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ELEVATING AND CONVEYING MACHINERY.

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In presenting this paper the author said he would endeavour to describe some of the most important of the main types of Mechanical Handling Plants, which came under this heading, their application and construction.

The subject covered such a wide field that he did not propose to do more than speak of a few of the types of equipments which were being generally adopted for handling various materials.

BELT CONVEYORS.

This class of equipment was now very widely used in Australia, and there was probably not another type of Conveyor which was so generally used for handling materials and of such very varied natures. This was undoubtedly due to the fact, that to the practical and Mechanical Engineer the advantages the Belt Conveyor possessed were at once apparent. These advantages might be briefly summed up as follows:—

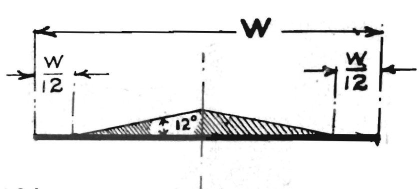
(1) Simplicity of construction, (2) small amount of power required for driving, and (3) the small liability of breakdowns.

The foregoing, combined with the automatic features possessed by Belt Conveyors for receiving and discharging material, made it a system which also appealed very readily to the purchaser, as the cost of handling the product was obviously reduced to a minimum. The capacity of Belt Conveyors was a point upon which there was a considerable difference of opinion amongst Engineers and Manufacturers. This was due to the heavy loading which was possible with some classes of material on this type of Conveyor, therefore Table I. of the capacities of various widths of Conveyors operating at 100 feet of travel per minute, and handling material of various weights, would probably be of some interest. These figures were the result of a series of experiments carried out in America during last year, and the capacities given were based upon the belts being loaded as shown in Fig. 1.

Table I.
Capacities of Flat Belt Conveyors.

Width of Belt in inches.	Cross Section of Load Sq. Ft.	Cub. Ft per Hr. at 100 F.P.M.	Cu. Yds per Hr. at 100 F.P.M.	Bu. per Hour at 100 F.P.M.	Tons per Hour at 100 F.P.M. Weight of Materials in lbs. per Cub. Ft. 25	50	75	100	125
10	·025	150	5·5	121	1·9	3·8	5·7	7·6	9·5
12	·036	216	8·	174	2·7	5·4	8·1	10·8	13·5
14	·049	294	10·9	236	3·7	7·4	11·1	14·8	18·5
16	·064	384	14·2	309	4·8	9·6	14·4	19·2	24·
18	·081	486	18·	391	6·1	12·2	18·3	24·4	30·5
20	·100	600	22·2	482	7·5	15·	22·5	30·	37·5
22	·121	726	26·9	584	9·1	18·2	27·3	36·4	45·5
24	·144	864	32·	694	10·8	21·6	32·4	43·2	54·0
26	·169	1014	37·5	815	12·7	25·4	38·1	50·8	63·5
28	·196	1176	43·5	945	14·7	29·4	44·1	58·8	73·5
30	·225	1350	50·	1085	16·9	33·8	50·7	67·6	84·5
32	·256	1536	56·9	1235	19·2	38·4	57·6	76·8	96·
34	·289	1734	64·3	1393	21·7	43·4	65·1	86·8	108·5
36	·324	1944	72·	1562	24·3	48·6	72·9	97·2	121·5
38	·361	2166	80·2	1741	27·1	54·2	81·3	108·4	135·5
40	·400	2400	89·	1928	30·	60·	90·	120·	150·
42	·441	2646	98·	2126	33·1	66·2	99·3	132·4	165·5
44	·484	2904	107·5	2334	36·3	72·6	108·9	145·2	181·5
46	·529	3174	117·5	2551	39·7	79·4	119·1	158·8	198·5
48	·576	3456	128·	2777	43·2	86·4	129·6	172·8	216·

The Above Table Based Upon This Cross-Section



Formulae:-

Cub. Ft. Per. Hr at 100 F.P.M. = $1 \cdot 5\ W^2$

Where W = Width of Belt in Inches

Fig. 1.

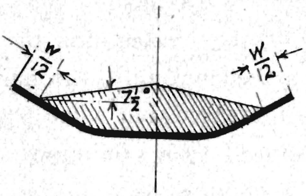
Table II. and Fig. 2 give the capacities of Troughing Belts operating on 3 pulley carriers and loaded as shown.

Table II.

Capacities of Belt Conveyors with Three Pulley Troughing Idlers.

Width of Belt in inches.	Cross Section of Load Sq. Ft.	Cub. Ft. per Hr. at 100 F.P.M.	Cu. Yds per Hr. at 100 F.P.M.	Bu. per Hour at 100 F.P.M.	Tons per Hour at 100 F.P.M. Weight of Material in lbs. per Cub. Ft.				
					25	50	75	100	125
10	·058	350	12·9	281	4·4	8·8	13·2	17·6	22·
12	·084	504	18·7	405	6·3	12·6	18·9	25·2	31·5
14	·114	686	25·4	551	8·6	17·2	25·8	34·4	43·
16	·149	896	33·2	720	11·2	22·4	33·6	44·8	56·
18	·189	1134	42·0	911	14·2	28·4	42·6	56·8	71·
20	·233	1400	51·9	1125	17·5	35·	52·5	70·	87·5
22	·282	1694	62·7	1361	21·2	42·4	63·6	84·8	106·
24	·336	2016	74·7	1620	25·2	50·4	75·6	100·8	126·
26	·394	2366	87·6	1901	29·6	59·2	88·8	118·4	148·
28	·457	2744	101·6	2205	34·3	68·6	102·9	137·2	171·5
30	·525	3150	116·7	2531	39·4	78·8	118·2	157·6	197·
32	·597	3584	132·7	2880	44·8	89·6	134·4	179·2	224·
34	·674	4046	150·	3251	50·6	101·2	151·8	202·4	253·
36	·756	4536	168·	3645	56·7	113·4	170·1	226·8	283·5
38	·842	5054	187·	4061	63·2	126·4	189·6	252·8	316·
40	·933	5600	208·	4500	70·0	140·0	210·0	280·0	350·
42	1·029	6174	229·	4961	77·2	154·4	231·6	308·8	386·
44	1·129	6776	251·	5445	84·7	169·4	254·1	338·8	423·5
46	1·234	7406	274·	5951	92·6	185·2	277·8	370·4	463·
48	1·344	8064	299·	6480	100·8	201·6	302·4	403·2	504·0

The Above Table Based Upon This Cross-Section



Formulae:-

Area of Cross Section in Sq Ft = $\cdot000583\ W^2$

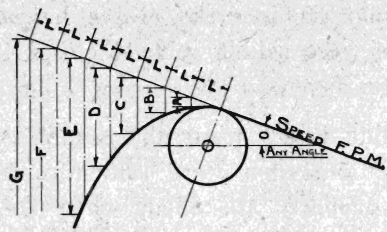
Cu. Ft. Per. Hr. At 100 F.P.M. = $3\cdot5\ W^2$

Where W = Width of Belt in Inches

Fig. 2.

There were several conditions which influenced the capacity of a Belt Conveyor, such as the method of feeding material to the Conveyor, the sizes of pieces and the nature of the material, and in order to get the best results from an installation the method of feeding should be given very careful consideration, it being often possible to reduce the width of a Conveyor by ensuring a regular feed, and at the same time to obtain better operating conditions. The speed at which Belt Conveyors should operate depended mainly upon the class of material to be handled and the method of discharge, and, owing to the belt itself being the most expensive portion of the Plant, those who are contemplating the installation of Conveyors of this type were inclined to run the Conveyors as fast as possible in order to reduce the width of the belt. The speed in almost every case must depend upon the method of discharge, especially where the material being handled was of a brittle nature, and liable to breakage through coming into contact with the chutes into which it was delivered. When handling brittle material, such as the South Coast coal, the speed must be kept down as low as possible in order to reduce the breakage at the delivery point, but at the same time the speed required to be such that the belt was not unduly wide. Where delivery was made over the end pulley the correct position of the chutes was of considerable importance, for if placed wrongly, the danger of breakage was considerably increased, but when properly placed the breakage was reduced to a minimum.

In this connection a curve showing the discharge of material over the end pulley from a Belt Conveyor at various speeds might be of interest, and he might add that the curve given was the result of experiments made by the Jeffrey Manufacturing Co. See Fig. 3.



FORMULA L (IN INCHES) - $\frac{\text{Feet Per Minute}}{100}$

Constants.

	Decimal	Fraction
A	.4284	$\frac{31}{64}$
B	1·9296	$1\frac{15}{16}$
C	4·3416	$4\frac{11}{32}$
D	7·7184	$7\frac{23}{32}$
E	12·0600	$12\frac{1}{16}$
F	17·3664	$17\frac{3}{8}$
G	23·6376	$23\frac{5}{8}$
H	30·8736	$30\frac{7}{8}$
I	39·0744	$39\frac{1}{16}$
J	48·2400	$48\frac{1}{4}$
K	58·3704	$58\frac{3}{8}$
L	69·4656	$69\frac{15}{32}$
M	81·5256	$81\frac{17}{32}$
N	94·5504	$94\frac{9}{16}$
O	108·5400	$108\frac{35}{64}$

NOTE: THE ABOVE FORMULA HOLDS GOOD IN ALL CASES EXCEPT WHEN THE MATERIAL BEING CONVEYED TENDS TO STICK TO THE BELT OR IS VERY LIGHT AND EASILY DEFLECTED BY THE RESISTANCE BY THE AIR.

Fig. 3.

In the erection of Belt Conveyors the distance between the carrying rollers was one which required consideration, as this important point had a considerable effect upon the life of the belt. Upon the weight per cubic foot of material handled depended mainly the distance between the carrying rollers, and as an average the centres between these rollers for Troughing Belts when handling material equal to about 40 cu. feet to the ton was 4ft. 6in., and for the material of a heavier nature 3ft. 6in. to 4ft. centres was ordinary practice.

The return idlers were usually placed twice as far apart as the troughing carriers. With flat belts for handling material in sacks, crates, boxes, etc., the carrying rollers were seldom placed closer together than at 5ft. centres.

Side guide idlers were not required with very long Conveyors, and then were seldom necessary after the belt was properly stretched, when they could be entirely dispensed with, provided the carrying rollers were in perfect alignment. It was advisable to allow plenty of clearance between the edge of the belt and the side guide idlers so that they would not operate unless the carrying rollers were not in perfect alignment, the object of this being to increase the life of the belt.

The diameter of the flat or troughing carriers was of considerable importance, and for Belt Conveyors operating at a speed of 300 per min., and faster, should not be less than 6in. in diameter, and for slower speeds 4½in. to 5in. Particular attention should be paid in the design to the method of lubrication of the rollers, it being most necessary that they should not be stationary at any time while the plant was in operation. The head and tail pulleys should always be 2in. wider than the belt in use, and neither should be smaller in diameter than the width of the belt. For Conveyors of great length it was necessary to make the driving pulleys of considerably larger diameter than the width of the belt, in order to increase the frictional or driving efficiency, thus overcoming any tendency of the belt to slip, also this was desirable in order that the belt might not suffer through passing round small pulleys; especially was this necessary when the drive for long Conveyors was placed at the foot or receiving end of Conveyor.

The angle of the troughing carriers was also important, and this varied according to the material being handled, but 30° could be taken as a general rule to be about correct for 3 pulley troughing carriers and 15° to 20° for 2 pulley troughing carriers. For discharging material at any point along the Conveyor the best method to adopt was to fit a belt tripper, which could be arranged to be of either hand or self propelled Frequently, when it was required to discharge the material right along a portion of the Conveyor, the tripper was made self propelling and self reversing, and was, therefore, continually moving slowly backwards and forwards along the portion of the Conveyor from which the material was to be discharged, and ejecting it at the same continuous rate.

Before showing some illustrations of Belt Conveyors in operation a word might be said regarding the type of belting to be used. For flat belts to handle material that was dry, and which had not an abrasive nature, Balata Belts were very satisfactory, and for troughing belts, to handle rough, sharp, or wet material, experience had proved that a good rubber belt with plenty of rubber cover on the carrying side was most suitable. This was due to its flexibility and (when constructed with proper rubber cover) to its abrasion resisting qualities.

The author then showed many illustrations of Belt Conveyors in operation and described the loading and other conditions.

One of these illustrated a Standard Tripper, assembled prior to shipment to Australia. Practically all of the gearing was enclosed in a dust proof casing on account of the Conveyor being used for handling superphosphate. Fig. 4 depicted a Belt Conveyor, heavily loaded, approaching a tripper, portion of the belt being carried on the idlers.

Another view showed a 20in. Belt Conveyor over a small storage ground, the capacity of the Conveyor being 120 tons of small coal at a speed of travel of 450 feet per minute. The belt was a 5 ply canvas one with 1/8in. rubber cover (on the carrying side) and the length 440 feet between centres.

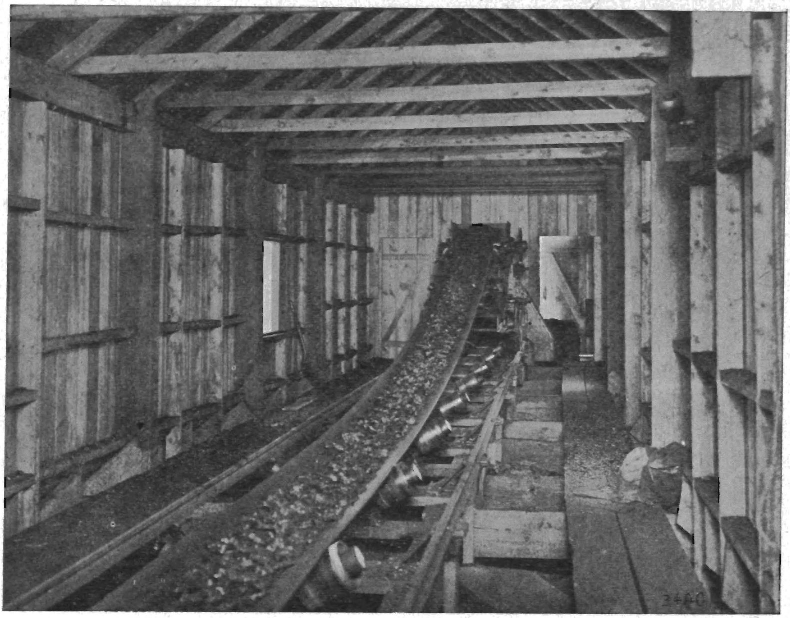


Fig. 4

Another Conveyor installed for stacking tailings and fitted with self propelled tripper, was described by the Author. The tripper was arranged with a Boom Conveyor on each side to increase the stacking area before it was necessary to jack the plant round.

The centres of this conveyor were 500ft., the belt 24in., 8 ply with 1/8in. rubber cover on each side of the belt. The capacity was 650 tons tin tailings per hour, the speed 450ft. of travel per minute. The drive was at the tail end of Conveyor, and consisted of a 50 B.H.P. motor direct geared. A rubber cover 1/8in. thick on each side of the belt was necessary owing to the fact that there were 3 driving pulleys at the tail end, the belt passing under and over them, the material being handled containing very sharp pebbles. The pulleys were all direct geared to motor by machine cut spur gearing, the two snub pulleys being approximately 2ft. 9in. diameter, and having exactly the same peripherial speed as the main tail end pulley. This method of drive was necessary owing to the amount of water that was thrown about the foot end of Conveyor from the large drainage bucket elevator by which the tailings were delivered to Belt Conveyor. The rise of the Conveyor was 50ft. in 500 feet.

METAL APRON CONVEYORS.

Metal Apron Conveyors were taking a prominent place in most mines for handling ores and coal, and were mainly installed where centres did not exceed 250ft., and the quantity required to be dealt with was a large one. In selecting the type of Metal Apron Conveyor to install a very great deal must depend upon the local prevailing conditions, but for handling ores and coal which had only to be discharged at the delivery point the continuous overlapping double beaded flight steel Apron Conveyor was a favorite with mining engineers, due to its large capacity and method of construction. With these Conveyors the speed should not exceed 200 feet of travel per minute, unless the chains upon which the flights were mounted were specially constructed for greater speed. A speed of 100 feet of travel per minute had actually proved to be the most satisfactory for this class of Conveyor. The type of chain used on Conveyors constructed of steel flights depended, of course, upon the conditions under which the Conveyor was to operate and the material to be handled, but for handling ores the chain should invariably be a Steel Thimble Roller chain. By this he meant a chain constructed with either flat face, or flanged rollers at every joint, properly bushed with a steel thimble passing through the roller and the inside link of the chain. The rollers usually should be well cored out and fitted with special oiling arrangements, which after the chain had been thoroughly oiled left the rollers or working parts practically dust proof. The diameter of the rollers should be large, so that the speed of the rollers would not be too great, and the pitch of the chain should rarely be less than 12in., in order to reduce the number of working parts and the cost of manufacture.

When material such as small coal was being handled malleable roller chains were frequently used and made an efficient chain for Metal Apron Conveyors, but these chains were not suitable where the Conveyor had to handle gritty material, as the chains were constructed with the object of being used without much lubrication.

Beaded Flight Conveyors with flights mounted on S.T.R. chains were rapidly replacing the ordinary overlapping steel Apron Conveyor, which, for many years, had been used for picking belts at Australian collieries, the reason being that the friction with Conveyors using S.T.R. chain was reduced to a minimum, provided the chains were properly lubricated, and consequently the H.P. required to drive them was very small. The ordinary overlapping metal Apron Conveyor mounted on plain steel chain, and forming Picking belts 70ft. centres 4ft. 6in. wide, require approximately 10 x 12½ H.P. to drive them when operating at 65 feet of travel per minute, whilst a Beaded Flight Conveyor mounted on 2 strands of S.T.R. chain of the same length and operating at the same speed, and handling the same capacity, required but 3½ H.P.

Some interesting illustrations of Beaded Flight Conveyors were then shown by the Author, one of which was given in Fig. 5. This view was of a Picking belt operating in America, and it would serve to show how the men frequently stood on the belts when picking coal.

Fig. 5.

This method was very widely adopted in Pennsylvania, and, in fact, at nearly all the collieries working on bituminous coal in America. The end of the belt is adjustable, being raised or lowered so as to reduce the drop between the belt delivery and the coal waggons, the object of this being to prevent breakage of the coal as far as possible, when being delivered to the waggons.

When this type of Conveyor was operating on an incline back stops were attached to the bottom flights to prevent the coal moving backwards. By this method it was possible to operate a Conveyor of this type up to an angle of 60deg. if necessary, and still obtain a good capacity.

One of the Author's views showed a double compartment belt handling two sizes of coal. Due to the many sizes to which the coal was graded in America Picking belts often dealt with 3 sizes of coal at the one time.

Another view showed a very large Conveyor in operation, it was 500 feet centres and had a capacity of 450 tons per hour, the coal being delivered from the mine cars to screens.

The equipment installed at the most recently opened colliery in the Maitland field, viz., Abermain No. 2 Colliery, consisted of two picking belts of the double beaded flight type mounted on two strands of S.T.R. chain 18in. pitch, the width of the picking belts was 4ft., the height of the sides 6in., and the centres 80ft. The shaking screens delivering the coal to the belts were shown at the tail end of the belts. The screen were 23ft. long overall, the screening surface being 18ft. x 6ft.; the angle of the screens 1 to 8 and the speed of the eccentric shaft 115 R.P.M., the capacity of each unit, of which there were two, being 250 tons per hour.

While speaking of coal handling, a few details of Portable Yard Elevators, which were frequently adopted for loading waggons from yard storages might not be amiss. These loaders could be constructed in a variety of ways, but the bucket loader found much favor where small coal was to be handled. The loader consisted of a double strand bucket elevator mounted on a self contained steel frame. The engine, or whatever power was used for driving the elevator, was placed well towards the front of the truck and was kept as low as possible in order to allow the elevator to be adjusted at either end as required.

Another loader, and one which possessed features which made it distinctive, was shown in Fig. 6.

Fig. 6.

The machine was really a single strand Scraper Conveyor, the tail wheel being low down near the ground. By this method of construction the Conveyor automatically picked up its own load. The chain used was a specially drop forged all steel chain, the scrapers being also drop forged and operated in a mild steel trough. This illustration showed the machine working on run of mine coal, but the best results were obtained when the largest pieces of coal did not exceed 6in. or 8in. cubes, otherwise the trough became too wide, causing too much leverage on the ends of the scrapers. The machine required 5 H.P. to operate it, and a two ton waggon could easily be loaded in ten minutes. This machine was, of course, not suitable for operating on material of a gritty nature, being of the scraper type of Conveyor.