2nd. Compressed air distributed through pipes.

3rd. Steam distributed as above.

4th. High speed rope or "endless cotton cord," which runs at a speed of 5,000 to 6,000 feet per minute.

5th. Low-speed rope running 1,500 to 2,000 ft. per minute.

6th. Square shaft supported on tumbler bearings.

7th. Steam from a boiler delivered on the top of a piston with multiplying chains similar to the hydraulic system.

8th. Boiler and engine fixed on the Crane and driving gear for the several motions required.

The 1st, 2nd and 3rd can only be applied to cranes fixed or moving over very limited areas. The 4th, 5th and 6th will transmit power over large areas, which, however, should be nearly rectangular. The other two can be used generally wherever there is a railway track. The hydraulic system possesses great advantages over compressed air or steam, but experience tends to the conclusion that its common use will be attended with considerable inconvenience where the winters are cold. The use of compressed air has not been applied with great success in many cases.

Steam is largely used, and frequently carried through 1,000 feet of pipe without much inconvenience. The high-speed cotton cord runs at a speed of 5,000 to 6,000 feet per minute. The cord works in grooved pulleys, is carried on rollers or other supports at intervals of ten to twenty-five feet and is kept in tension by a weighted pulley. Low-speed rope transmission is generally effected by a hemp rope running from 1,500 to 2,000 feet per minute. The square shaft has been used for many years, the only special difficulty experienced being that of supporting the long main line of driving shaft. The Author exhibited recent designs whereby this difficulty has been very successfully overcome. The relative advantage of rope or shaft transmission is largely influenced by local circumstances. As a general rule the rope system costs less and is better where the distance for transmitting exceeds 200 feet. Below that distance the shaft is probably the best and cheapest. But the rope possesses advantages when machinery has to be driven at different levels, or at an angle with the point from which the power is transmitted. The steam crane employed under many differing conditions perhaps performs more functions than any other mechanical arrangement for lifting and placing loads. All such cranes should lift and turn around by steam power. One specially illustrated had additional motions for altering the radius of the jib, for hauling materials so as to bring them within the reach of the machine, and also for moving empty or loaded cars. Fixed cranes are often seen so placed that one-third or even one-half of the number erected at a particular point are idle. It would therefore seem that for the same outlay, the best duty will be obtained from movable cranes. Where two or more railroad tracks are parallel with the water front it will often be desirable to make the crane span the two lines of tracks, allowing headroom for the vehicles to pass under it. Cranes fixed on floating vessels were also illustrated up to 60 tons power. Locomotive cranes up to 25 tons were described and also cranes specially adapted to terminal freight stations. One of these has lifted 80 tons per hour a height of 20 to 30 feet and deposited the loads 1½ to 2 tons each 60 feet from the point where taken up. A similar crane commonly delivers 240 barrels of oil per hour the same height of lift and length of deposit.

The cost per day is one driver's wages and the necessary fuel, oil, etc. Five per cent. per annum is ample allowance for depreciation. The cost of this system of working is easily ascertained, but a great gain also arises from the increased speed of passing large quantities of merchandise.

CURVED CROSS-SLEEPERS.

BY — KECKER.

(*Organ für die Fortschritte des Eisenbahnwesens* vol. xx., 1883 *p*. 31.)

The Author remarks in this Paper that the shortness and curved form of most of the iron cross-sleepers now in use have been regarded as great defects. He determines the most appropriate length, and not only justifies the use of the curved form, but proves its advantages over that of the straight sleeper.

The best length for a cross-sleeper, whether of iron or wood, is found to be 2·57 metres (8·42 feet).

The modulus of elasticity in a beam is found by measuring the reversed sine f of the curve of deflection

$$f = \frac{2\ P}{E\ I} \cdot \frac{(2\ a)^3}{48},$$

where E = modulus of elasticity of prismatic body.
I = moment of inertia with regard to neutral axis of cross section.
2 P = weight over centre of beam.
2 a = distance between supports.

The versed sine of the curve of deflection is thus proportional to the weight 2 P and the cube of the distance between the supports.

It is not necessary to know the absolute weight with which the beam is loaded at its centre, and the amount of its deflection, as long as the proportion to which the deflection increases with the load can be ascertained.

As long as the limit of elasticity is not exceeded, the deflection increases in the same proportion as the load. It would therefore be immaterial whether the beam was originally straight, or shaped according to the curve of deflection. The same applies to an uniformly loaded beam on two supports, as in the case of a cross sleeper, where the ballast forms the load, and the rails the supports, only in this case the deflection would be, of course, less than if the load were concentrated at the centre.

Curved sleepers also possess the following advantages over straight ones. In the former the pressure from the trains acts at right-angles to the sleeper, and is transmitted directly to the ballast, whilst in the latter a horizontal thrust, P cot a (the rails being inclined an angle 90° — a from the perpendicular), has to be borne by the fastenings of the rail and sleeper. Curved sleepers also offer a greater amount of resistance against lateral movement than straight ones.

It might certainly be argued against the curved sleeper that it has a tendency to act as a blunt wedge and force the ballast asunder, but experience proves that this is not the case when tolerably good ballast is used.—*Tr. Ins. C. E.*

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THE ZINC MINES OF MINE HILL, N. J.

BY W. F. FERRIER.

SITUATION, EARLY HISTORY, ETC.

The celebrated Zinc Mines of New Jersey are situated at both Stirling Hill and Mine Hill, but it is with the latter place only that I shall deal in this paper. During the summer of 1883, I accepted the kind invitation of Dr. Cook, the State Geologist of New Jersey, to pay a visit to these mines. He accompanied me to them, and went over the ground with me, explaining all the points of interest. After this I spent some time at Mine Hill, studying the zinc veins and the method of working them, and also collecting the numerous and rare mineral species of the locality.

The vein of zinc ore at Mine Hill is situated in a hill to the N. W. of the Wallkill River, and extends in a S. S. W. direction from the road leading to Hamburgh towards the S. W. end of the hill near the Wallkill. The peculiarities of its formation will be noticed further on. The two names "Mine Hill" and "Franklin" sometimes lead people into the idea that they are two different localities, so that it may be well to mention here, that the full designation of the locality is Mine Hill, Franklin Furnace, Hardiston Township, Sussex Co., N. J. It is situated about 60 miles to the N. W. of the city of New York, on the line of the New York, Susquehanna, and Western Railway. In 1815-16, Dr. Fowler, who was a property-holder of the vicinity, first drew attention to the great variety of minerals to be found in the outcrops of the veins at Mine Hill. He was an enthusiastic mineralogist and although the

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Note.—Summer Essay, Second Year, Faculty of App. Sc., McGill University.