Koepe Versus Drum Hoisting

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ABSTRACT

The pros and cons of Koepe and Drum Hoists have been discussed since the first Koepe wheel in 1877 and will continue to be a subject of great interest. The greatest difficulty is putting the proper value on each feature of the two systems. There are pros and cons even between the different types of Drum Hoists because mine operators put a different value on the various features.

General statements claiming that one is better than the other for all conditions of depth, speed and load are impossible. The hoist manufacturer can point out the pros and cons for each specific case and then the mine operator can apply his particular set of values and a decision can be made.

Koepe friction hoisting has definitely found a place in the American Mining Industry and is particularly suited for deep, high capacity shafts. For a given condition both the Koepe and Drum systems should receive due consideration until an objective choice can be made.

INTRODUCTION

The pros and cons of Koepe and Drum Hoists have been discussed since the first Koepe Wheel in 1877 and will continue to be the subject of great interest in the mining industry. Because of the entirely different nature of these hoists the title of this paper should probably read "KOEPE HOIST PLANT versus DRUM HOIST PLANT" since there is more involved in the comparison than just the hoists themselves. Discussing the mechanicals and electricals only, could give misleading results.

To put this comparison in the proper perspective, I think we should first examine pros and cons of the various types of drum hoists. This discussion will be in connection with the cylindrical type of drum hoist only, since this design is used almost exclusively today as opposed to the more expensive cylindrical-conical type of drum.

First, let us consider the simple Single Drum Hoist (Figure 1). As a Service or Production Hoist with cage or skip in balance with a counterweight, a Single Drum Hoist can efficiently service one or more levels since the location of the counterweight at anytime is not important. As a Production Hoist with skips in balance the Single Drum Hoist is best used for single level hoisting. However, this hoist is also used by some for a multi-level Production Hoist that requires skip re-spotting which reduces hoisting efficiencies. In fact, more production can be obtained from the lower level since re-spotting is required for the upper level. With this situation, consideration is given to dropping all material to the lower level. All rope adjustments for proper spotting must be done manually for the Single Drum Hoist.

A variation of the Single Drum Hoist is the divided drum hoist. If multi-layer winding is necessary the Single Drum Hoist must have a divider to allow a separate compartment for each

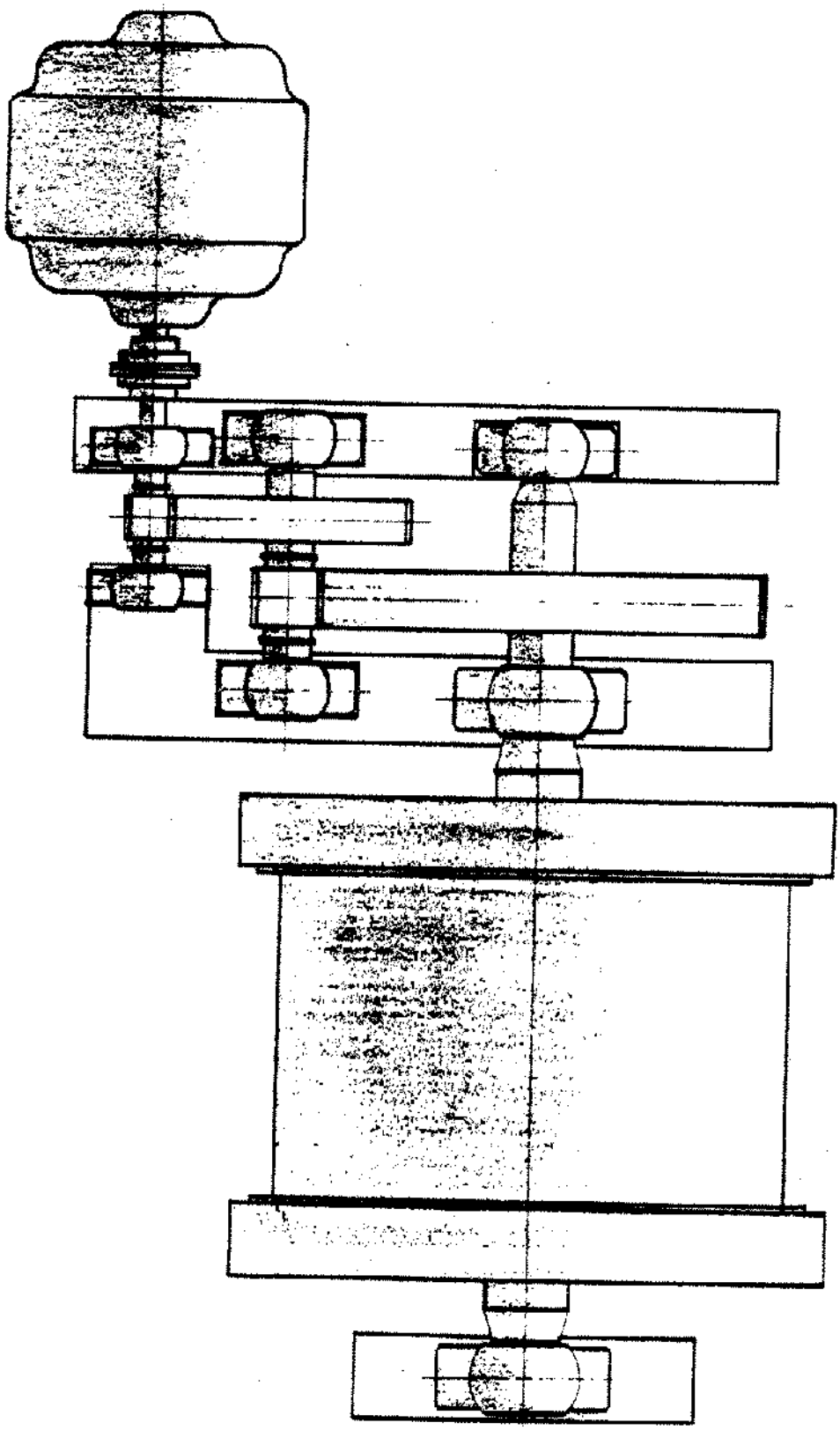

Figure 1.

rope. If a counterweight is used with a divided drum application the counterweight rope can be wound on a smaller diameter (Figure 2). Consequently, it moves a lesser distance than the main conveyance and rope adjustment problems are reduced.

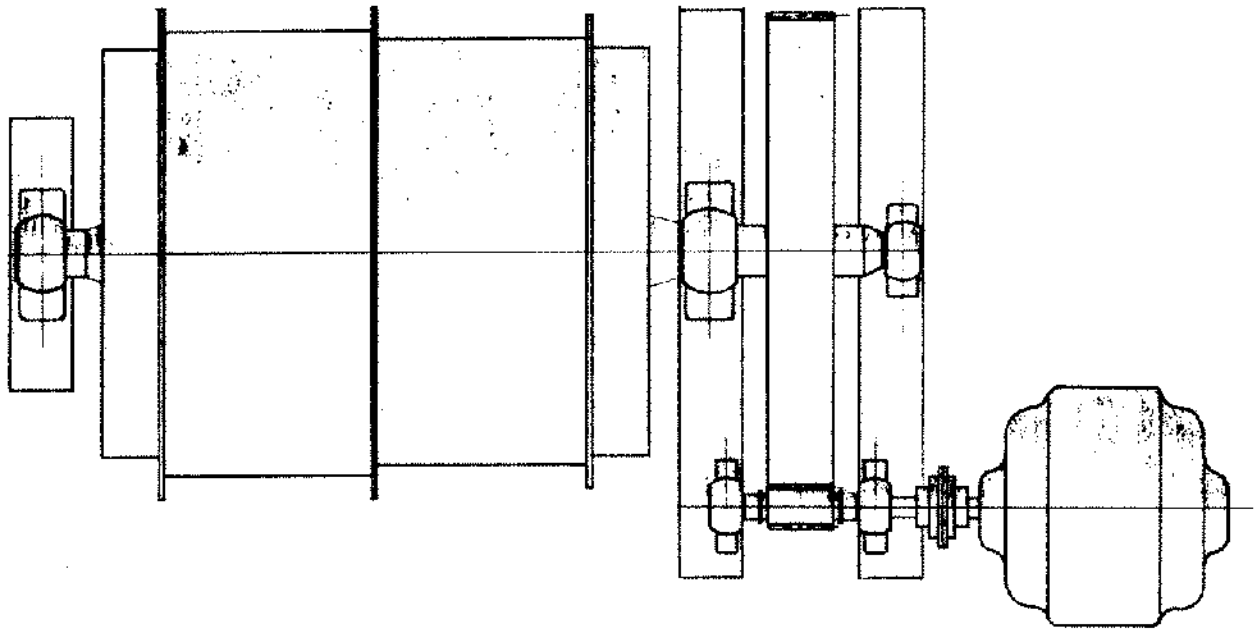

Figure 2.

Next, we have the Double Drum Hoist with one drum clutched (Figure 3). As a Service Hoist with cage and counterweight this hoist can also serve several levels efficiently. The advantage of

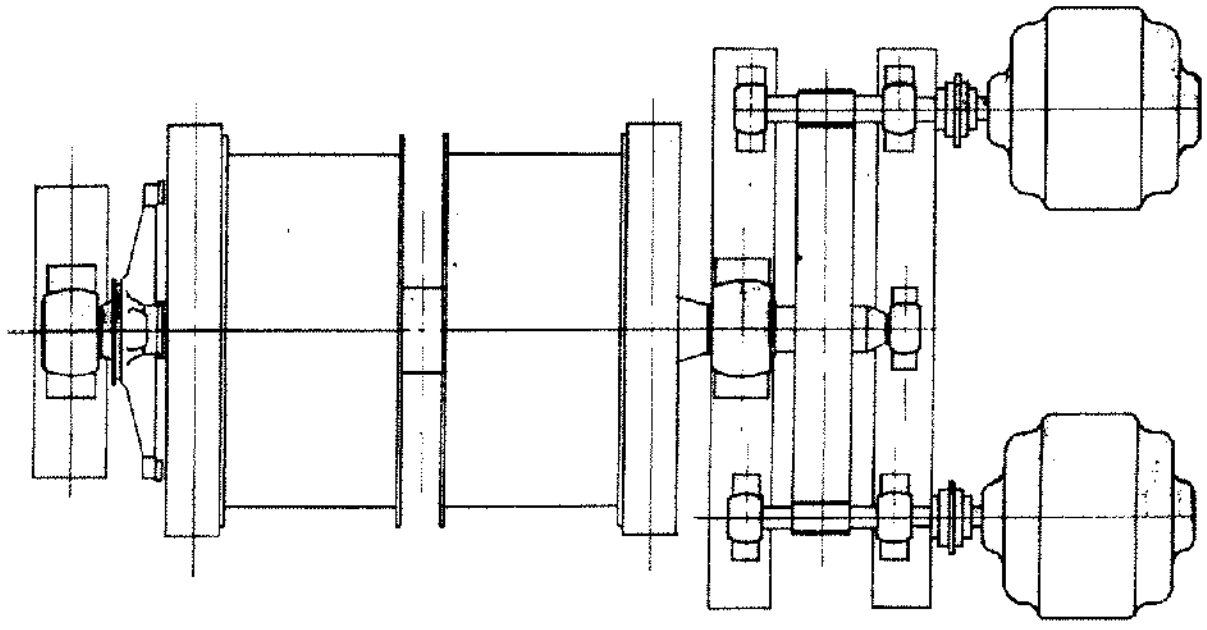

Figure 3.

having the clutch drum here is quick adjustment of ropes due to initial stretch. Here is a comparative study that the hoist manufacturer can only point out and it is up to the customer to decide on which system has the greater value. One prefers the cheaper Single Drum Hoist with manual rope adjustment, the other feels that the added expense of the second drum and clutch is justified to make rope adjustments quickly. As a Production Hoist with skips in balance for one level, some still prefer the clutch for rope adjustment. As a Production Hoist with skips in balance for a multi-level operation, the clutch can be adjusted for efficient hoisting from any level.

There are also Double Drum Hoists that have both drums clutched (Figure 4). The main advantage claimed for this type of hoist is that if something happens in one of the two compartments the hoist can operate in the other compartment to raise and lower men and supplies. This is particularly favored if there is only one shaft entrance to the mine.

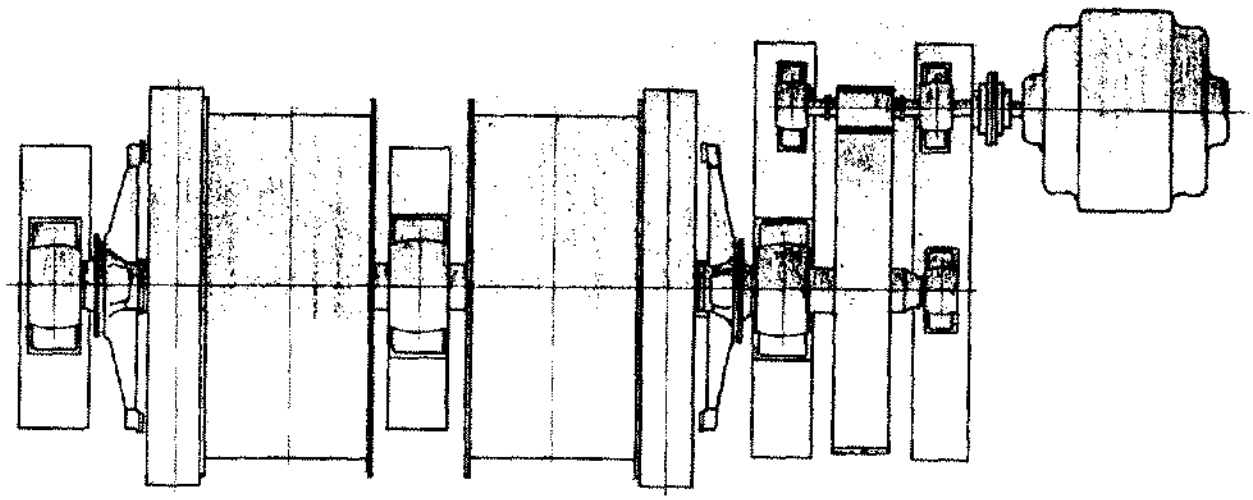

Figure 4.

This shows that for a given condition several different drum hoists could be picked. The preference will depend on the value put on each feature by the customer and who can say which choice is the wisest.

Figure 5 shows a single rope Koepe Wheel and Figure 6 shows a multi-rope Koepe Wheel. (Each figure has a different drive to show the various types and are not necessarily used only on that particular hoist.)

Comparing a Koepe Hoist with a Drum Hoist is even more complex than comparing the different types of drum hoists because more parts of the hoisting plant are effected.

The first problem is the method of comparison. We think the following is the most logical:

CONDITION	DRUM HOIST	KOEPE HOIST
(1) Cage and Counterweight) Skip and Counterweight) Single or Multi-level)	Single Drum	Single Wheel
(2) Skip and Skip) Single Level)	Single Drum	Single Wheel
(3) Skip and Skip) Multi Level)	Double Drum one Clutch	Two Wheels (Skip & Counterweight each)

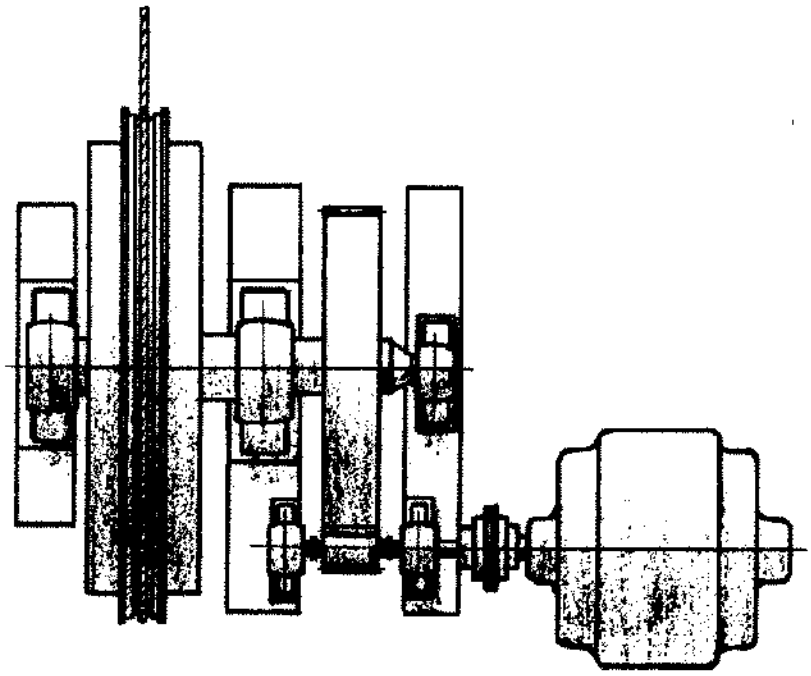

Figure 5.

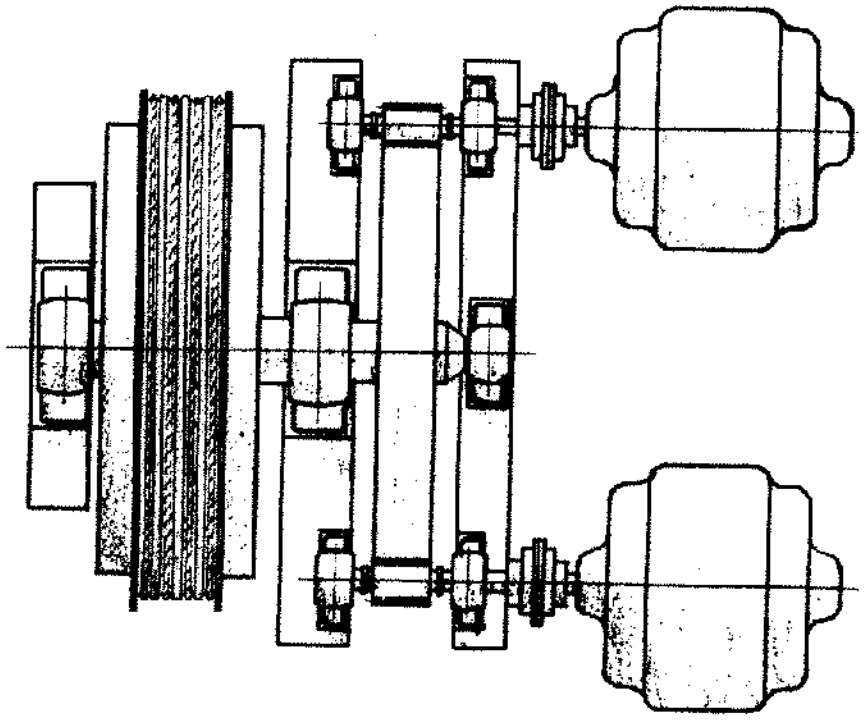

Figure 6.

Condition 3 is not a true comparison since two Koepe Wheels are more flexible than one Double Drum Hoist. This extra flexibility can be advantageous if hoisting two different materials is a condition that prevails. It would take two Single Drum Hoists to equal the flexibility of two Koepe Wheels.

For any one of the three above conditions the factors of depth, speed and load can vary the results of a comparative study considerably. Therefore, the following items will be discussed separately:

MECHANICALS

ELECTRICALS

ROPES

SHAFT LAYOUT

HEAD FRAME AND ENGINE HOUSE ARRANGEMENT

MECHANICALS

In many cases the Mechanicals of the Koepe Hoist will be less than the Drum Hoist. The larger the production and the deeper the shafts the greater the difference. The advantage of the Koepe Wheel here is that it does not require rope storage. For the shallow shaft and heavy unbalanced loads the mechanicals can move in favor of the Drum Hoist, since it would be difficult to maintain the proper T_1/T_2 tension ratio.

ELECTRICALS

In many cases the horsepower requirements and therefore the cost for the Koepe electrics are less than for the Drum Hoist. This is particularly true of deep shafts with high capacities under Conditions 1 and 2.

However, since automatic control is more costly for Friction Hoists it is possible to have a case where the horsepower requirements are close and the electrics are more costly for the Koepe Wheel. This possibility occurs when comparing two separate counterweighted Friction Hoists with one Double Drum Clutched Hoist as in Condition 3 for multi level operation.

Peak power requirements are less for a Koepe Wheel mainly due to the balanced tail rope. Tail ropes can also be used on Drum Hoists to reduce the peak requirements considerably, but the Koepe Wheel cannot be equalled because of the difference in the rotating masses. This peak power advantage of the Koepe Hoist will depend on the local power supply and power contract and may not be an advantage at all.

Much is dependent in the assumption as to shaft efficiency and mechanical efficiency. In our horsepower calculations, we have given the advantage to the tower mounted multi-rope Koepe Wheel since the twist reaction of the ropes can be overcome by using opposed lays of ropes. This reduces friction on the shaft guides. The rope bending stresses are minimized by the absence of headsheaves. When you compare 2 Koepe Wheels to 1 Double Drum Hoist the total efficiency of the two wheels would be reduced for the same production as in Condition 3. Hoisting efficiencies of the two systems have been argued pro and con; however, we feel that the choice of hoisting plants won't be decided one way or the other just on their differences in efficiency.

ROPES

There has been much discussion with reference to the size of ropes that should be used on these two types of hoists. The majority of opinions favor a larger factor of safety on the Koepe Wheel, because the ends of the rope cannot be re-shackled periodically for inspection. The recommended factor of safety of various governments and rope experts vary considerably for both types of hoists, but in any case the Koepe factor of safety is generally higher.

A cost comparison would show that the ropes for the Koepe Wheel would be more than the Drum Hoist and can be twice as much. This initial cost difference is a small percentage of the total hoist and electric cost and, of course, the shaft conditions and local restrictions would determine what effect this difference would have on operating costs.

One point of great concern on multi-rope Friction Hoists is the equalization of load between the ropes. There have been lengthy investigations into this problem and the results have been various types of equalizers, some of which are quite complicated and costly. Some of these investigations are quite involved even to the point of using higher mathematics in proving their validity. All of these investigations are a necessary part of any engineering problem and will and should continue. However, in this case they have a tendency, because of the involvement, to scare a prospective customer from using a multi-rope Friction Hoist. There are many multi-rope systems working quite satisfactorily, some with and some without equalizers. The important point with a multi-rope Friction Hoist or any other type of hoist is proper rope inspection. We feel that whether or not equalizers are used, a satisfactory installation can be maintained if periodic inspection and rope adjustments are made. The important thing to remember is that an equalizer is an aid but not a cure-all.

SHAFT LAYOUT

The shaft layout will be the same with either Drum or Koepe Hoists for Conditions 1 and 2. For Condition 3 where two separate Koepe Wheels are used, extra counterweight compartments are required. While the additional area of shaft is not too costly, the additional cost of fixed guides would be considerable in a deep shaft. With rope guides the additional cost of this counterweight space could be kept to a minimum.

HEADFRAME AND ENGINE HOUSE ARRANGEMENT

The space requirements of a Koepe Hoist are less than for a Drum Hoist under Condition 1 and 2. Under Condition 3 with two Koepes, the space requirements are about the same. If a Koepe Hoist is mounted on top of the headframe, ground space can be conserved. When ground or terrain limitations are critical this is a definite advantage.

We have not had access to good comparative Headframe costs. Here again, any difference in cost would certainly depend on the height of the headframe and the size of the hoisting system. Figures 7 and 8 show a schematic comparison of a ground mounted Drum Hoist and a tower mounted Koepe Hoist. Headframe costs should be considered in an analysis of the two systems.

CONCLUSION

With a given set of conditions, it is not too difficult to compare the Mechanicals and Electricals of a Koepe and Drum Hoist. However, the comparison should not end there, but should also include a comparison of all facets of the hoisting plants affected by each system. After the customer has reviewed the pros and cons of the two systems, he must apply his particular set of values and then a decision can be made.

General statements claiming that one system is better than the other for all conditions of depth, speed and load are impossible.

Koepe Friction Hoisting has definitely found a place in the American Mining Industry and is particularly suited for deep, high capacity shafts. For a given condition both the Koepe and Drum system should receive due consideration until an objective choice can be made.