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THE NEW AND ENLARGED WATERWAYS
REQUIRED TO MEET THE DEMANDS
OF COMMERCE IN RUSSIA

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THE NEW AND ENLARGED WATER-
WAYS REQUIRED TO MEET THE
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Russia possesses a large number of very important navigable rivers, such as are found in no other European country. Most of these rivers are so situated as to be easily united into uninterrupted navigation lines, by means of canals connecting the upper waters of the different streams. The sources of several large rivers are separated by only slight elevations of small area. These natural conditions of the river system of Russia are exceptionally favorable to the development of internal navigation. In comparing the navigable lines of France and Germany with those of Russia, it is noticeable that in France the rivers are comparatively small, with small low-water discharge, and, as a rule, rather steep grades. This is the reason why, with a few exceptions, the French rivers have needed to be canalized and provided with locks, in order to serve with advantage for internal navigation. Specially of late, since the extensive development of railroads, the rivers of France, which in their natural conditions could only carry very small boats, could not have withstood the competition of the railways without the extensive constructive works which have created and maintained sufficiently large and deep channels to allow of the circulation of the larger boats, which alone are able to carry merchandise at low rates. Naturally, under these conditions, the establishment of the system of navigable ways in France has necessitated large expenditures.

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In Germany the navigable rivers are larger, so that their improvement has been much less expensive than was the case in France. German rivers have slighter grades and larger discharge of water. Usually, it has not been necessary to canalize or lock them, in order to obtain sufficient depth of water. Works of regularization, which are much less costly than those necessary for canalization, have been sufficient. Thus the natural qualities of the rivers of Germany are more favorable to their improvement for navigation, which can be realized at comparatively moderate expense. From what we have said it follows that the same amount spent for improvement of navigable ways will produce greater results in Germany than would be possible in France.

In Russia, the natural conditions of the navigable rivers are still more favorable. The majority of the large streams have comparatively insignificant grades, with large discharge, which facilitates very much up-stream navigation. On the large rivers, there are but few rapids and falls. There are but very few that are entirely impracticable or that present great difficulties to navigation. On our largest river, the Volga, from the town of Tver down to the Caspian Sea, a total distance of 3,000 kilometres, there is not a single cataract. Other large rivers, like the Dwina of the North, the Neva, the Vistula, the Don, etc., have none; or, if there are a few, they are but slight rapids. Among the large rivers, the Dnieper alone, in its lower course, has very considerable rapids, presenting great dangers to down-stream navigation, and entirely forbidding up-stream navigation, so that the Dnieper is, so to speak, cut into two separate parts,—that below the rapids, extending 350 kilometres, and that portion above, with a length of 1,500 kilometres. In order to give an easy passage through the rapids of the Dnieper, it would be necessary to establish locks. This, however, is but an isolated case; and most of the rapids of small importance on the other large rivers are practicable even for up-stream navi-

gation in their natural state, without any constructive works, and it is but in rare cases that recourse is had to towage. It may be said, in a general way, that on the rivers of Russia boats may ply, most of the time, thousands of kilometres without meeting with rapids or cataracts of any importance. All the above conditions contributed to the development of interior navigation in Russia at a time when the population was still small and the financial means of the country amounted to figures quite insignificant. The oldest of the commercial cities of Russia, Novgorod, has had an exceptional development, owing to its favorable situation on the banks of one of the large navigable rivers, the Volkhoff,* which flows from Lake Ilmene to the Baltic Sea. The upper waters of one of the tributaries of this lake, the Lovate, are but a short distance from the sources of the Dnieper, which, after a run of some 2,000 kilometres, discharges into the Black Sea. These two rivers, the Volkhoff and Dnieper, with Lake Ilmene and its tributaries, were used in olden times for transporting merchandise from the Baltic to the Black Sea, and *vice versa*. The merchandise was transported from one basin to the other, over the summit, on men's backs. Large quantities of freight thus reached Novgorod from the region of the Volga, by going up the Tvertsa, an affluent of the Volga, then, after a short portage over land, coming down by the Msta, an affluent of Lake Ilmene, from which, as we said, flows the Volkhoff.

The first lines of artificial navigation used to unite the basins of the different rivers in Russia were built toward the end of the seventeenth century, under the Emperor Peter the Great, who personally took the initiative. After some unsuccessful attempts to connect the Don with the Volga and the Oka, Peter the Great built the Vychenevolotsky Canal, uniting an affluent of the Msta with the Tvertsa. As above stated, the Msta flows into Lake

* See the Hydrographic Atlas of the Principal States of Europe, published by the Ministry of Public Works in Paris.

Ilmene, from which starts the Volkhoff, emptying into the Baltic. On the other hand, the Tvertsa flows into the Volga. Thus the Vychenevolotsky Canal unites the waters of the Caspian Sea with those of the Baltic. Since the time of Peter the Great, the principal navigable rivers of Russia have gradually been connected by canals. Thus, besides the Vychenevolotsky Canal, the Volga has also been connected with the Baltic by the Tikhvinnsky and Mary Canals, the latter being the most important of the artificial navigable ways of Russia. There is between the tributaries of the Volga and the Dwina of the North the "Duke Alexandre of Wurtemberg" Canal.* The Dnieper has been connected by three canals with the Vistula, the Niemane, and the Dwina of the West; and the two last-named rivers are themselves connected by a fourth canal, the Augustoff Canal. All these artificial ways were built at the commencement of this century, and have from time to time followed the same fate as the Erie Canal in America; that is to say, their dimensions were no longer sufficient to serve the modern requirements of shipping. For this reason the Erie Canal had to be rebuilt scarcely twenty years after its completion. The above-mentioned Russian canals have lost their preponderant importance for freight transportation, which is largely done by the railroads. Commerce is now clamoring for the reorganization of the existing lines and the establishment of new artificial waterways. The renewing of our whole system of artificial navigable ways would require enormous sums of money. Up to the present time, only the reorganization of our principal artificial line of internal navigation could be undertaken; that is, the Marie line, or, as it is called in Russia, the "Marie System." For several decades, Russian commerce has been calling for the reorganization of this route, connecting the largest river of Europe, the Volga, with the capital of the Russian Empire, and with the Baltic, forming thus an uninterrupted line of navigation

* Named in honor of the Director-General of the Lines of Communication of that name.

from the Caspian Sea to St. Petersburg, with a total length of more than 4,000 kilometres. The city of St. Petersburg is situated in the delta of the Neva River, near its mouth. The Neva rises in Lake Ladoga, and falls in the Baltic, and has a length of 65 kilometres. It has an abundant supply of water from Lake Ladoga, and a depth and width of channel amply sufficient not only for the circulation of the boats in actual use, but would present no difficulties for larger-sized boats.

Lake Ladoga, from which flows the Neva, presents many difficulties to navigation: it is subject to storms, so that the shipping coming from the "Marie System" can only cross the lake with great danger. For this reason it has been circumscribed by canals on its southern side for a distance of 168 kilometres. Along this whole distance there is a double line of canals. The older canals, built partly during the last century, partly early in the present century, are situated the farthest from the lake: whereas the newer canals built later on—1863 to 1883—are between the lake and the old canals. The loaded boats take the new canals: the old are used for logging and for empty barges or light loads, going from St. Petersburg to the Volga. The Ladoga canals connect on the east with the mouth of the Svir River, which flows from Lake Onega to Lake Ladoga. The Svir River, for a distance of 200 kilometres, forms part of the "Marie System." For most of its length, this river has sufficient depth and width for navigation. But rocks and rapids, of which there are several in its course, present difficulties from want of depth and from the great rapidity of the current. Lake Onega, from which flows the Svir, is also surrounded by a canal called the Onejsky, about 65 kilometres long. Then comes the Vytegra River, which is locked on nearly its whole length, and connects at its upper end by a canal and locks with the Kovja River. This canal, called the "New Marie Canal," forms the summit level of navigation between the Neva and the

Volga. This canal was built some ten years ago to replace the old Marie Canal, which passed through Lake Matko, and was for this reason, and on account of its numerous locks, not convenient for navigation. The new canal goes around this lake, and has only two locks instead of nine on the old one. The Kovja falls into Lake Bielo-Ozero, which is also turned by a canal 67 kilometres long, called the Bielozersky Canal. From Lake Bielo-Ozero flows the Chekska River, which joins the Volga, near the city of Rybinnsky, and forms the last link of the Marie System of navigable ways. The Chekska is more than 400 kilometres long, with a total fall of 35 metres, very unevenly divided along the course of the river. For nearly 100 kilometres there is an almost uninterrupted series of rapids, with steep grades. These rapids present the greatest difficulties to internal navigation on the whole route from the Neva to the Volga, and freight charges on this portion of the Chekska are very high. But still the advantages presented by the navigation over railroad transportation were such that, notwithstanding the building of several railroads connecting fertile countries situated on the banks of the Volga with the Baltic ports, the traffic on the Marie route of navigation continually increased, and four years ago already amounted to over a million tons. No further increase in the traffic could take place without a fundamental reconstruction of several portions of the route. The number of boats had reached 3,400: with the short season of navigation — about five months — and the double lift locks situated on the route, this number could scarcely be increased. It was then decided to rebuild all the locks, increasing their size, so as to pass boats of 65 metres in length and 650 tons burden, whereas the old style boats carried but half this amount of freight. At first, when the question of rebuilding the “Marie System” was brought up, the shipping interests wanted the adoption of a model of boat corresponding to the large boats used on the Volga, having

85 metres in length. The administration of Lines of Communication did not see things in the same light: these dimensions seemed exaggerated, and it was feared that they would not be so easily handled. Besides, in adopting the size of boats used on the Volga, it would have been necessary to entirely change the lines of the Marie route by widening the channel, and avoid all sharp turns or curves, which would have increased the cost enormously. The topography of the country where the locks of the route are situated is such that the locks have to be placed close together, so that sharp curves cannot be avoided. Under such conditions, boats of great length (85 metres) could only circulate at reduced speed, thus preventing most of the boats returning the same year to their starting-point, and would present great hardships for the crews, who would be obliged to pass long winters away from their homes. Gradually commerce and the shipping interests became convinced of the exaggeration of their demands, and saw that the reorganization of the Marie Navigation Route, so as to admit of the circulation of the large barges of the Volga, would necessitate extraordinary expenses without being absolutely indispensable. As early as 1887, the Chambers of Commerce of the cities the most interested in the wheat trade, supplied by means of the navigation route from the Volga to St. Petersburg, began to make appeals for the adoption of a plan of reorganization of the "Marie Route" such as would answer for the use of barges 64 metres long, 9.60 metres wide, and with a draft of 1.78 metres, of about 650 tons burden. Boats of this model would allow of a great increase in the traffic: in fact, it could be double its present amount. The present boats on this route measure only 42 metres, with a capacity of about 350 tons.

In order to obtain the results required, the following works were found to be necessary. On the Onejsky and Ladojsky Canals and the Svir River there is considerable excavation and rock-cutting going on; for the canals were

somewhat silted up, and the Svir River presented many shallows over ledges, with insufficient water. On the Kovja and Vytegra Rivers and the "New Marie Canal," which unites them, all the locks have been rebuilt of wood, like the old ones, but of larger size, suitable for the new model of boats. Instead of twenty single chamber locks and eight double locks, one above the other, there will be thirty-two single chamber locks. This is done by increasing the fall on some of them, which was previously very unequal: the new ones are about alike, the fall not exceeding 3.50 metres. The channel will be 25.60 metres wide in the tangents, and the curves of at least 240 metres radius. Where the curves are sharper than this, the width has been correspondingly increased. The Bielozersky Canal has been widened and deepened. As on this canal there are straight sections several kilometres long, without any curves, 23.50 metres has been adopted for the width in these sections instead of 25.60, as in the other sections. On the Chekska considerable work of canalization and regularization is being carried on. In the upper portion of this river there are several quite sharp curves. The improvements in these sections consist in cuttings having 25.60 metres in width at the bottom and a minimum radius of 530 metres. Near the outlet of the Bielo-Ozero Lake, a weir of the Poirée System is being constructed, with a lock for the passage of boats going from the Chekska to the lake and *vice versa*, and to retain in the lake a portion of the flood waters, which are to be supplied to the river during low waters, in order to increase its flow. In the central portion of the river, where there are several important rapids, three large lock chambers are being built in lateral canals, capable of containing whole tows, consisting of four barges and their tug-boat. The available length of the chambers is 320 metres. Near each lock the river is closed by a weir of the Poirée System. These are in the principal rapids. Several less important rapids are being improved by rock excavation.

The lower portion of the river abounds in sand bars, over which the new model of boats could not pass. These are being removed by the construction of longitudinal dykes and training walls, both formed of fascines and rock-work. At the present time, over one-half of the proposed works are completed. It is expected that the whole route will be completed and turned over to the navigation of the new model of boats by 1895. The administration of Lines of Communication is actually building one of the new type boats, to be used as a model by which to build others. One of the great difficulties in this reorganization of the "Marie Route" is the fact that navigation must not be interrupted during the prosecution of the work. This route is so important for the transportation of wheat to St. Petersburg that even a temporary closing would almost amount to a disaster. For this reason the work had to be planned out so that all construction which might interfere with, or completely stop, the passage of shipping should be carried on in winter. During the past year, when there was a cholera epidemic in several parts of the Empire, special precautions had to be taken on the works of reorganizing the "Marie Route," where, at short distances apart, gangs of several thousand workmen were engaged on the improvements. Notwithstanding these difficulties, the works are progressing rapidly, so that they are somewhat ahead of the estimated time.

The work is subdivided into three contracts,—one for the excavations on the canals of Lake Ladoga, a second one for all the works on the Vytegra and Kovja Rivers and the Marie Canal which unites them, the third contractor is enlarging and deepening the Bielozersky Canal and executing all the works on the Chekska River (weirs, locks, dykes, cuts, etc.). The improvements on the Svir River and the Onejsky Canal are being done by day labor, under the charge of the Direction of Lines of Communication of the Vytegra Arrondissement, which also has the supervision of most of the rest of the work, which is under

contract, as above stated. The head of the Direction, Engineer and State Counsellor Zviagintsef, has for several years been studying the project of the reorganization of the "Marie System" of navigation. Fifteen years ago he was sent out by the Russian Imperial Ministry of Lines of Communication to the United States, where he studied the great works of reconstruction of the Erie Canal, which was already completed at that time. The rich harvest of information gained during this trip helped him to the conception of the vast project for reorganizing the navigation on the "Marie System," the execution of which, we just stated, was being carried on successfully toward completion.

After the completion of these important works, there will still be other works and problems connected with the improvement of the navigation lines of Russia, the extreme importance of which must not be overlooked. One of these problems is that of the connection, by means of an artificial waterway, of the Lower Volga with the Don River, which empties into the Azoff Sea, a bay of the Black Sea. This project dates from olden times. Sultan Selima of Turkey, back in the sixteenth century, started to dig a canal between the Ilovla, an affluent of the Don, and the Kamychnenka, which empties into the Volga. He expected to use this canal for the transportation of his army. Works were begun in 1568 in a locality actually forming part of the province of Saratoff, but were not completed. Probably it was expected that a communication could be had simply by cutting away the summit that separated the respective affluents, taking no account of the steep grades existing in this region; and, as at that time chambers with locks were unknown, the enterprise naturally failed.

Later on the Emperor Peter the Great, who had conceived a vast plan for connecting all the principal rivers of Russia by means of lines of internal navigation, took up the question of canal between the Volga and the Don. At the end of the seventeenth century, he confided the

direction of the works of this canal to Colonel Broeckel, who, however, was not able to overcome the many difficulties that presented themselves in carrying out the work, and he left the works soon after their commencement. Then Peter the Great appointed the English Engineer, Perry, director of the works. He built a portion of the cut between the Ilovla and Kamychennka Rivers and several locks. But in 1701, owing to war declared between Russia and Sweden, the troops that were working on the canal were recalled, the works stopped and have never been resumed. Still, the problem of uniting the Don and Volga by a canal has continued to occupy the thought of the engineers. Under Nicholas I., the Direction of Lines of Communications had detailed studies made on the grounds, which served as a basis for a project of canal from the Volga to the Don. But the estimated cost of this work was such that it was never carried out. A few years ago a private company (Franco-Russian) was formed, which obtained from the government the permission to make new studies for a canal from the Volga to the Don. These studies were carried on in 1885-86, and the result was a preliminary project of canal by a new route. But the elaboration of the details necessary before the plan can be presented for examination to the Russian Imperial Ministry of Lines of Communication is not yet complete. However, one of the founders of the company, Mr. Leon Dru, published in 1886, in Paris, a pamphlet under the title of "Project of Canal from the Don to the Volga: Report on the Project. Franco-Russian Civil Society for the Promotion of the Don and Volga Canal." This contains a description of the principal points of the project. The canal is to serve for navigation of boats 64 metres long, 12.80 metres wide, with a draft of 2.13 metres. It is proposed to start the canal from the right bank of the Volga, 16 kilometres below the city of Tsaritsine. Thence it follows up the valley of the little Proudovaia River, an affluent of the Volga, clear to the summit, thence descend-

ing by the valleys of the little rivers, Yagodnaia and Karpofka, toward the Don. The total length of the canal from the Volga to its outlet in the Don is 85 kilometres. The summit section is 10.8 metres long and 85 metres above the level of the Volga. On the Volga side, which is 7.46 kilometres long, there are twenty-one locks, with an average fall of 4 metres: the other branch, descending toward the Don, presents twelve locks in a length of 67.2 metres, and a total fall of 42 metres. The most important excavations are at the summit, where for over 4 kilometres the depth of cut reaches 30 and even 40 metres. The canal is to be supplied by means of reservoirs, storing rain and snow water. Plans have also been prepared for raising the waters of the Volga by means of powerful steam pumps. The total cost is estimated to be about fourteen millions of dollars.

The Volga-Don Canal would have great advantages for the grain trade. During several months of each year the transportation by water of the wheat crops of the fertile countries along the Volga, toward the Baltic ports, is interrupted by ice. A navigable route from the Lower Volga to the Don would allow these crops to reach the Black Sea during that portion of the year when the northern routes and northern ports of Russia are closed by ice. Besides, this route would allow the products of the vast basin of the Volga being brought to a shipping port without having to be taken up stream. On the contrary, they would come down stream to Tsaritsine, and, after crossing the short canal from the Volga to the Don, would continue down this latter river. This would naturally reduce the cost of transportation.

Another project of interior navigation, the execution of which might have great influence in developing the navigation on another of our large rivers, the Dnieper, is the improvement of the rapids situated on its lower course, between the cities of Yecaterinoslaf and Alexandrofsk, where at the present time only down-stream navigation and log-

ging is possible, and even this with considerable difficulties and dangers.

Thus, one of our largest rivers, which from the earliest times has been used for transportation of merchandise between the north and the south of Russia, remains up to the present, cut into two separate parts, between which no regular navigation can be carried on. Soon after the union of the south-western provinces with the Russian Empire, the government undertook the improvement of the navigation of the Dnieper rapids. In the second half of the last century, about 1780, some rock excavation was done, by means of powder, to remove the most dangerous rocks. At the same time lateral canals were excavated in the Nenassytets and Kaidaki rapids. At the time of the trip of the Empress Catherine II. to the south of Russia, in 1787, the corps of pilots was established to pilot oats and logging rafts through the rapids. In the first years of the present century, the work of rock excavation was continued, and three lateral canals were begun, without locks, in the three first cataracts below Yecaterinoslaf, and one locked canal in the most dangerous cataract, that of Nenassytets, from plans prepared by General Devolant of the Engineer Corps. But these works were not completed, owing to the insufficiency of the sums appropriated for them. Most of these works were destroyed by the waters and the ice. About 1830, the General Direction of Lines of Communication (later on transformed into a Ministry) had plans prepared for extensive works intended to make these rapids accessible for up-stream navigation; but, owing to the enormous expense that these works would have involved, it was found necessary only to undertake the improvement of the rapids with a view of down-stream navigation only, by means of non-locked lateral canals, limited on each side by random rock dykes. The first of these canals was begun in 1833 in the Old-Kaidaki cataract: the building lasted eight years, and was completed in 1841. In the other eight cataracts the works lasted till

1854. The construction of these nine canals and some rock excavation in the secondary rapids, which are very numerous between the principal ones, cost about one million dollars.

The above-described canals present, no doubt, advantages for down-stream navigation, especially in low waters; but they are not sufficient to allow of boats passing up stream, and consequently do not afford an efficacious final improvement of the Dnieper rapids, which can only be done by means of locked canals, owing to the extreme steep grades, reaching over 4 metres per kilometre in some places.

For several years, systematic rock excavations have been going on in the rapids for removing the most dangerous rocks and ledges by means of dynamite. But a project for the final improvement of the Dnieper cataracts is still to be elaborated. It is a difficult problem, quite unique of its kind.

“The Iron Gates” of the Danube, the regularizing works of which have been pushed forward since 1891, are much more easy of treatment than the cataracts of the Dnieper. At the Iron Gates of the Danube the cataracts are less numerous, not so extensive, the grade and velocity are less, and the rock is not as hard as on the Dnieper.

It is to be hoped that the experience gained on the works of the regularization of the Iron Gates will help to hasten the solution of the problem for the complete and final improvement of the cataracts of the Dnieper. At the present time, the budget of interior navigation is pretty well loaded down with the large expenses necessitated by the works of reorganization of the Marie Navigable Route (from the Volga to the Neva). When these works are completed, which will be in 1895 or 1896, it is hoped that means may be more easily obtained for executing, in the domain of interior navigation, other very urgent works, among which the canalization of the cataracts of the Dnieper is of very great importance, and merits special attention.

I do not wish or intend to retrace, in this brief notice, a programme of all the navigable routes, the execution of which would have an important bearing on the development of our interior navigation; but it is proper to state that there are still several principal arteries between our large rivers missing, and that most of our artificial navigable routes have to be rebuilt the same as the Marie Route, in order to satisfy the requirements of modern shipping, which, in order to compete with the railways, is obliged to use boats of very large capacity and draft of water.

Besides the canal from the Volga to the Don, already spoken of, it would be of great importance to connect the Volga and Dnieper, by an artificial navigable route, which could be done by means of the Oca, one of the principal affluents of the Volga and the Desna, which fall into the Dnieper near Kief. The respective affluents of these two rivers run close to each other in several places, and might present favorable conditions for digging a connecting canal. If at the same time the Berezinnsky, Oguinnsky, and Dnieprofsko-Bougsy Canals, uniting the Dnieper with the Western Dwina and the Vistula Rivers, could be improved, an uninterrupted navigable route would be obtained several thousand kilometres long, crossing the fertile, and in part industrial, countries of Central Russia, and extending from the Caspian Sea to the western frontier of the empire. As most of the streams and rivers that would be part of this route have but slight grades and large discharges, the execution of this work would call for much less expense than has been needed to build the principal artificial navigable lines of the countries of Western Europe, such as France and Belgium.

KIEF, RUSSIA, May 30, 1893.

MAP OF THE RUSSIAN WATER-WAYS, BY E. F. DE HOERSCHELMANN.



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