

### A NEW SPEED INDICATOR FOR MARINE PROPELLERS.

When the steamship "Perry G. Walker" collided with the lock gates at Sault Sainte Marie, causing the wreck of two other steamers and doing damage to the locks which required weeks for repair, the captain stated under examination that he had signaled to his engineer to go astern, but that his signal had somehow been misunderstood, and the engines had started full-speed ahead. Such an accident is conclusive and incontrovertible evidence of the need of a reliable system of indicating the direction and speed of rotation of the propellers of vessels. It is but one instance of a chapter of marine accidents occurring annually from either the incorrect interpretation of signals given to the engine room from the bridge or the execution of signals given by the bridge which, owing to mental stress from impending accident, are incorrectly given. It is always extremely difficult for a board of inquiry to determine just with whom the error lies.

In the above instance, it is claimed by the captain that the correct signals were given, but instead of the engines being reversed at the critical moment, they were sent ahead; and before the error was discovered, such headway had been gathered by the vessel as to preclude all hope of stopping her within the limited lock space.

There is no question of the importance of enabling the captain and pilot to be at all times familiar with the interpretation and execution of signals. Errors are thereby immediately discernible, and correspondingly corrected before damage is done.

In the absence of a tachometer to show at a glance the rate in revolutions per minute at which the propeller shaft is turning, signals are executed by the engineer according to his best judgment. For instance, the execution of "half speed astern" may vary eight or ten revolutions per minute, and the pilot, depending upon a speed-checking effect, may be thrown off in his calculations by too slow a rate of turning of the engines.

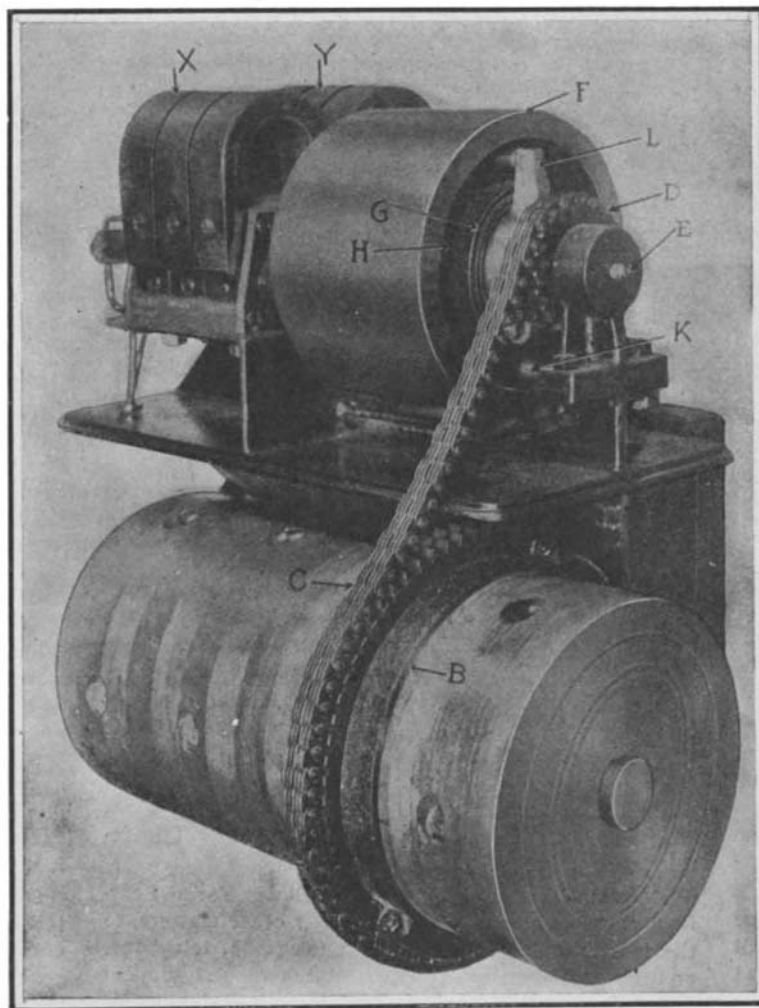
When equipped with a tachometer system, however, the signals can be obeyed at an exact predetermined propeller-shaft speed, with corresponding increased accuracy and efficiency of handling the vessel. Warships in line or column formation must correctly execute the orders of the flagship, setting their speed to conform to the desired headway between ships, quickly and accurately. Otherwise a collision is probable.

The absence of an accurate and dependable tachometer up to the present, has made it necessary to arrive at the revolutions per minute by noting the turns successively by the revolution counter for preferably at least a half minute. If the speed of the shaft is too high, a rough guess must be made as to how much the throttle is to be closed, and another counting gone through. All this takes time, and is on too much of a cut-and-try system. With a tachometer to guide him, the man at the throttle has but to operate the throttle until the pointer of the tachometer rests on the desired R. P. M.

Range finding, for the accurate sighting of the guns, includes the determination of the distance of the object to be fired at, angle at which the warship is

approaching or receding from the target, and the speed at which the vessel is traveling.

The first two factors are quickly and accurately determined by means of the modern range finder in the hands of skilled men, located on the masts or range towers of the warship. This is telephoned to the fire control sub-station. It then becomes imperative that the rate at which the engines are turning over at that instant be immediately determined, in order that the



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proper instructions may be telephoned at once to the turrets. The sooner the discharge of the projectile is effected after the range has been determined, the more accurate is the aim, and the greater the execution done.

In these calculations, the effect on ship speed by propeller speed, taking into consideration the extent and direction of wind and tide, is quickly and accurately calculated.

Relation between ship speed and propeller speed is frequently calibrated with due reference to increased fouling of the ship's bottom from marine growth, and is immediately available. Even when the engine-room forces are endeavoring to maintain an exact pre-arranged speed of rotation, this speed often varies, owing to the absence of accurate deadbeat tachometers for indicating at all times the rate of revolution.

Aside from the strategic advantages of a tachometer for indicating engine speed of rotation, the economic

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### POWERFUL HOISTING AND CONVEYING MACHINE.

Nowhere in the field of mechanical engineering has American ingenuity in the design of labor-saving plants been shown to more striking effect than those great hoisting and conveying plants, which are such a prominent factor in our modern constructive and industrial operations. The rapid and cheap raising, removal, distribution and deposit of materials in large bulk is one of the most serious problems of the day; and it is the ingenious solution offered by American hoisting and conveying apparatus that has enabled our engineers to dig canals, build embankments, handle enormous loads of coal, iron ore, wheat, and corn with an economy undreamed of in an earlier day. We present illustrations of a powerful electric bridge tramway, designed and erected by the Brown Hoisting and Machinery Company for the Michigan Alkali Company, which is an excellent sample of the type of machinery above referred to.

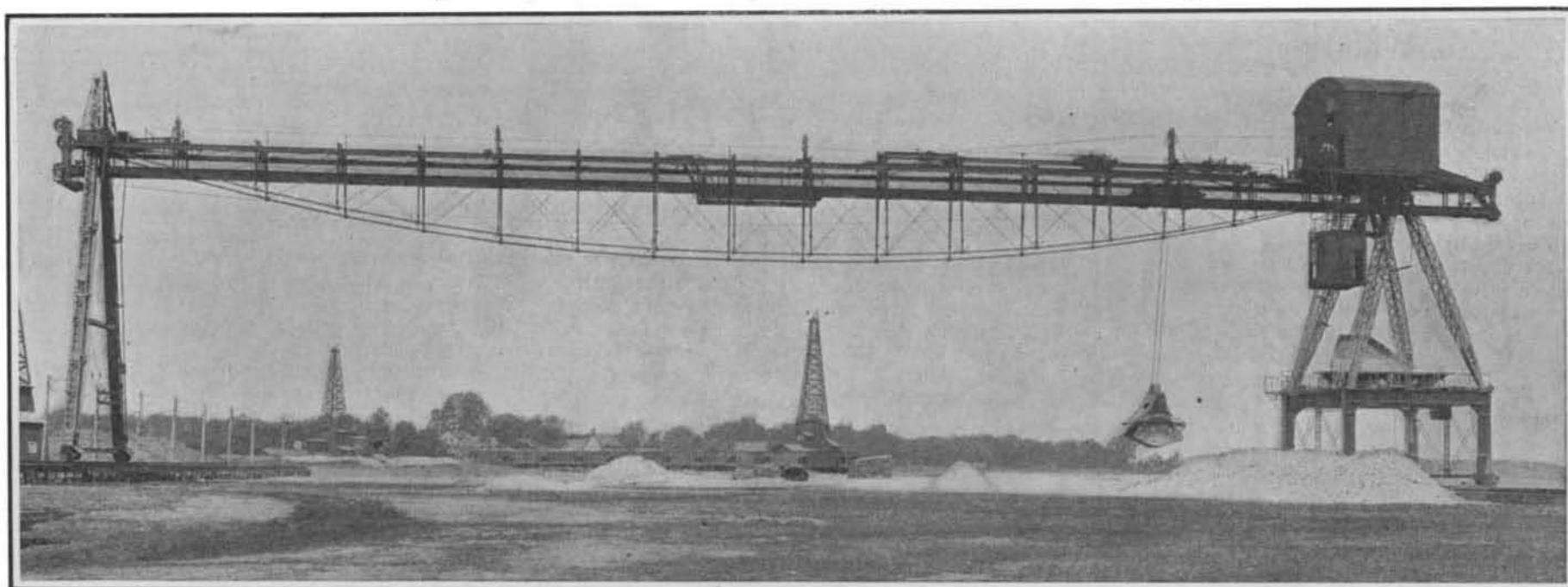
The bridge, which is designed to handle the limestone in the stock yard of the company, has a span of 256 feet from center of pier to center of shear, with the center depth of 17 feet, and the total over-all of the structure is 286 feet 4½ inches. The height from top of rail to top of bridge at the shear is 59 feet 9 inches, and at the pier 61 feet 9 inches, the bridge being level. To the bridge span and its projection is attached a runway carrying a special trolley, arranged to handle either a two-rope grab bucket or a scraper bucket.

The pier consists of two specially designed shear legs mounted on a portal structure, arranged to straddle over two lines of railway track. The two shears are joined together at the top by a yoke connection, designed to carry the bridge structure. By this arrangement a free opening is allowed for the passage of the buckets through the pier support. The structure of the pier throughout is of medium open-hearth steel. The portal or lower portion of the pier consists of two pairs of legs joined together by girders and braces, and arranged to carry a bin for the reception and distribution of the limestone. The lower portion of the portal is mounted on four two-wheel equalizing trucks. These wheels are con-

nected by bevel and spur gears to the driving machinery in the house on the bridge. The shear-leg support is of A-frame construction, mounted on two-wheel equalizing trucks, arranged to run on a single line of rail. At the top of the shear is a ball casting, upon which the main bridge is hung. The track wheels are connected with the moving gear in the engine by bevel and spur gears.

The bridge span consists of two parabolic pin-connected trusses, supporting the cross beams, from which the track stringers are suspended. The bridge span is supported on the pier support by roller bearings, and held in place by a vertical center pin. At the shear support it is hung from a ball-and-socket connection, in such a manner that the bridge may be skewed in either direction from its normal axis, so as to give an angle of one foot crosswise to nine feet lengthwise of the bridge span. The moving gear is operated from the main operating mechanism located

(Continued on page 169.)



Length over all, 286 feet 4½ inches; depth of trusses, 17 feet; height of bridge above ground, 61 feet 9 inches.

Hoisting and conveying machine; capacity 200 tons per hour.

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**A NEW SPEED INDICATOR FOR MARINE PROPELLERS.**

(Continued from page 156.)

function enters largely. Each marine plant has its most efficient cruising speed, and in the case of cargo-bearing merchant marine vessels, every pound of coal saved means increased earnings, also increased cruising area to warships. When this economical speed had been determined, with a tachometer system consisting of a plurality of indicators distributed about the vessel to guide, the engines can be kept at this rate of speed accurately and with but slight effort. The captain, in his cabin or on the bridge, the chief engineer when off duty—all can keep track of exactly what rotation speed is being maintained.

The accuracy of dead reckoning is greatly facilitated by an exact knowledge of what engine speeds have obtained during stated and frequent intervals of time, instead of having to take the total number of revolutions over a protracted period and guess roughly at the distance traveled; because the distance traveled per minute by the ship at say 100 R. P. M. is not increased in proportion when 125 R. P. M. obtains. Therefore, during long periods the rate of speed of the shaft may vary considerably with no tachometer to guide the man at the throttle.

Efforts along this line have been made for a number of years, but have been productive of no dependable and accurate device prior to the invention of the system which is the subject of this article. Centrifugal devices are not susceptible to mechanical transmission to various remote parts of the vessel, and lack extreme accuracy over protracted periods of operation. Pneumatic devices, operated by air-pumps actuated by the propeller shaft, are less accurate. Electrical tachometers have failed in accuracy heretofore because of the error introduced, and varying from day to day, by rubbing or abutting contacts becoming foul, thereby introducing a resistance in the circuit with corresponding inaccuracy of reading of a voltmeter operated by the dynamo, calibrated in R. P. M. of the propeller shaft. Owing to the former use of direct-current instruments, commutators and brushes were necessary on the magnet. The spring tension of these brushes varied, the commutator became oxidized and covered by oil from the bearings, and considerable error crept in. As a warship going ten knots per hour with engines turning over 72 R. P. M. is not traveling ten knots at 71 or 70 R. P. M., it is seen that a tachometer, to be of value, must be accurate to a fraction of a revolution, and maintain its calibration.

All reciprocating engines, owing to the use of connecting rods between the crank and the piston, impart rotation to their shafts of constantly varying angular velocity. The fewer the number of cylinders or the slower the speed of rotation, the greater this variation. These variations are smoothed out more or less by the flywheel on the stationary engine, but a marine engine has no flywheel except a propeller, the weight of which is not sufficient to possess flywheel action to any extent. Therefore, any tachometer actuated by the propeller shaft by gearing or otherwise, has imparted to it an unsteady rate of speed. If the tachometer is geared up to the shaft so that it will rotate faster than the shaft, any momentary irregularity in the revolution of the main shaft is multiplied in the tachometer proportionally to the ratio of gearing between the main shaft and the tachometer. Therefore, whatever indicating device is used in connection with the tachometer will pulsate, and the reading of the pointer on the scale of the instrument will be largely a matter of guesswork between two values of low and high. Hence it is evident that some sort of compensating device must be used to take up these momentary fluctuations of the propeller shaft, and impart to the generator of the tachometer a steady av-

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(Continued from page 167.)

erage speed, not affected except by decided slowing up or acceleration of the engine.

A tachometer has recently been perfected by Mr. Mellor Reece Hutchison, in which these defects are avoided by very simple and dependable means.

The accompanying illustration shows a merchant marine generating set of this electrical tachometer, installed in the shaft alley of a steamer.

The large split sprocket wheel *B*, of proper diameter to conform to the shaft *A*, is firmly clamped thereto. A Morse silent chain *C*, engaged by the sprocket wheel *B*, drives a similar sprocket wheel *D* mounted on a countershaft *E*, which forms part of the tachometer generating set. The rotation of this small sprocket is transmitted to the flywheel *F*, keyed to the countershaft *E*, through the intermediary of two opposite coiled spiral springs *G, H*. Inside the rim of the flywheel *F*, and on the end opposite to the spiral springs *G, H*, gear teeth are cut which engage two pinions. These pinions respectively actuate magnetos *XY*. It is seen that any momentary fluctuation in the rotation of sprocket *D*, occasioned by variations in the angular velocity of the main shaft *A*, are smoothed out by the springs *G, H*, imparting to the flywheel *F* and countershaft *E* a steady average speed. To protect the springs *G, H*, against rupture from sudden reversal of rotation of main shaft *A*, stop pin *K* is mounted on the flywheel, and engages radial arm *L*, mounted on the sprocket wheel *D*, thereby preventing more than one-half an independent revolution of the countershaft. This one-half revolution is sufficient to take care of practical conditions on marine equipments.

The magnetos *XY* are of the inductor type. The armatures and the pole pieces are stationary. 1 is a permanent magnet of finest steel, properly aged to insure absolute permanence. 2 2 are the pole pieces of soft iron attached thereto. 3 is a stationary shuttle armature, on which is winding 4. Rotating between the pole pieces and the armatures is the soft iron inductor 5. As the inductor is rotated, an alternating electromotive force is generated in the armature, two cycles per revolution.

The magneto is so designed that the voltage is directly proportional to the speed of rotation of the inductor, over a wide range. Therefore, the faster the propeller shaft turns, the higher the voltage directly proportional thereto.

It will be noted there are no commutators or brushes, the armature being stationary and the leading-out wires soldered to the main-line wires. Therefore, no error can creep in from increase of resistance of contacts.

The indicators are alternating-current voltmeters of the dynamometer type, i. e., having a moving coil and stationary coils.

In present practice, however, alternating-current voltmeters read but one way, with the zero on the left of the scale. A tachometer, specially for marine use, must show direction of rotation of main shaft as well as the speed. In the design of this, therefore, the zero is at the center, deflections of the pointer to the left indicating speed of rotation of the propeller shaft astern, and to the right ahead.

The pointer of the indicator is deadbeat at its reading, and is not influenced by the rolling or pitching of the ship. Provision is also made to protect the instrument against concussion or atmospheric disturbance from heavy gunfire.

In the naval type each indicator is entirely independent of all the rest, being connected to its own pair of magnetos; hence, should one indicator be shot away or otherwise damaged, it will not affect the reading of any of the other indicators.

In the merchant marine type, however, this is not deemed necessary, one pair

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 Syringe, A. Bean ..... 931,113  
 Tag fastener, Harris & Flood ..... 931,420  
 Talking machine stylus replenishing mechanism, Beulna & Burson ..... 931,676  
 Tanks from bursting by freezing, means to prevent, A. Ballard ..... 931,112  
 Tap, Turner & Dignman ..... 931,526  
 Telegraph and selective system therefor, automatic, A. O. Gilmore ..... 931,065  
 Telegraph and telephone pole, J. H. Hile ..... 931,425  
 Telegraph pole arm, L. Tyerman ..... 931,661  
 Telegraphy and telephony, receiver for wireless, S. Eisenstein ..... 931,586  
 Telephone deck stand, J. A. Birsfield ..... 931,179  
 Telephone exchange selector, automatic, F. H. Loveridge ..... 931,072  
 Telephone exchange switchboard apparatus, J. L. McQuarrie ..... 931,330  
 Telephone exchange system, measured service automatic, W. W. Leach ..... 931,132  
 Telephone instrument mounting, H. E. Shreeve ..... 931,231  
 Telephone key, J. L. McQuarrie ..... 931,331  
 Telephone service rent collecting means, R. Yearneau ..... 931,547  
 Telephone system, private branch intercommunicating, J. L. McQuarrie ..... 931,138  
 Telephone system, private branch intercommunicating, N. H. Holland ..... 931,307  
 Telephone transmitter, A. G. Kaufman ..... 931,127  
 Telephone transmitting mouthpiece, R. E. Miller ..... 931,452  
 Threshing machine, H. O. Sageng ..... 931,347  
 Tie. See Cross tie.  
 Tie plate, A. L. Stanford ..... 931,517  
 Time recorder, W. Beresford ..... 931,254  
 Tire antiskidding device, T. I. Duffy ..... 931,284

(Concluded from page 168.)

of magnetos supplying all the indicators, which are connected in multiple.

A very important fact in Mr. Hutchison's system is the use of an exceedingly small current value and low voltage; hence, in the event of the indicators being located in proximity to ammunition, should the circuit be opened by the breaking of a wire or otherwise, the resultant spark is barely perceptible and cool, therefore incapable of igniting anything. Should the line become short-circuited, no heating effect whatever is produced and no damage done to the magnetos, as they can run for an indefinite time on dead short circuit. No effect is produced on the compass by the current in the wires, and, taken all in all, the system seems to meet every requirement of accuracy and safety.

POWERFUL HOISTING AND CONVEYING MACHINE.

(Continued from page 156.)

in the machinery house at the pier end of the bridge, the power from which is transferred to the moving gear wheels by a line of shafting on top of the bridge, thence to lines of shafting down the pier and shear supports, and thence by a proper train of gears to the wheels.

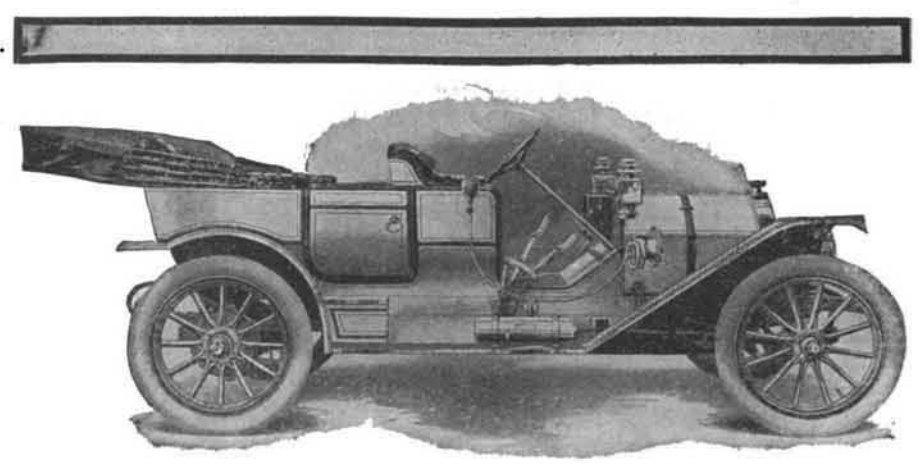
The moving gear mechanism is attached to the operating mechanism by means of friction clutches, so arranged that the motion of the crane may be made in either direction at the will of the operator. Further provision is made for disconnecting the gearing, in order to skew the bridge within the limits given.

The main operating mechanism for the bridge is located in the machinery house, and consists of two drums. Each of these drums is mounted loose on its supporting shaft. Each drum is controlled by a Brown friction clutch and a band friction brake. The drums are connected one to the other through an equalizing gear mechanism, which is equipped also with a powerful foot brake, so that the two main operating drums may be made to rotate in opposite directions with the same speed. This feature of connecting the two drums is one of the all-important points in the Brown two-drum operating mechanism. The main operating machinery is further arranged to operate from the intermediate shaft the bridge crane moving gear mechanism, to which the supporting truck wheels are connected by shafting and gearing. This mechanism is controlled also by a powerful clutch and band friction foot brake.

In further connection with the two main operating drums is a small closing drum which, in conjunction with the two main drums, controls all of the motions of hoisting and lowering the load and traveling the trolley. The trolley, which in reality forms also a part of the main hoisting mechanism, is specially designed to operate in conjunction with the drum arrangement above described. In general, this trolley consists of a steel structural frame mounted on four turned cast-steel track wheels arranged to run on the trolley runway of the bridge crane. In the trolley there are mounted specially-designed drums, which run loose on their supporting shafts. The large section of each drum on the trolley is connected to the main hoisting drums in the machinery house in the following manner:

One length of wire rope will connect, from the under side, one of the main hoisting drums to the top side of one of the large sections of the trolley drums. The under side of this trolley drum is connected by wire ropes to the top side of the other main hoisting drum. The top side of this same hoisting drum is connected by suitable cable to the top side of the other trolley drum, and likewise this trolley drum from the under side is connected to the underside of the other main hoisting drum. By this arrangement of ropes, if one of the main

(Continued on page 170.)



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