Duluth to Liverpool in One Bottom

The Arguments Advanced in Favor of a Deep-Water Route Between the Great Lakes and the Sea

By Robert G. Skerrett

THE measure of our productiveness, the prompt distribution of our multiple commodities, and the satisfying of a restless public, hinge in large measure upon the expeditious movement of our tremendous and steadily increasing volume of freight. The tide of this traffic is today distressingly slowed up by reason of the demoralized condition of our railways, and it is inevitable that we find other means of distribution so that the tide of foreign and domestic commerce may be brought to a state of equilibrium.

We cannot achieve this vital end—a goal which is profoundly linked with the nation's well being—unless we bring the vast industrial areas of the West and the Middle West within easier touch of the seaboard. The citizenry of other divisions of the country seldom realize the economic significance of the States bordering upon or tributary to the Great Lakes.

In certain phases of agriculture, meat packing, dairy products, manufactures, and mineral yields, the total for the United States six years ago amounted to \$29,398,414,000, while the group of interior States just referred to furnished nearly 40 per cent of this magnificent sum. And this is only the beginning of the story: a few of the details will make it clearer how much of a treasure house this region really is. Occupying but one-third of the national area, its wide-awake population produces something like seven-eighths of our principal staples, exclusive of cotton and tobacco. Upon its fertile fields are 75 per cent of our wheat; 65 per cent of our corn; substantially all of our flax; half of our potatoes and sugar beets; 50 per cent of the country's cattle, dairy cows, and swine; 60 per cent of our horses. From the mines in these States come 85 per cent of our iron; 39 per cent of our copper; 74 per cent of our zinc; 46 per cent of our lead. And the geologists tell us that quite 72 per cent of our measured coal reserves lie within this favored zone.

The stimulus of the recent conflict did much to augment many of the foregoing figures; and now as a people we must either help ourselves by helping those States to continue at their present productive pace or we shall have to see them slump as a source of stupendous economic power. In a large sense the future of this section and the welfare of all of us depend upon the Great Lakes being opened to the sea so that ocean-going craft can steam from Duluth to the Atlantic and thence along our neighboring seaboard or afar to the markets of Europe. A deep-water route of this character, ample enough to float laden craft of drafts from 20 to 25 feet, would accommodate the great majority of the existing ocean steamships.

This splendid project has been agitated at intervals during the past two decades and more, and the probable cost would be trifling in comparison with the immediate and prospective benefits to be realized. Indeed, the entire outlay for us, including the deepening of present channels through the Great Lakes and tributary to the cities thereon, would probably not equal one-fourth the sum we gladly subscribed to build the Panama Canal; and the gains in some respects would be much bigger at the very start than those

now reaped by us through the agency of the Isthmian waterway. Thanks to the enterprise of neighboring Canada, the problem broadly reduces itself to submerging certain rapids lying in the international

are now plain sailing with plenty of deep water. The engineering task here would involve the rearing of dams at suitable points across the river to flood the shallows and rapids in about 22 miles of travel. This part of the scheme would rest upon Canada, inasmuch as that section of the river lies wholly within her domain. The river will not be canalized in the usual sense of the term; the submerged rapids would afford broad channelways along which steamers could proceed at full speed. Traffic would be slowed down only when using the canals interposed between Lake Superior and Lake Ontario or when changing level in going through any of the locks. This celerity of movement will mean much toward making it profitable to operate ocean-going freighters over the projected route.

In June of last year, the Lake Grandby, an American freighter, 251 feet long, 43½-foot beam, and of 1,605 net tonnage, sailed from Chicago with a cargo of meat destined for Liverpool. She was the first of a fleet of 15 craft built by the United States Shipping Board and intended for this traffic. However, because the St. Lawrence canals now limit the draft to 14 feet, the Lake Grandby cannot start from her Lake port full laden—she takes on more cargo at Montreal. This means

that when returning from abroad she must also discharge part of her freight at the Canadian port in order that she may steam on to Chicago. With the enlarged Welland Canal available, and with the contemplated dams and their great locks built, big cargo carriers of many thousands of tons could traverse the whole length of the St. Lawrence to and from Lake Erie; and with improved facilities at the Soo and deeper channels through the Lakes here and there, Duluth, Superior, Milwaukee, Chicago, Detroit, Toledo, Cleveland, Buffalo, etc., would have an unhampered outlet to the ocean.

As those familiar with the subject know, vessels laden with wheat bound from Duluth, Chicago, etc., generally break bulk at Buffalo, and the grain is then dispatched by rail or canal to New York, Boston, and Philadelphia on its journey to consignees over-

Map showing how a deep-water route from the Great Lakes to the Atlantic Ocean via the St. Lawrence River would shorten a voyage to Great Britain or Northern Europe by quite 500 miles and yield hydro power for distribution over a wide radius from the dams

(Continued on page 686)

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Duluth to Liverpool in One Bottom

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seas. This entails not only much additional handling, but it involves a good deal of increased expense. If ships could load on the Great Lakes and steam thence to their destinations across the Atlantic without further to-do, under normal conditions grain could be landed in Liverpool, for instance, for five cents less a bushel.

According to the engineering estimates, our part of the proposed undertaking would not involve an outlay of more than \$60,000,000 on the St. Lawrence, and \$100,000,000 would cover that work as well as the necessary channel and canal improvements needful to provide ample passageways for sea-going freighters trading with every first-class port on the Great Lakes. This sum does not loom large if we bear in mind that the State of New York has already spent on its barge canal system a matter of quite \$150,000,000. But other material benefits of an economic nature would accrue to us through our participation in the damming of the St. Lawrence. The outpouring waters from the enormous reservoirs of the Great Lakes would furnish our side of the St. Lawrence with motive force capable of developing substantially 1,000,000 horsepower of electrical energy. Converted into terms of coal burned in steam generating plants, this water-developed power would represent each twenty-four hours a saving of 36,000 tons of fuel. Changing our potential million horsepower into electrical units we have 750,000 kilowatts, which at Niagara Falls rates of \$20 per kilowatt-year would produce a yearly revenue of \$15,000,000. If coal were burned to develop continuously so large a block of energy, the cost in the course of a twelvemonth would amount to \$65,700,000.

The hesitating taxpayer may be inclined to ask: "Do we really want this volume of potential horsepower—do we need it?" Census figures covering the period between 1889 and 1917 should satisfy the doubter and, at the same time, point to what will certainly be required in the course of the next five or ten years. The installed capacity of prime movers in central stations, manufacturing establishments, and the power plants of electric railways throughout New England and New York State amounted in 1900 to 12,270,000 horsepower. By 1910 this total had reached 21,200,000 horsepower, and today the aggregate of these plants represents fully 27,200,000 horsepower. By 1925 this great industrial region will need installations totalling 30,100,000 horsepower, and ten years from now, at the present rate of increase, installations will be called for capable of a maximum development of 33,000,000. And it should be borne in mind that this array of figures does not include the horsepower of locomotives and thousands of isolated steam plants now meeting the demands of widely varying services.

It is true, of course, that navigation between the Great Lakes and the Atlantic would be halted during four months of the winter period, but during the eight months remaining a tremendous tonnage could be moved via this route to and from our intensely productive interior section. The immediate and the reflex economic gains due to this new highway of commerce cannot be comprehensively evaluated in mere dollars and cents. In the winter time, many of the ships that might be employed in the Great Lakes-ocean trade could shift their activities to the Atlantic seaboard. The project in its entirety reasonably promises to deal with the peak-load period of seasonal freights and to lend itself potentially to the general stabilizing of our internal traffic system. Incidentally, it will promote the upbuilding of vast stretches of territory and bring in its train social, industrial, and economic readjustments of primary importance to the whole country.

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What Goes On Inside a Gas Cylinder

IT is a simple matter to take an indicator card of a steam engine. The apparatus for doing this is familiar, and the principles upon which it is built and operated date back to the time of the immortal James Watt. Naturally, in the development of the gas engine, engineers wished to apply the indicator to this new prime mover; but the question of how to do it proved very formidable. An apparatus which functioned very well in an engine running from one hundred to two or three hundred revolutions a minute and using pressures that rarely exceeded a maximum of two hundred pounds to the inch, could not be applied to the internal combustion engine, with its enormous maximum pressures, its wide range of pressure, and its speeds of revolution that run up to three thousand per minute or even more. The illustrations which accompany this article show a beautiful solution of the problem by the engineer whose name the Midgley Indicator bears. We had the pleasure of seeing one of these in operation recently at the laboratory of the Dayton-Wright Airplane Company.

The indicator is composed of two separate units, one of which is connected to the rotating parts of the engine, the other to the combustion chamber of one of the cylinders; the first giving a record of speed and the other of pressure and the two being ingeniously combined in their effect, through the medium of a beam of light, so as to produce a luminous indicator card.

Briefly stated, the luminous diagram is produced by means of a pencil of light and two movable mirrors, the first recording the changes of pressure, and the second the travel of the piston.

The system comprises a six-volt light bulb, *A*, which is used as the source of light; a motor box, *B*, which is supported by a bracket, *C*, clamped to the cylinder to be tested; a concave rocking mirror, *D*, mounted above the cylinder, and a rotating mirror, *E*, which is in the form of an eight-sided prism and is carried at the rear of the motor box.

The front of the motor box consists of a curved pane of frosted glass, *F*, upon which the diagrams are projected. At the back of the box and outside of it is the light bulb, *A*, above mentioned. A beam of light passes through a small hole in the back of the motor box and falls on the concave mirror, *D*. From this mirror it is reflected back through the motor box to the eight-sided mirror, *E*, in the rear of the box, which may be either oscillated or revolved, according to whether pressure-volume, or pressure-time cards are desired. The convergent ray of light is then reflected from the eight-sided mirror and projected forward upon the frosted curved glass, *F*, forming the front of the motor box.

The pressure-element consists of a small cylinder, *G*, and its piston. The lower end of the cylinder screws directly into the combustion chamber, the gases of

This huge stone crusher has a capacity of from 2,500 to 2,700 tons of stone an hour

which are free to pass into the cylinder. The pressure in the cylinder, *G*, raises its piston and compresses a resisting spring. This movement is transmitted through a vertical shaft to an arm which causes the curved mirror, *D*, which is mounted on the top of the cylinder, *G*, to rock on its horizontal axis and so change its vertical angle in proportion to the pressure on the piston. Thus, it can be seen that, as the pressure rises, so the reflected beam of light will rise upon the octagonal mirror at the back of the box and conversely, with the fall of the pressure, there will be a fall of the beam of light.

The eight-sided mirror, *E*, at the rear of the motor box is mounted on a vertical shaft, which is so geared that it rotates at exactly one-eighth engine speed. The movement of this mirror causes the beam of light to move to and fro across the curved glass front, *F*, of the motor box, which has been made ninety degrees in order that the beam of light focused and reflected

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A Giant Among Stone Crushers

A HUGE stone crusher with a capacity of from 2,500 to 2,700 tons of stone per hour has recently been installed in a Michigan quarry. This stone crusher, which is said to be the largest in the world, has been the center of attraction for quarrymen ever since it assumed its finished lines in the Pennsylvania machine works.

This large stone crusher, which is shown in the accompanying views, was built in ninety working days. Furthermore, despite its great weight and bulk, it was loaded on the cars, transported, unloaded and set up ready for work in fourteen days; a remarkable record, to be sure. The upper view, showing the revolving member which in conjunction with the stationary member does the crushing, weighs 65 tons.

Measuring the Flow of Liquids

INSTRUMENTS for measuring and recording the flow of liquids have recently been brought out by a large British firm. In a description of these the curve deduced for the formula chosen to represent the flow of water over a weir or notch is cut on a drum in the form of a spiral or screw thread, the pitch of which increases from the zero end of the drum in correspondence with the increased rate of flow over the weir or notch as the depth of water increases. A float having a fine toothed rack attached to its spindle is placed the weir channel or in a chamber connected with it, and this rack engages with a union on the axle of the drum, so that the latter rotates as the float rises or falls. In cases where the depth of water exceeds about 12 inches a chain sprocket wheel is substituted for the rack and pinion. A pin attached to the end of a saddle arm engages with the screw thread and imparts a lateral motion to a slider bar carrying a pen, which is thus caused to move over a chart equal distances for equal increments in the rate of flow. The proportionate diagram obtained in this way can be readily interpreted by the aid of the planimeter and the total volume of water passed in any given time determined. The beak of the saddle arm as it moves along the graduated spiral groove gives a magnified indication of the rate of flow, and a pointer attached to the float rod shows on a scale the actual depth of water in the weir.

In another form of the instrument an integrating arrangement is added; this counts up the total number of gallons or cubic feet passed, and the quantity can be read off directly from ordinary counting dials. These recorders, for which an accuracy within one per cent is guaranteed, are applicable not only to determining the flow of rivers and streams, but also to measuring the feed water to boilers and the condensate from engines and turbines, as a check upon steam consumption and the efficiency of the plant.

1. The optical system which provides a means for indicating either the pressure-volume or the pressure-time relations within the cylinder of an engine by making use of a beam of light. 2. Normal pressure-time card taken with the new indicator. The new indicator, by giving diagrams with pressure and time co-ordinates, has opened a new field for studying the behavior of fuels in internal combustion engines. 3. The synchronizer and rotating mirror—a detail of the mechanism shown in the first view of this group. 4. A conventional pressure-volume card.

Some features of a newly developed indicator for internal combustion engines and the results

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What Goes On Inside a Gas Cylinder

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from the rotating mirror may be moved across the ground glass once for each revolution of the engine. Just at the point where the beam of light reaches the limit of the glass screen, the next succeeding face of the rotating mirror engages the beam of light and simultaneously reflects it to the opposite end of the glass screen. In this way the pressure-time relations with the engine cylinder for two revolutions, or one cycle, are rendered visible on the ground glass in the form of a pressure-time card.

It should be explained that, for taking pressure-volume cards, a synchronizer is provided, which oscillates the eight-sided mirror within the motor box in synchronism with the reciprocating motion of the engine piston.

We present two cards, one a conventional pressure-volume card, and the other a normal pressure-time card, both taken on a Midgley Indicator.

The conventional indicator card shows the relations between pressure and volume in the engine cylinder; but the pressure-volume card is not well adapted for making a study of the phenomena occurring during the combustion in an internal-combustion engine. The reason for this is that ignition and combustion occur when the piston is close to top dead center, during which time the horizontal movement along the pressure-volume card is so small that pressure changes are recorded merely as a single vertical line. The pressure-time card is preferable because the movement along the horizontal or time axis is always uniform, thus making pressure changes clearly distinguishable.

Photographic indicator cards are obtained by holding a sheet of bromide paper against the glass front of the motor box. By pushing a button, the voltage of the light circuit is increased for exactly two revolutions of the motor, and the result is a sharp black line on the photographic paper.

What is Wrong with Our Paper Supply?

(Continued from page 674)

the drive to prevent stretching the paper and tearing it as it passes through the machine. The difficulty has been met in several ways. One form of drive is by a train of gears, each gear being provided with a friction clutch to provide flexibility. Another form of drive is by rope pulleys. In either case there is a limit to the possible speed. A new form of drive has just been devised using synchronous motors with a special control mechanism to govern the speed.

The machine is divided into sections and each section is driven by an individual motor. The speed of each motor is carefully adjusted and controlled to a fine degree of accuracy by the special control mechanism. Recent installations of this type of drive have shown that it gives the mill an almost unlimited range of speed, permitting the machine to be run at all times at the highest speed the pulp will permit.

It is possible this invention will relieve, in some degree, the present shortage by speeding up existing mills which have a good pulp supply available. Wherever possible paper mills have been located near water falls so that a supply of cheap electric power is available, making the motor drive most practical.

Woods similar to spruce, such as fir and pine, are sometimes used for pulp, but the resin in them fouls the machinery to such an extent as to halt operations frequently. Materials other than wood cannot be used economically in the sulfite process because of their light weight for the bulk involved. Thus cotton stocks have been found to produce a good sulfite pulp but only one-fourth the weight of cotton stocks, as compared with spruce, can be put in the digester at one time.

The same amount of chemicals and cooking are required, so the treatment cost is about four times as great for a given quantity of pulp. The cost of collecting the cotton stocks also is prohibitive and it is doubtful if a sufficient supply could be had.

Experiments are being made now with a species of southern grass, but the same objection applies in the making of sulfite pulp. It is possible, however, that a substitute for ground wood will be developed from this or a similar source. Great quantities of the grass are available in our Florida swamps. But here another difficulty is encountered. There is no coal or water near the grass supply and it takes nearly as much coal as pulp to produce a ton of paper. So it would probably be more economical to haul the grass to the present northern mills than to build new mills at the source of such a supply.

Scientists at Columbia University are conducting a series of experiments with bamboo as a substitute for spruce in the production of book papers. Bamboo grows very rapidly in the tropics so that a paper mill located in the center of a bamboo forest would have a perpetual supply by rotating its cutting operations, with the plant as the center of a circle. There is good assurance of the ultimate success of these experiments.

Bamboo pulp produces a fair quality of book paper and there is the possibility, as our knowledge of the methods of making bamboo pulp improve, that one day our paper industry will be transferred largely to the tropics and that our newspapers will be printed on quality of paper equal to that now used in magazines. The paper may cost even less than ordinary newspaper, such as we know it now. Another angle of the problem in which a little work has been done is the reforesting of the lands devastated by our present mills.

Relief might come from still another source. As noted above, the chief reason many other woods cannot be used instead of spruce is because of the resin in them. Fir, for instance, has an appearance very similar to spruce, both in the tree and in the board, but it cannot be used, except to a limited extent, because of the resin in it. If some economical method of extracting the resin could be found, fir and other woods would be made available and the supply of raw material multiplied many times. This, however, seems a rather forlorn hope.

In fact, with the exception of the new electric drive for paper machines, none of the possible remedies for the situation reviewed here offers hope for any immediate relief. The chief reason is the skepticism of the paper industry itself as to new schemes. Too many of them have already been tried with no results and any new method that finds general adoption will first have to be demonstrated by some venturesome soul in competition with the established methods of the industry.

But it is the history of invention that whenever a great need arises, there usually is found a way to meet it. It would seem that this is the psychological moment for the introduction of some revolutionary idea or invention in the paper industry. Indeed, now that the problem is being tackled by real scientists in a serious way, it is not at all a wild guess that some way out of the "blind alley," in which the paper industry finds itself, will be discovered within the next few months or years.

Until some new material or method has actually been demonstrated it would be worse than folly—almost suicide—to continue our course of cutting off our only source of raw material—spruce forests—without reforesting.

As for the immediate future—the next year—there seems little chance of escape from the present paper shortage and possibly higher prices.

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