6	17.2	
16"	.149	896.	33.2	720.	11.2	22.4	3
18"	.189	1134.	42.0	911.	14.2	28.4	4
20"	.233	1400.	51.9	1125.	17.5	35.	5
22"	.282	1694.	62.7	1361.	21.2	42.4	6
24"	.336	2016.	74.7	1620.	25.2	50.4	7
26"	.394	2366.	87.6	1901.	29.6	59.2	8
28"	.457	2744.	101.6	2205.	34.3	68.6	10
30"	.525	3150.	116.7	2531.	39.4	78.8	11
32"	.597	3584.	132.7	2880.	44.8	89.6	13
34"	.674	4046.	150.	3251.	50.6	101.2	15
36"	.756	4536.	168.	3645.	56.7	113.4	17
38"	.842	5054.	187.	4061.	63.2	126.4	18
40"	.933	5600.	208.	4500.	70.0	140.0	2
42"	1.029	6174.	229.	4961.	77.2	154.4	23
44"	1.129	6776.	251.	5445.	84.7	169.4	25
46"	1.234	7406.	274.	5951.	92.6	185.2	27
48"	1.344	8064.	299.	6480.	100.8	201.6	30

Above Table Based on Following Cross-S



Formulae:—

Area of Cross-Section in Sq

Cu. Ft. per Hr. at 100 F.P.M.

Where W = Width of Be

S-15

Continuous Conveyors for Handling Materials.

Curved Flight Conveyors (Fig. 22).

Double beaded flight conveyors are used for picking tables in coal tipples, feeders, etc., where a continuous apron conveyor is required for materials in bulk. They are made up on roller chains and vary from 12" to 6'-0" or 7'-0" in width. Steel ends are provided to extend up at right angles with the flights, thus making the completed conveyor in the shape of a rectangular trough. These ends are made up to 12" in height. When used as feeders, stationary skirt boards 18" to 24" in height are arranged inside the ends, thus making it possible to handle material of this depth full width of the conveyor. The conveyor is then run very slowly to obtain the desired capacity. When used as feeders they are driven at 20' to 30' per minute. When used as ordinary conveyors they are driven at 60' to 100' per minute. The shape of the flights gives them stiffness for ordinary spans, but for the wider conveyors they are reinforced with an angle iron placed on the under side and running the full length of the flight. When the conveyor is on an incline such that the material has a tendency to slide back down same, angles are riveted on top of the flights with an upstanding leg. These act as lifting blades and hold the material from rolling back.

When handling material the breakage of which is an important item, such as lump bitumionous coal, the single beaded flight (Fig. 23) is used because of the fact that the delivery spout can be raised higher than with the double beaded flights and the coal does not drop as great a distance when discharging from the conveyor; consequently, there is not as much breakage at this point as with the double beaded flights.

Figure 23a shows relative height of discharge chute for single beaded and double beaded flights.

Pivoted Bucket Conveyors (Fig. 24).

The pivoted bucket type of conveyor is used in boiler houses, cement mills, coal storage plants, etc., where a conveyor is required to elevate, convey to storage, and reclaim to storage or where a runaround conveyor can be arranged, to do the work of two conveyors. For instance, in a boiler house the pivoted bucket will elevate coal from a railway track hopper to an overhead bunker from which the coal is delivered directly to furnace hopper, through valves and chutes, as required. The same conveyor will also reclaim the ashes from a pit under the boiler room floor and deliver them to a storage tank outside of the building from which they can be delivered to cars or wagons through valves and chutes.

Thereare two styles of pivoted buckets. They are known as the "contact lip bucket" and the "overlapping lip bucket". In the former the edge of the buckets barely butt together when assembled in the chain and loaders are required for delivering material to them. The loaders are

placed directly over the conveyor on a horizontal run and attached to the bottom side of a bin. They are so constructed that as each bucket comes centrally under them a given amount of material is dropped directly into the bucket. The loaders are operated automatically by the conveyor through a set of levers which project down so as to engage the chain rollers. This type can be reversed and operated in either direction.

The overlapping pivoted buckets are made with a projecting lip so that one end of one bucket overhangs the end of the next bucket when assembled in the chain. Instead of the loaders, skirt boards are provided at the loading points. These consist of steel plates arranged just above and at each side of the conveyor, on a bevel, with the lower edge overhanging the buckets. These form a hoppered trough full length of the loading portion of the conveyor. The material is delivered to the conveyor in a steady flow thru chutes arranged at the loading points. Material can also be shoveled or scraped directly into the conveyor at any point along the loading section. This type of bucket can be operated in only one direction. Lap changing devices are also necessary to keep the buckets lapped in such a way that they will turn the corner wheels when loaded without tipping and spilling their loads.

Either the "contact lip" or "overlapping lip" bucket can be discharged at any point desired along the horizontal run. This is accomplished by a tripping cam which engages

rollers or projections at the ends of the buckets and tilts them sufficiently to allow the material to run out. The tripper is carried by rollers on a runway, extending the full length of the bin or hopper into which the material is to be delivered, and is operated by an endless rope over a drum located at one end of the conveyor either automatically or by hand so that an even distribution of material may be had in the bins.

These conveyors operate at a speed of about 50 ft. per minute. The buckets are made of malleable iron and mounted in either 18" or 24" pitch steel thimble roller chains.

Drop Pan Conveyors.

The drop pan conveyor (Fig. 25) is used for delivering rock, cement clinker, etc., to furnaces where a practically continuous feed is desired to more than one furnace at a time. These are made up of steel pans in sets, the number of pans in a set corresponding to the number of furnaces to be fed. The front ends of the pans are carried by axles extending from chain to chain, with a roller at each end of the axle, the axle being arranged to pivot in the chain. The rear end of the pan is also carried by an axle and rollers. The axle, however, does not connect in the chains and the rollers are at a different gage than the front rollers, each pan in a set has rear rollers of a different gage than the other pans. There is also a separate runway for each set of rear rollers. The discharge is effected by a curved drop in the runway for rear rollers at the discharge point for that particular pan. As the pan passes this point the rear end drops down and the material slides out. Pan #1 of a set will discharge at the first furnace; pan #2 will discharge at the second furnace; pan #3 will discharge at the third furnace; and so on, thus making a constant intermittent feed at such short intervals of time as to be practically continuous at each furnace.

Cast Iron Pan Conveyors.

Cast iron pan conveyors (Fig. 26) are made very shallow, not over 3" to 4" in depth, for handling hot ashes and clinkers. When the material handled has a temperature equal to a red heat the pans are made in halves and bolted together to prevent their breaking due to expansion and contraction. These conveyors can only discharge over the end.

Wood Apron Conveyors.

Wood apron conveyors (Fig. 27) are used for handling boxes, barrels, bundles, etc. They are made up of a double strand of chain with wood flights bolted to them so as to form practically a continuous apron.

For short conveyors, or for handling light material, such as in cooling tanks in canning factories, a flat and round link chain is often used. With this chain the ends

of the boards are notched out and fitted into the flat links. This makes a very simple and inexpensive construction.

A more durable construction, however, consists of a roller chain with attachments on one side only so as to hold the chain outside of the flights. This leaves the chain in the clear to be carried by its rollers on runways for both carrying and return strand. This construction with heavy chains and flights is used for freight ramps, heavy packages, etc.

Steel Pan Conveyors.

Steel pan conveyors (Fig. 28) are used for handling crushed rock, gravel, ores, etc. The pans are made of steel, often wood lined, and suspended between two strands of chains by being bolted rigidly to the chain bars. The lips of the pans are curved and overlap each other. The best construction for this type of conveyor is with thru rods in place of the regular chain pins and with each end of the rod drilled and fitted with grease cups so as to force the grease out into the roller at about the middle of the hub. Material can be discharged only as the pans turn the head wheel to take the return strand.

Continuous Conveyors for Handling Materials.

Elevators.

(See Fig. 29-the following lettering arranged for elevators reading left to right).

A- Single strand Chain Centrifugal Discharge.

B- Double " " " "

C- Belt Elevator " "

D- Deflecting Wheel - Perfect Discharge.

E- Knuckle Wheel " "

F- Continuous Type Bucket " " and Centrifugal Discharge.

Continuous elevators may be equipped with different styles of buckets. The most common and widely used is what is known as the "Standard Steel Bucket". These are pressed and folded into shape from steel plates, of various thickness for each size of bucket to suit the weight and nature of material to be handled.

For handling materials which wear on the equipment rapidly, malleable iron buckets are used. They are made in practically the same sizes and shapes as the steel buckets. For handling sticky material, such as sugar, damp clay, fine wet ore, etc., the malleable iron "shelf bucket" is used. This is made with the back and bottom at right angles with each other, so as not to allow any"pockets" for the material to cling to.

Centrifugal Discharge Elevators.

Centrifugal elevators are usually made up with a

chain or belt attached on the back of either "standard steel" or malleable iron buckets and are driven at such speed that as the buckets turn over the head wheels the material is thrown out into a discharge chute. The following table gives the chain travel and r. p. m. of head shaft for various diameters of head wheels, as determined by careful tests, to give a clear discharge from the buckets. These speeds may be varied by 8% or 9% and still obtain fair results.

Dia. of head wheel	15"	18"	21"	24"	27"	30"	33"	36"	40"	48"
Rev. per min.	42	40	38	37	36	35	34	34	33	32
Speed in ft. per min.	165	188	209	232	254	274	294	320	345	402

Deflecting Wheel Elevator.

This type of elevator is made up of two strands of chain, one attached at each end of either steel or malleable iron buckets. The deflecting wheels are placed just below and under the head wheels, and deflect the chain back on the down strand so that as the buckets turn the head they will overhang the end of a delivery chute. In good practice these elevators are constructed with head wheels 24" to 36" dia., and with the buckets traveling at a speed of about 175 ft. per minute.

Knuckle Wheel Elevator.

Knuckle wheel elevators are made up with chains and buckets assembled the same as for deflecting wheel elevators. They are driven at slow speed, 50' to 100' travel per minute, and the buckets discharge their loads into a chute located between the two upper wheels. These upper wheels are raised one higher than the other, so that as the buckets pass the discharge chute they are traveling down an incline, thus bringing the buckets as near bottom side up as possible at the delivery point. This type of elevator is serviceable in handling very wet sand, gravel, and other substances which have a tendency to cling to the buckets. When handling sticky material a water pipe is often arranged just above the chute and extending across under the buckets, so as to throw a spray into the bucket while over the chute, to wash the material out and keep the buckets clean. The spray also keeps the chain clean and reduces the wear caused by sand and grit at the points of oscillation.

Continuous Type Bucket Elevator.

The continuous type bucket is made to have a chain or belt attached on its back with only a small clearance between the bottom of one bucket and the top of the next bucket. With these buckets material can be fed to the elevator along the up-going strand with very little spilling. When run at slow speed, as the buckets turn the head wheel, the material is discharged upon the back of the next preceding bucket, and to prevent the material from spilling over the ends of the buckets and falling back down the elevator, their ends are made to extend about 2" below the bottom so that as they turn over the head the bottom of each bucket forms a trough for the material of each succeeding bucket to flow directly into the discharge chute. With the above style of bucket the elevator may be driven at a speed of 100 ft. to 140 ft. per minute.

Continuous buckets without the flanged bottom are also used, but in these cases the elevators must be driven fast enough to obtain a centrifugal discharge, in order to insure a clean delivery.

V Bucket Elevator and Conveyor (Fig. 30).

This style of elevator is made up of two strands of chains, one bolted on each end of a V shaped bucket. For light run-around systems this makes a very simple construction. The buckets scrape the material along on the horizontal runs, and with a curved trough at the corners, they can scoop the material up and carry it on the vertical strand, drop back into a trough on the upper horizontal run and scrape along to the discharge points. They are used mostly for handling small coal.

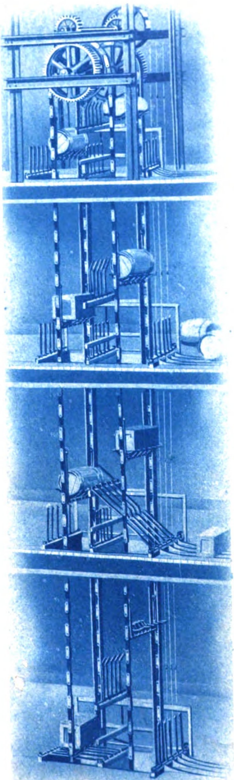
Barrel Elevators.

Barrel elevators (Fig. 31) are made up of curved arms braced by heel links and extending out at right angles from two strands of chain. Both arms and heel links are fastened to chain attachments and to each other by pin connections to allow them to turn the head and foot wheels. Barrels or packages are picked up from loading fingers which project out from the loading platform, and are discharged over the head on to unloading fingers. For handling sacks of flour, grain, or any material which does not pack closely so as to make a firm, solid package, it is necessary to use arms of special shape and with a wide face to keep the sack from sagging down between the arms and catching on the sprocket teeth as they turn over the head, or wedging between the tray fingers and loading fingers, as they are picked up, in such a way as to break or tear the sack.

Tray Elevators.

Tray elevators (Fig. 32 and Drg. 4543-C) are used for handling packages from one floor of a building to any other floor. The package is picked up on the up going strand, carried over the head and delivered at any floor desired while on the down strand. The trays are hung from stud-pins between two strands of chain by arms of such length that the center of gravity of the package is well below the pivot point of the hangers. At the lower end of the hangers is a cross bar to which the carrying arms are fastened. The cross bar extends through the hangers and is fitted at the ends with rollers which run in guides to prevent the tray from swinging on the up and down strands.

The loading and unloading of trays is effected by fingers which extend across the floor opening from either side and are so arranged that the trays and fingers can pass between. The loading fingers are slightly inclined



4543-C

toward the center so as to have a tendency to load the trays centrally. The unloading fingers are arranged with the inner set raised above the floor and the outer set at about the floor level all of them on a straight incline from the inner shaft to the edge of the floor opening. This incline with fingers for handling barrels and kegs is about 30 degrees with the horizontal and 45 degrees for boxes, bundles, bales, etc.

When handling large packages it is necessary to use two short head shafts instead of one thru shaft. Each of these shafts is provided with a spur gear and is driven by pinions from one countershaft. It is customary to use a worm gear drive to this countershaft. The worm will act as a lock to prevent the elevator from running away should power be suddenly cut off while the elevator is loaded.

These elevators should run at 50' to 70' per minute. The trays can be spaced from 8' to 10' apart, thus giving a capacity of 6 to 8 packages per minute.

These elevators are especially serviceable in large ware houses, wholesale houses, breweries, storehouses for barrels, etc.

There is also a patented tray which will discharge its load while on the up going strand. This is serviceable where available space is very limited for installing an elevator.

So much for the conveyor and its companion, the elevator. Following are several descriptions of installations of conveyors.

Continuous Conveyors for Handling Materials.

Some Typical Installations.

A Coal-Handling Conveyor.

Drg. 0-5608-09, Sh. #1-A shows a system of belt conveyors for handling coal from the mine entrance and delivering either to washery or to storage bins. The entrance to this mine is by means of a drift into a side hill. The washer and power plant is located below the entrance on the hill side and the coke ovens are scattered along the bottom of the valley below the washery. As all of the coal mined at this plant is made into coke, it is all pulverized and washed before delivery to coke ovens so as to make the coke as low in sulphur as possible.

Previous to the installation of this system of conveyors, the coal was gathered in the mines in small cars and brought to the opening by means of an electric locomotive. A wooden trestle extended from the opening out from the hill side to a point over the pulverizer in the washery building. The cars of coal were hauled out on this trestle, a distance of about 175 ft., one at a time, with a mule, dumped and brought back to the entrance. The out put of the entire plant was limited by this method of getting the coal from the entrance to the washery. It will be noted from the drawing that the coal is now delivered to the conveyors from a large concrete hopper by means of a double beaded flight conveyor acting as a feeder. This hopper, for

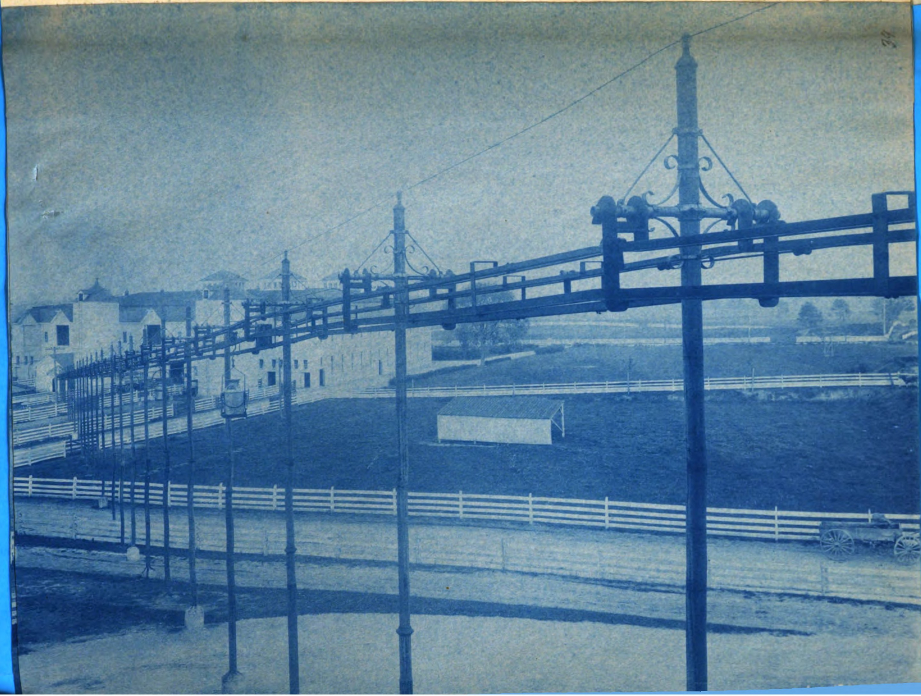
which it was necessary to blast out the rock, is located just outside of the drift, the top being at a level with the track into the mine. The entrance to the mine was made a Y so that the car tracks could come out around a small loop and back into the mine. The loop passes over this hopper. The cars are now brought out of the mine in a long train by the locomotive, and as they pass slowly over the hopper they are dumped two at a time and are immediately returned into the mine for reloading. While these are being loaded another train is brought out by the locomotive, and so on.

It will be noticed that the first conveyor is on an incline and terminates in a steel frame head house. Here the coal is delivered into a two way chute provided with a fly valve. One chute leads out to the power house boiler roomand the other, which is about 50 ft. long, leads on down to a chute at right angles with the main chute and delivers into the washery building to the crusher. If for any reason the washery is shut down, the coal is allowed to pass on down the main chute, instead of going to the crusher, to a second belt conveyor which delivers to an elevated storage bin. The delivery end of the first conveyor is elevated so as to get sufficient incline for the chute leade ing to the boiler room. This chute is used only as coal is needed for the boilers, and delivers the coal on to the boiler room floor in front of the furnaces. The head house is utilized for transmission machinery for conveyors, and steam engine for driving same. The chute to crusher is provided with a flat bar screen which removes the fine coal, thus relieving the duties of the crusher considerably. The fine coal taken out by the screen is carried on into the washery by a flume.

The coal delivered to the storage bin is drawn out into cars, which pass underneath the bins, and is delivered to the coke ovens without being washed and made into a second or cheaper grade of coke.

The entire structure and supporting frame is of structural steel work covered with corrugated iron. A walk-way is provided on each side and the full length of the conveyor runways. Small doors are placed opposite all idlers to facilitate oiling and inspection. A 30", 5-ply Century rubber conveying belt with 1/8" cover was used and was carried by 3-pulley troughing idlers every 5'-0" on the carrying side and straight faced return idlers every 10'-0" on the empty side. Head and foot pulleys were 36" diameter and 32" face, and snubbing pulleys of the same size were used near the driving pulleys. Both conveyors are driven from one main jack shaft by chain and sprocket and provided with clutches so that they may be started one at a time and also so that the lower conveyor may be thrown out when not in use. The double beaded flight feeder is driven from the foot shaft of the first conveyor.

With the installation of modern machinery as above




4354

described, the output of this mine was increased approximately one hundred percent without an increase in cost of handling, this to say nothing regarding the greater ease of handling.

Milk Can Conveyor.

Drawing 0-392-11, Sh. 41, Drawing H-2455 and Photographs Nos. 4352 and 4354 show the arrangement of a conveyor for transferring cans of milk from milking barn to dairy building. The conveyor is made of wire rope cable with attachments for pushing a trolley which carries the can of milk. The attachments and transmission clamps are provided with rollers which are carried by angle iron runways and just above the trolley runway. The runways are held in proper position relative to each other by steel slings and are supported from the cross arms of steel pipe poles. The poles are 5" diameter, spaced 15'-0" apart and set in concrete piers.

A large loop is provided in the trolley track at each end of the conveyor on which the trolleys are allowed to accumulate or be held for loading and unloading. The cans are placed in the trolley slings on the loop at one end of the conveyor, pushed out on to the runway and as the pusher attachments come around they engage the trolleys and push them to the other end of the conveyor. Here the trolleys run out on to the loop and stop.

Continuous Conveyors for Handling Materials.

Clean cans, milking pails, strainers, etc., are sent to the barn on the conveyor as needed.

With this equipment the milk is delivered to the dairy as fast as gathered, thus making it possible to produce "certified milk" on a commercial scale and at the same time facilitating the work in the dairy because the milk is brought in one can at a time as fast as collected instead of being delivered all at once and not until the last pailful has been gathered.

Two of these conveyors were installed at the Hartman Stock Farm near Columbus, Ohio. One conveyor is about 250'-0" and the other about 450'-0" long. The total cost of the installation of these two conveyors was about $4500.00. However, they mean a saving of the time and expense of a team and wagon as well as a half day of one man's time. The manager of the farm claims this to be a saving of $2.50 per day or a return of approximately 20% on the investment.

The construction is very simple and amply heavy for the work so that repairs will be very light. The design is also one that presents an attractive appearance on the landscape.

These conveyors were designed by the writer and installed under his direction and so far as known they are the first of this type to be used. Shortly after the above installation as made the dairy at the Elmendorf Farm of Lexington, Ky., was also equipped with the same kind of a conveyor.

Sh. #33.

Continuous Conveyors for Handling Materials.

Conveyor for Handling Bananas at Docks to and from Holds of Ships.

The banana conveyor is used for transferring bunches of bananas from docks into the holds of ships which transport them to the markets of the world. It can also be used for unloading from ship to dock. The machine consists of a structural steel frame for supporting the machinery parts and runways, the conveyor itself, with the necessary gearing and transmission machinery for driving it, and a steam engine, steam supply being obtained from the ship. A general erection of the complete machine is shown on drawing 0-2890-10, sheet #2.

The structural steel frame consists of two trusses latticed together at top and bottom to form a box and is made up of standard sizes of angles and Z bars. It is arranged to hinge on the dock and extend out from same over the vessels which are moved along the wharf for receiving or discharging their cargoes. A steel platform is provided at the wharf for the hinge shaft of the frame, and also the engine, so as to distribute the weight of the whole conveyor over a considerable space on the dock, and also to make it possible to move the apparatus intact from one dock to another. The platform is made of standard steel channels placed edgewise and provided with an angle riveted to the back of same so as to give a good footing. The tops of the channels are covered with $\frac{1}{4}$" steel plate. Two short

sections of I beams are riveted on top of the platform and directly over two of the supporting channels for carrying the hinge shaft bearings. The hinge is made by bolting a solid box in an inverted position to the lower cords of the two trusses, also one to each of the two sections of I-beams on the platform and passing a shaft thru the four bearings. The bearings carried by the platform are spaced so as to come just outside of those on the frame, thus making the distance center to center of the bearings at either side of the frame equal to the length of the bearings and making the bending stress in the hinge shaft as small as possible. The trusses of the frame are 3'-3" deep from back of the Z bar which forms the upper chord of truss to back of the bottom chord angle. The Warren type of truss was used so as to take care of the different stresses caused by the various positions encountered in raising and lowering. The upper chords of the trusses are made of Z bars so that the inner leg of same could be used for the upper runway of the conveyor, and the outstanding leg for connecting the cross ties and bracing between the two trusses. The runway for the lower or return strand of conveyor consists of an angle carried by the diagonals of the trusses and set out from same by washers so as to bring the back of the upstanding leg of the angle on a line with the web of the Z bar above. This brings the horizontal leg of the angle central below the inner leg of the Z, thus keeping the conveyor chains in line. The upper end of the frame is pro-

vided with heavy plates which are drilled for attaching a hoisting rope which passes thru a set of blocks and sheaves and is fastened to the steam capstain or hoist of the ship being loaded or unloaded, when the frame is to be raised or lowered as the case may be.

It was necessary to keep the frame as compact as possible and as the conveyor takes up all of the space inside of the frame it was impossible to have diagonals in the cross section to prevent the frame from racking, consequently, the upper end of the trusses are given a slight curve or bend to stiffen the frame and also to give a better appearance. It is also impossible to have thru corner shafts at the upper end of the frame with this style of conveyor unless very large sprocket wheels are used. So, instead, brackets were built out from the trusses at the upper end to carry two bearings for each of the stub corner shafts.

The frame is shown in detail on drawing O-2890-10, sheet Al.

The conveyor is made up of two equal matched strands of #18 JEFFREY Malleable Roller Chain with T-1 attachments spaced 48" apart in the chain. The chains are spaced apart by pieces of 1" standard pipe which fit over the T-1 attachments and are held in place by cotter pins which extend thru the end of the pipe and the attachments. Heavy canvas is stretched across the pipe spacers loosely so as to hang between same and form a pocket for the bunches of fruit on the vertical strand of the conveyor as well as on the inclined or horizontal section. The chains are carried by runway angles extending inside of the frame on either side. These keep the chains in perfect alignment and are wide enough apart to allow the canvas and fruit to hang between same. The conveyor was built with two stub head shafts, each of which is driven from the countershaft by a pair of spur gears. The countershaft is in turn driven by chain and sprockets from the steam engine. After the conveyor was completed it was found necessary to replace the two stub head shafts with one thru shaft and to place a drum, heavily padded with felt, on same, for discharging the bananas properly. This drum is about the same diameter as the sprocket and rolls the fruit out on a table instead of dropping it on same. The hanging shaft was also equipped in this manner.

The engine is located on the steel platform above mentioned. The piping for it is carried to the edge of the wharf where it is connected to the steam supply on the boat by means of a steam hose.

The machine has a capacity of 900 bunches of bananas per hour. This amount could be increased, however, if it were possible to get the fruit onto the machine and take it away any faster. It is an improvement over the old method of hand loading, the work being accomplished much more rapidly and with less damage to the fruit.

Continuous Conveyors for Handling Materials.

Apron Conveyors.

Drawing 0-3290-11, Sh. #1, and Photographs Nos. 4065, 4066 and 4064 show the general arrangement of an apron conveyor built for the Gendron Wheel Co. of Toledo, Ohio. This company manufactures bicycle wheels, sulky parts, baby buggies, toy carts, wagons, leather cushions, etc. The conveyor is used to transfer these various articles from the factory building to a storage building where they are held pending shipment. The ground space between these two buildings is taken up by small shop buildings which are one and one and one half stories high. There is no system or regularity in their location and arrangement. For supporting the structural frame work of the conveyor, it was desirable to have two steel frame bents in the span and it was necessary to locate these bents so that one would rest on the wall of a brick building and so that the other could extend to the ground between two buildings whose eaves clear each other by about 12 inches.

The work of securing data and plans of locations of these buildings with reference to the main buildings was very difficult, in fact, a local engineer had refused to undertake the task. However, he rendered the writer great assistance by the loan of instruments which aided in the success of the undertaking.

The conveyor is arranged in a steel truss frame

which is supported by the building walls at each end and by two bents intermediate in the span. A walkway is provided the full length on one side and the complete frame is enclosed with a corrugated iron housing.

The conveyor is made up of a malleable roller chain 6" pitch with 3" rollers and 11/16" pins. Every other link is provided with an attachment extending out on one side for fastening to wood flights. The overall width of the chains is about 30 inches. Both carrying and return strand are carried by the chain rollers on angle irons running the full length of the frame.

Power for driving is furnished by a 5 H.P. motor which is hung from the ceiling of the room into which the material is discharged. The motor connects by belt with a countershaft located in the head frame which in turn transmits power to the driving shaft thru a pair of spur gears. Blue prints from plates Nos. 4065, 4066 and 4064 are from photographs taken after the equipment was in operation.

The material handled is gathered from the different floors of the factory building by a platform elevator and discharged at the receiving end of the conveyor. In the storage building the material is discharged just in front of a platform elevator for distribution to the various floors of this building.

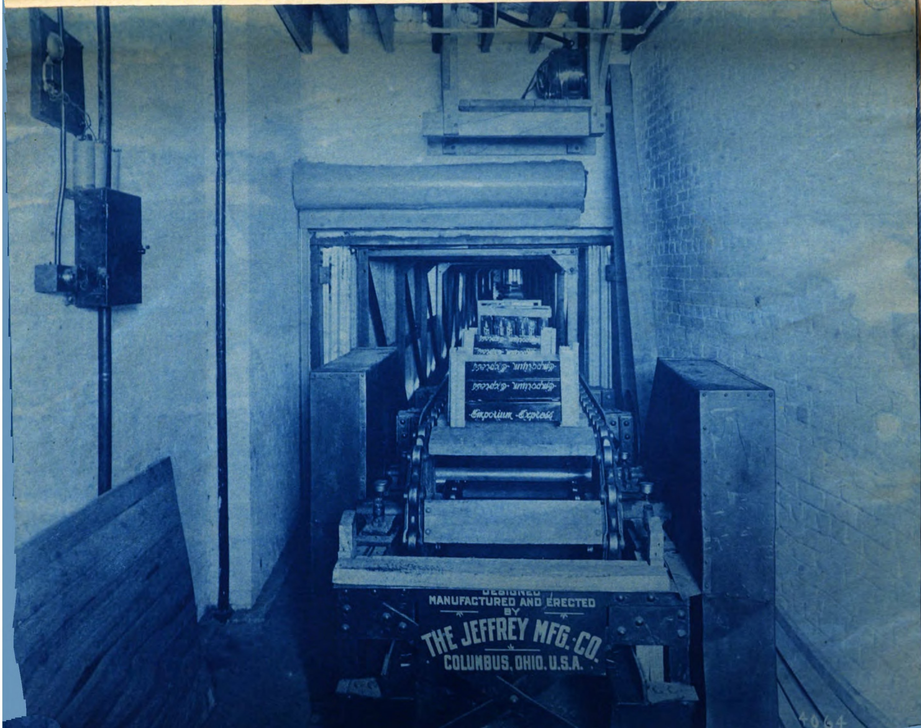
Before the conveyor was installed it was the practice to transfer all material from one building to the other with small two wheeled hand trucks. Now, with the conveyor, the

transfer is made more easily as well as more economically.

Conclusion.

Considering the subject of conveying machinery as a whole, it presents a varied and interesting field of endeavor to the engineer. As has been pointed out, in many respects, it is still in its initial stages, and new applications continually call for the best ability and endeavor of the engineer in solving just such problems as outlined above.

And finally, to recapitulate, as a labor saving device it occupies a field of its own, both in the greater facilities afforded in operation, and in the increased output of a given plant, as well as in furthering the production of a more perfect product. It must take its place as a factor of no mean importance in the present day tendency toward development of resources, conservation of energy and purity standards for all products.



Emporium Express
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MANUFACTURED AND ERECTED
BY
THE JEFFREY MFG. CO.
COLUMBUS, OHIO. U.S.A.
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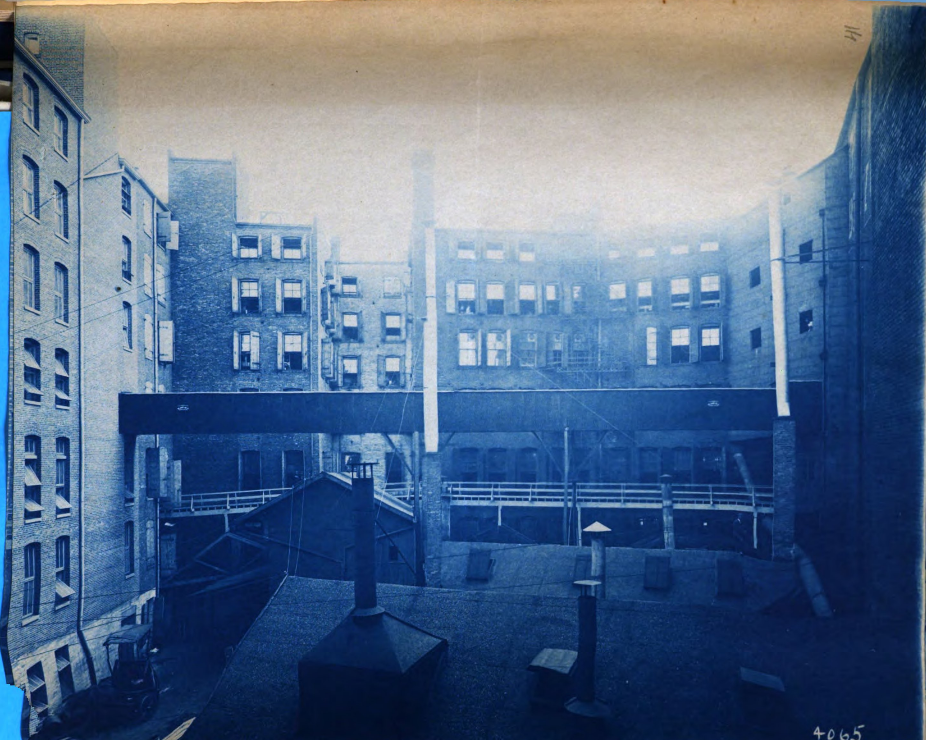

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