REPORT

ON THE

COALFIELD OF TKVARTCHELY,

NEAR

OTCHEMCHIRI ON THE BLACK SEA,

BY

W. GALLOWAY, F.G.S.

MINING ENGINEER.

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GENTLEMEN,

The Coalfield of Tkvartchely lies in a roughly quadrangular depression, between some of the spurs on the south-west slope of the Caucasus, at a distance of about 30 versts from Otchemchiri on the Black Sea coast. It was discovered a few years ago by M. Boutmy de Katzman, and has since then formed the object of careful and elaborate prospecting operations by M. Boutmy himself, and by the Russian Mining Engineers Rabinowitch, Denbski, Prince Schach Gouli Mirza, Tchernevsky, Loutouguine, and Weber, of whom the two latter are specialists in Geology.

GEOLOGY.

The coal-bearing beds belong to the Jurassic formation. They rest immediately upon a floor of plutonic and volcanic rocks. Their lowest member consists of an exceedingly coarse dark brown obscurely stratified conglomerate, made up of rounded water worn boulders, nodules, and fragments of rocks of volcanic origin, derived in part, probably, from the floor itself. Some of the largest of the boulders are several feet in diameter. Amongst these are found Ammonites and pieces of coal, the latter in considerable quantity. In passing upwards the conglomerate is succeeded by beds of fine-grained buff, yellowish-brown well stratified sandstone, whose individual beds are intersected at more or less regular intervals by fissures at right angles to the stratification.

In places where this rock is exposed to the weather, the separate blocks have weathered in the form of concentric scales to such an extent that many of them present the appearance of veritable boulders. Above this sandstone come the blue, yellow, and black shales and sandstones which enclose the seams of coal, surmounted by a bed of conglomerate 210 feet thick. Above the latter conglomerate are red and parti-coloured clays and argillaceous sandstones, and finally, above the latter the Jurassic limestone.

According to the Mining Engineer Tchernevsky, the thickness of these subdivisions of the Jurassic rocks may be taken as follows :—

		Feet.
(1)	Lower conglomerate and buff sandstones ...	1,400
(2)	Coal-bearing beds and upper conglomerate (210 feet)	840
(3)	Red clays and coloured sandstones	1,400

The coal-bearing beds contain four principal seams of coal, of which detailed sections are given in sheet IV.

The Jurassic Formation is older than the Caucasus, and has been subjected to upheaval and flexure in consequence of the earth-movements which accompanied the rising of the chain. Hence it is that in some parts of the basin the seams of coal which were originally deposited in a more or less level position, are now found to be tilted at an angle of 30° to 50°, while in others they are undulating and still more or less level. As a result some parts of the seams now occupy a much higher position than others.

The persistence of the outcrops over long distances shows that, notwithstanding the disturbances to which they were subjected, the seams have not been greatly broken or dislocated, but have been bent in conformity with the direction of the forces which produced the corresponding movements of the ground.

There can be no question that the seams were originally continuous throughout the whole area within which they now occur. But within this area the river Galisga and its numerous tributaries have been gradually cutting their way downwards until the Galisga itself and some of its tributaries have reached the volcanic floor, while others are still flowing at higher levels—some, amongst the outcrops of the seams of coal, others, in the ground above the seams.

The original coalfield has thus come to be divided into five distinct areas (see Plan, sheet II., in which they are coloured red, and numbered I. to V.), separated from each other by wide gaps from which the coal-bearing rocks have been entirely removed by denudation. It is always possible that future operations will show that some of these areas such as Nos. III. and IV, and IV. and V., are connected by the continuation of the seams in the ground lying between them that has not yet been explored, but for present purposes it is convenient to assume that the five areas referred to are entirely separate.

PROSPECTING.

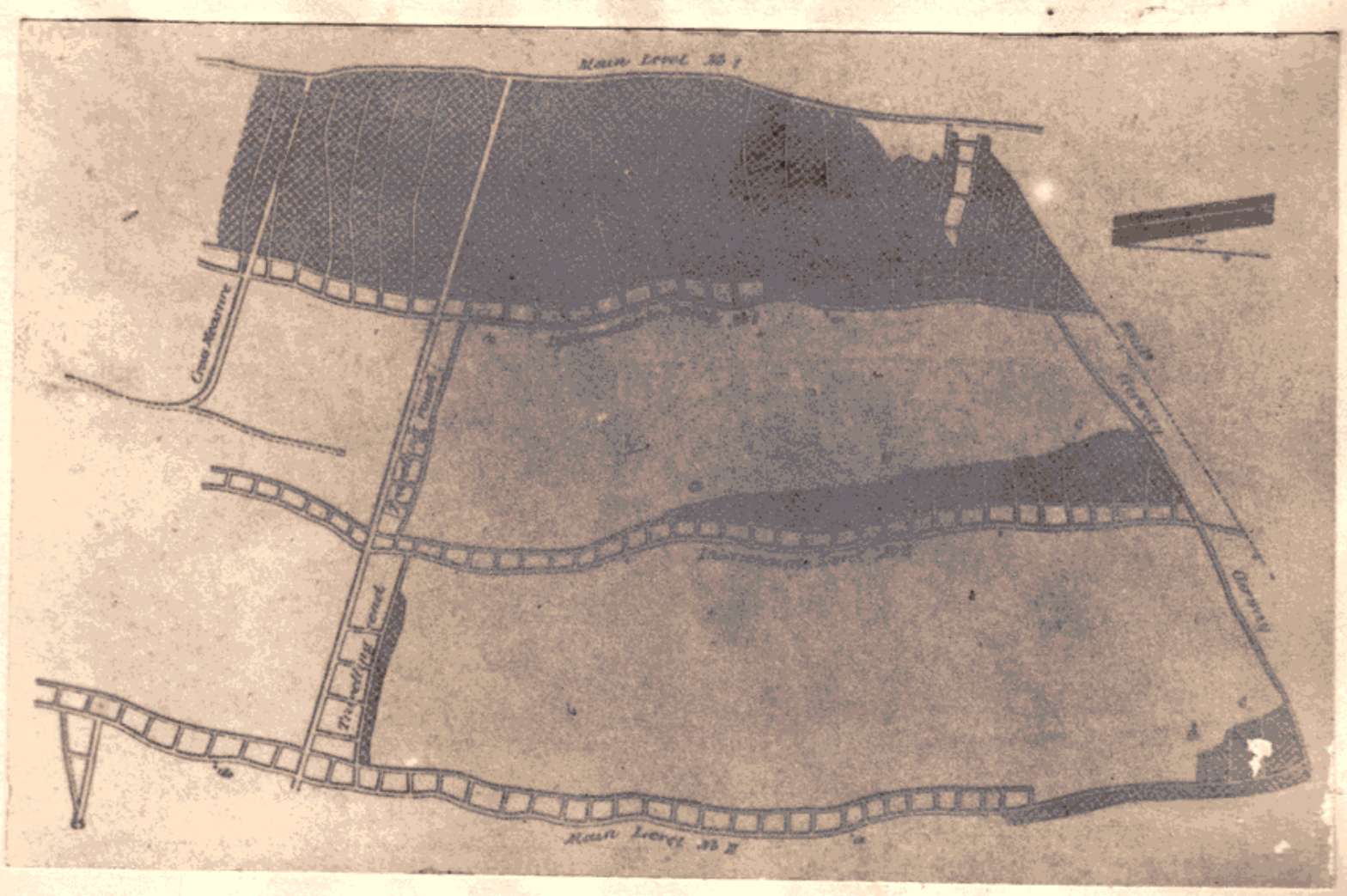
Prospecting operations have been carried out to some extent in all five areas, but to the greatest extent in Nos. I. II. and IV., and more especially in No. II. By means of these operations the outcrops of the seams have been laid bare, so that it has been possible to accurately measure the thickness of the various seams, and obtain the details of their structure at a number of separate points. Four short galleries have also been driven in No. II. area, namely, one 20 feet, one 8 or 10 feet, and one the "Germelo" gallery (so named in commemoration of the visit of the Minister of Agriculture), 15 or 16 feet deep in the lowest seam; and one 118 feet deep in the second lowest seam. Lastly, five bore holes have been put down, four of which have intersected and proved the existence of the seams in No. II. area, at the points indicated on Plan, sheet III. The points at which the outcrops have been laid bare in No. II. area are very numerous, and prove the outcrops to be persistently continuous along the upper edge of this area for a distance of 8 versts. In No. I area, the outcrops have been opened principally on the side next to the Galisga River, and exceedingly good sections obtained, and the continuation of the seams has been traced from point to point where no actual prospecting operations have taken place. In No. IV. area, good sections have been obtained, and the outcrops have been traced along the black line shown in the plan (sheet II.) In No. III. area, a detailed section has been obtained, which shows that the seams become divided up into numerous thin beds of coal separated by beds of shale in this direction, and that consequently they are not so valuable here as in the other parts of the field; and finally, in No. V. area, the existence of the coal has been proved, but no detailed operations have yet been undertaken.

During the week ending 20th October, 1900, I carefully examined some of the principal prospecting works on the outcrops in Nos. I. and II. areas, and was only prevented from examining some of those in No. IV. area by a sudden break in the weather. I also visited and examined the four galleries and the sites of the principal bore-holes in No II. area. I have also discussed the details of the plans, the sections of the seams, and all other matter of importance having a bearing upon the subject, with MM. Boutmy, Denbski, Tchernevsky and the Prince Schach Gouli Mirza, and I may say at once that I have never before met with any instance in which prospecting operations have been so carefully and completely carried out as they have been in this case. No expense or trouble has been spared to ascertain the exact particulars of the character and extent of the various seams, and the results reflect great credit upon the engineers who have carried out the works.

CONSTITUTION OF THE SEAMS. QUANTITY AND QUALITY OF THE COAL.

In No. II. area the outcrops follow a curved line across the ravines formed by the rivers Dzida-Akvara, Geliquara, Atzaka, Make, Machme, and Akguebra, their extreme

FIG. 1.



points, as the crow flies, being about $4\frac{1}{2}$ versts distant from each other. The outcrops are seen in the ravines, and have been laid bare at many points by cutting trenches, in which the thickness and constitution of each seam and its position relatively to the other seams are clearly seen.

From the outcrops on the east side of the area, the seams dip at first rapidly towards the west at an angle which varies from 25° to 50° at different points on the outcrop; but as they extend westwards, the dip gradually moderates, until a syncline is reached, and then they rise slowly to the lower outcrop at the western side of the area. This structure is seen in the ideal sections C,D, and E,F, sheet II., and in the measured and plotted section, sheet III. The eastern outcrops are about 2,000 feet higher than the western ones, and the former are about 3,600 feet above the level of the Black Sea, the latter about 1,600 feet.

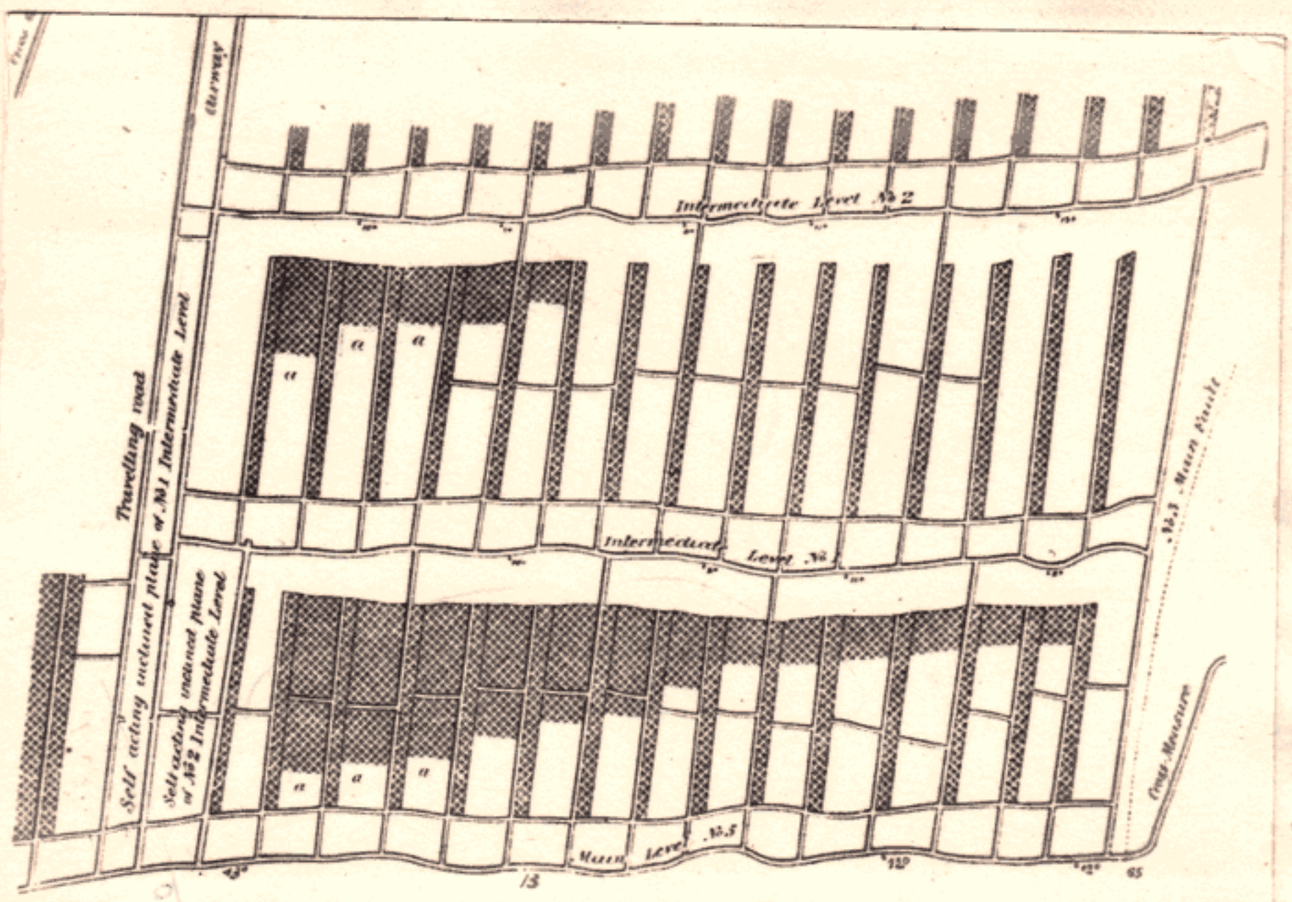
The area within the outcrops shown in sheet II. is about 8 square versts = 3·57 square miles = 2,246 acres.

As already mentioned there are four principal seams of coal underlying a bed of argillaceous sandstone. The seams themselves are sub-divided into a series of separate

beds by beds of shale and sandstone as shown in the sections, sheets III. and IV. The thickness of the beds of coal, and of the beds of shale and sandstone between them, varies considerably from point to point. Hence it is that in the sections the structure of the individual seams is seen to vary. This is a common feature in all seams of coal in all coalfields.

The lowest seam is 49 feet thick in the ravine of Arache river. In the Make river it is separated by a bed of sandstone. Each of the two seams above the lowest is 4 feet 8 inches. The uppermost seam is 2 feet thick, but it is not persistent, and sometimes it changes into shale, a not uncommon feature in other coalfields. The distance between the lowest seam and the seam next above it, measured at right angles to the stratification, is about 42 feet, and the other seams are about 21 feet apart. The structure of the various seams, taken from actual measurements in the trenches cut in their outcrops, in the ravines of the rivers Dzida-Kvara, Geliquara, Atzaka, Make, and Machme is shown in sheet IV.

FIG. 2.



From these sections it is seen that the thickness of clean coal in the five seams, taken together, is as follows :—

Dzida, 23·1 feet; Geliquara, 26·6 feet; Atzaka, 25·5 feet; Make, 23 feet; Arache, 37·8 feet; Arache-Machme, 31·9 feet; Machme, 26·6 feet. The average thickness is thus 27·8 feet.

If we allow 20 per cent. for loss in working, and assume that each cubic sagen = 12·7 cubic yards, will produce 600 poods = 9·67 tons of coal, then the available quantity of coal in No. II. area is 4,377,600,000 poods, = 72,377,000 tons.

In No. I. area the seams crop out along the eastern and northern edge and dip under the Jurassic Limestone in the west. The area of No. I. is about 6 square versts = 2·63 square miles = 1,683 acres.

The average thickness of the seams is 3 sagenes = 21 feet, and the quantity of clean coal, calculated as in the last case, thus amounts to 2,592,000,000 poods = 43,200,000 tons.

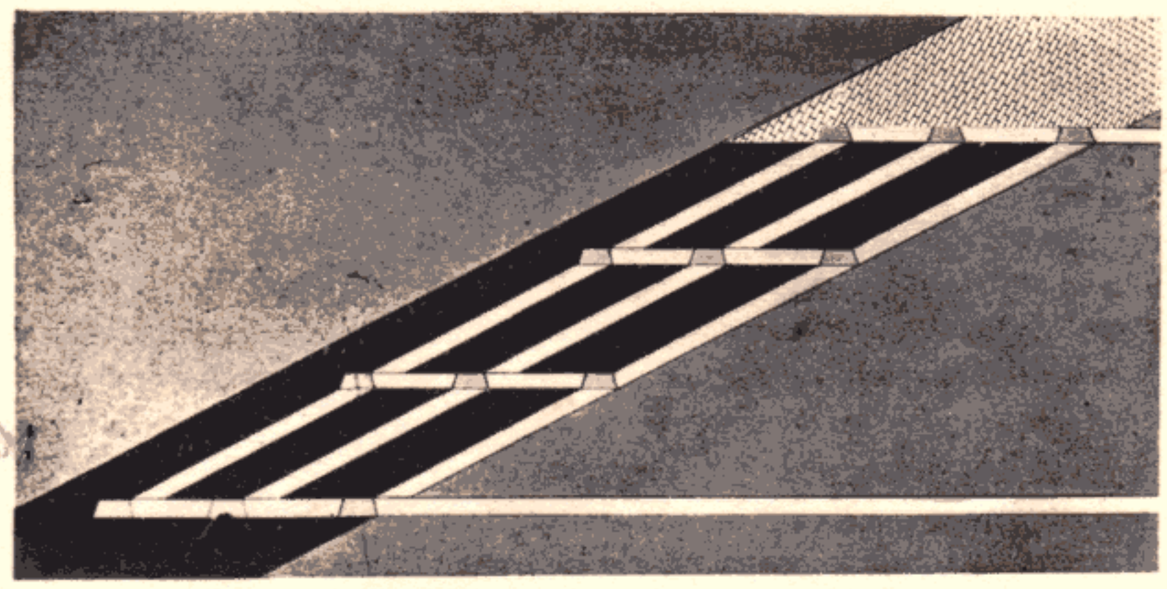
In Nos. III., IV. and V. areas there are very large quantities of coal; but, as neither the limits of the coal-bearing ground nor the exact sections of the seams have yet been accurately determined, except at certain isolated points, the actual amount contained in them cannot be stated with any degree of precision.

It will thus be seen that Nos. I. and II. areas contain over 110,000,000 tons of coal, or a sufficient quantity to last for over 100 years at an output of 1,000,000 tons a year, and that the remaining areas III., IV., and V. (and more especially IV., in which the thickness of the lowest seam has been proved to be 39·36 feet thick in two beds at one point, 19·68 feet thick, in one bed, at a second, and 26·24 feet thick at a third), contain immense reserves of coal.

The first workings will commence in No. II. area, which is the most accessible, and probably soon afterwards, or simultaneously, workings will be opened in No. I area, and the coal lowered, by means of a self-acting inclined plane, into the Galisga valley, where the railway will be constructed.

The quality of the coal contained in these seams is that of a bituminous steam coal. It is similar to that of the Welsh steam coal of Monmouthshire, obtained from

FIG. 3.



the celebrated Black vein, the small of which is made into coke at the Newport Abercarn Colliery. I tested it carefully by burning samples on a grate at the Kontoir Boutmy, on the ground, and found it to be caking to the same extent as the Black vein. It burnt with little smoke, which turned to a very pale blue colour after the fire was well under way. The ash is white from some parts of the seams, yellow from others, and brown from still others.

Two samples of this coal (one from the bed 7 feet thick near the bottom of the lowest seam in the Arache ravine, the other from the bed 23 inches thick of the second lowest seam in the same ravine, see sections on sheet IV.,) have been analysed in my Laboratory at Cardiff, with the following results :—

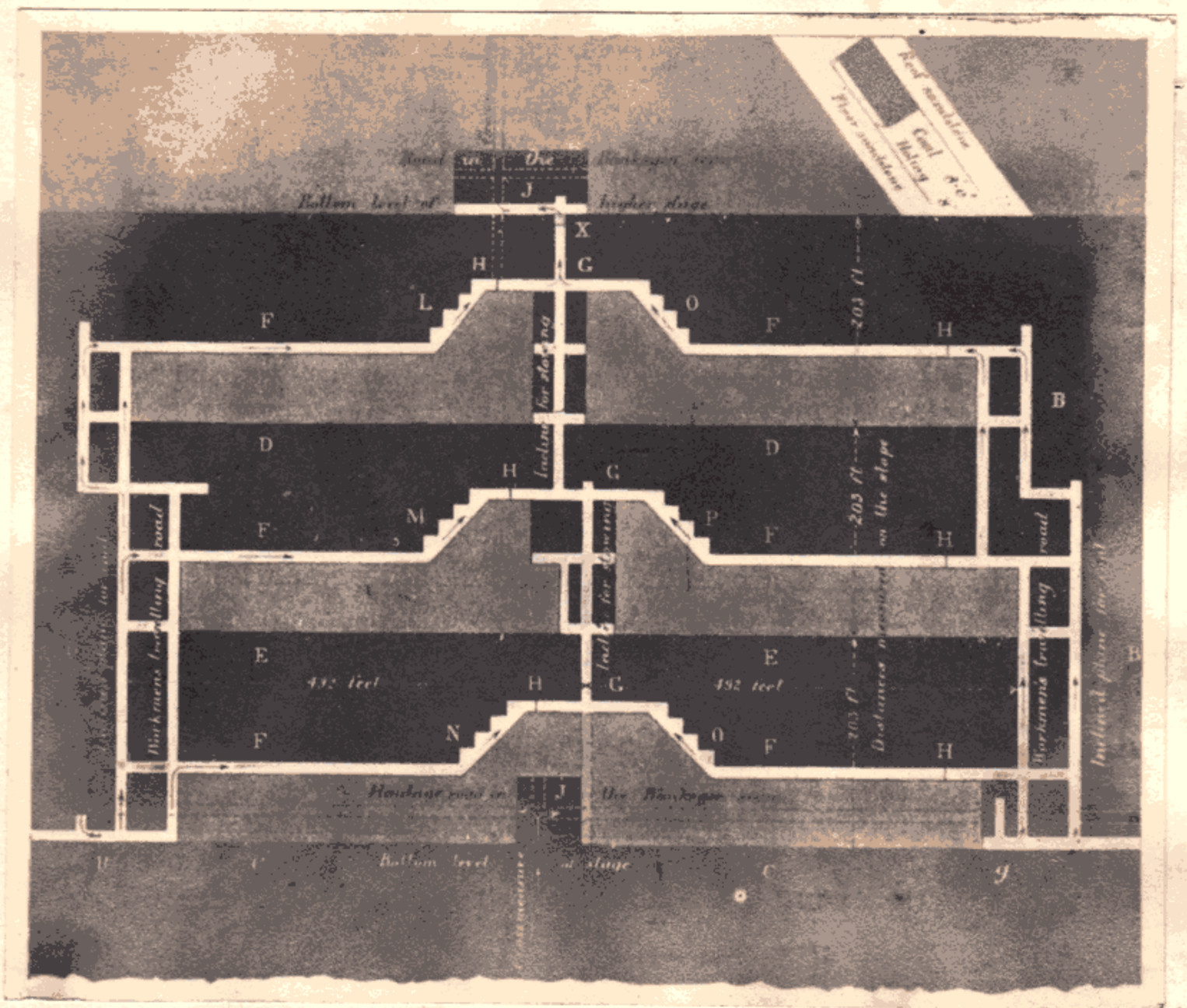
	7 FEET BED.		23 INCH BED.	
Moisture	3· 0		1·25	
Coke, exclusive of ash	62· 1	= 70.6	59·24	= 67·30
Ash	8· 5		8·06	
Volatile matter	26· 4		31·45	
	100· 0		100·00	
Sulphur	1·93		1·17	

These analyses prove the coal to be of similar quality to that of the black vein of Monmouthshire. The large quantity of moisture in the 7 feet bed is doubtless due to the fact that the sample was taken from the outcrop, and the smaller quantity in the 23 inch bed to the fact that the sample was taken from the end of the gallery, 118 feet long, driven in the second seam.

A number of determinations of the coke and ash have also been made by the Mining Engineer Tchernevsky, in M. Boutmy's laboratory on the concession, with the result that the coke, including ash, is found to vary from 71 to 77 per cent., and the ash from 3·5 up to 12 per cent. in samples taken from various beds of the lower seam in the Atzaka, Make, and Arache ravines.

A sample of coal was sent for trial to the Russian Black Sea Fleet, and carefully tested under the boilers of a torpedo boat, when its economic value for steam-raising purposes was found to exceed that of coal obtained from the Donetz Coalfield by 25

FIG. 4.



per cent., at a speed of 8 knots per hour, and 10 per cent. at a speed of 12 knots per hour. A copy of the official certificate issued by the Russian Admiralty is appended hereto (see Appendix).

The analyses, the tests made by myself and the tests of the Russian Admiralty, all show that the quality of this coal is the same as that of a moderately bituminous coal of the Coal Measures. But Jurassic Coal, as a general rule, contains a much higher percentage of moisture and volatile matter than the seams of the Coal Measures, namely, upwards of 45 per cent. altogether; and it is therefore at once obvious that these seams have undergone metamorphosis whereby their quality has been radically changed into that of Coal Measure coals.

Metamorphosis of this kind is due in every case to the action of heat, which has the effect of driving out a certain proportion of the moisture and volatile matter, and leaving the coal less bituminous than it would have been otherwise. For instance, the steam coals of the Welsh coalfield have undergone a change of the same kind and in the same direction, which has produced bituminous coals of similar quality to those

of Tkvartchely in one part of the coalfield; semi-bituminous coals, with less volatile matter in another; dry steam coal in a third; and anthracite in a fourth. It would not, however, add to the value of this Report to discuss the causes which have given rise to metamorphosis in the case of the Tkvartchely coal, but the fact remains that its value for steam-raising, and for coking purposes, has been thereby immensely increased above that of the coal usually obtained from the Jurassic Formation.

A third set of analyses made at the Laboratory of the Russian Minister of Finance, on 2nd May, 1900, gave the following results :—

	No. I.	No. II.
Water	0·93	1·0
Ash	6·37	5·92
Sulphur	0·98	1·39
Carbon	79·64	79·62
Hydrogen	5·38	5·48
Oxygen and Nitrogen	7·67	7·98
Coke	68·20	68·08
Calorific Value, according to Berthier	8314	7717

The original document is signed officially.

FIG. 5.

The analyses given above, as well as the tests made by myself, show that the Tkvartchely coal belongs to the category of coking coals, and therefore that the proposal to wash and coke the small coal is a wise one. An outlet for the coke will be found in the great iron works at Kertch and elsewhere, on the coasts of the Black Sea, and Sea of Azof, and in the other industrial works of this region, all of which are now dependent for their supplies on the Donetz coalfield and on importations from England.

COST OF WORKING THE COAL.

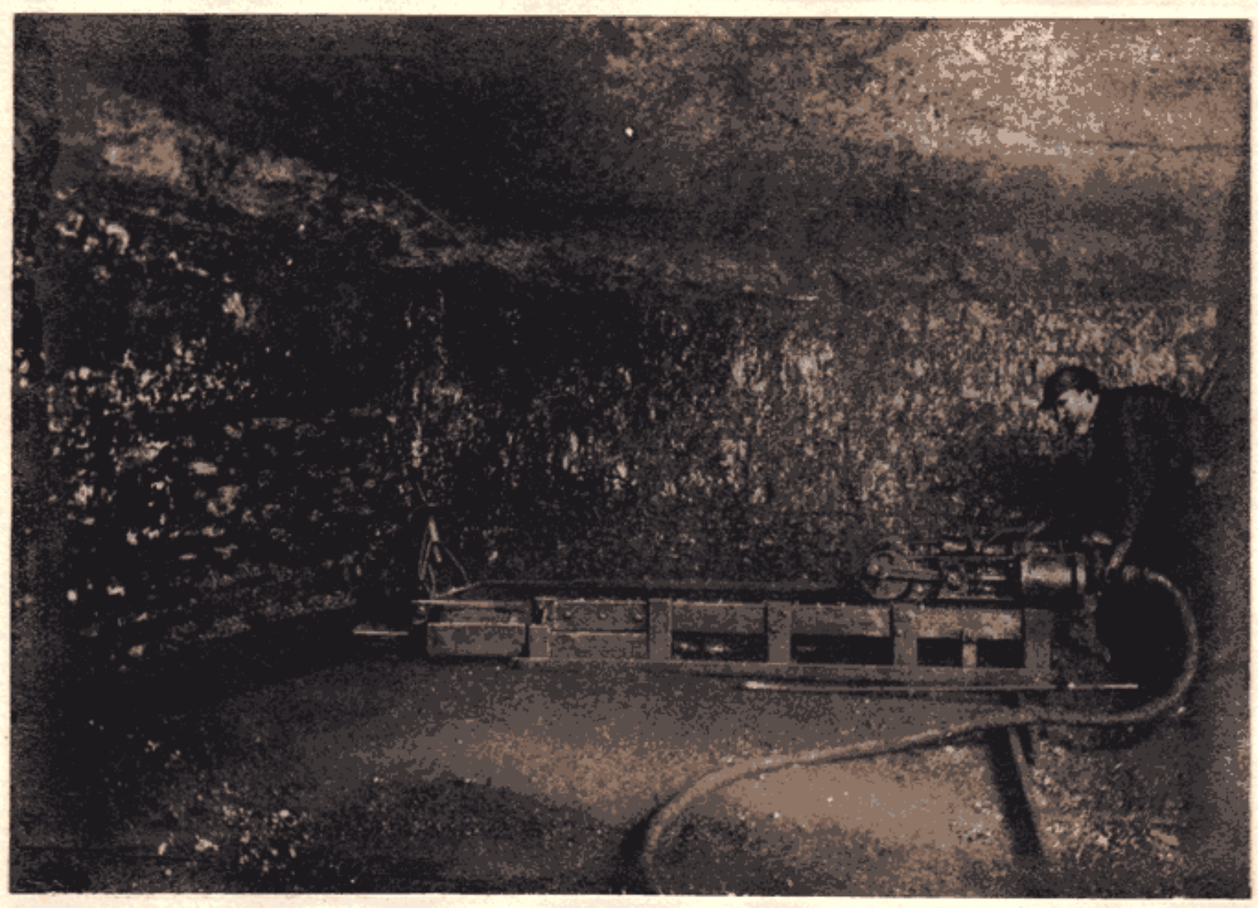
It is proposed, as has been already mentioned, to work Nos. I. and II. areas simultaneously, and to locate the screening and coking appliances at or near Otchemchiri. This will naturally form a legitimate subject for discussion. It will be necessary, to build a railway from the Port, which will require to be constructed at Otchemchiri to the neighbourhood of the mines, and to connect the mines to the railway, by a tunnel perhaps, in the case of No. II. area, and a self-acting inclined plane in that of No. I. area.

After considering the subject carefully on the ground, with the aid of the plans, it appeared to me that No. II. area should be opened by means of an adit level or tunnel, commencing near the end of the railway shown on sheet II., and driven towards the east

until it encounters the lowest seam, near No. 3 bore hole (sheet III.) The gallery would then be continued in or near the lowest seam nearly due eastwards, with branches toward the north-east and south-east, as shown by the thin blue lines in sheet III. Shafts would be sunk from the surface at various points, to facilitate ventilation and to admit of the introduction of stowing (*Remblais*) from the surface, as it would be impossible to work a seam as thick as the lowest one without filling up the empty space. The upper seams would be worked in advance of the lowest seam, the highest one most in advance, the third seam least in advance; and the coal from these seams would be lowered into the main galleries in the lowest seam by means of balanced cages working in shafts sunk from these seams down to the lowest seam.

If the lowest seams were worked before the upper seams, the ground would be so much dislocated, in consequence of the great amount of subsidence due to its thickness, and to the nearness together of the various seams, that some difficulty would be experienced in working the upper seams afterwards.

FIG. 6.



The upper seams may perhaps be worked according to the longwall system of working outwards, in all parts of the field where their dip is under 10° or 15°, that is to say, the whole of the coal would be removed in one face of working, and the roads maintained in the worked ground; or, otherwise, the upper seam being thinner than the others, would be worked longwall, the workings being arranged similarly to those shown in Fig. 1, and the two intermediate seams, according to the system of long pillars, Fig. 2, ranging either from dip to rise or in the direction of the strike.

The workings would be divided into panels, as shown, and each panel would be connected to the main haulage roads in the lowest seam by means of balance pits for letting down the coal.

In the comparatively level parts of the lowest seam, the various beds of that seam would be worked separately one after the other in descending order, advantage being taken of the beds of shale to form solid divisions between the various slices. The method of working each slice might be either that shown in Fig. 1 or Fig. 2.

In parts of the lowest seam, where the inclination is greater, the slices would be arranged in such a way that there would be a sufficient number of intermediate levels to prevent the coal from having to be carried very far down the slope before it reaches a level (Fig. 3).

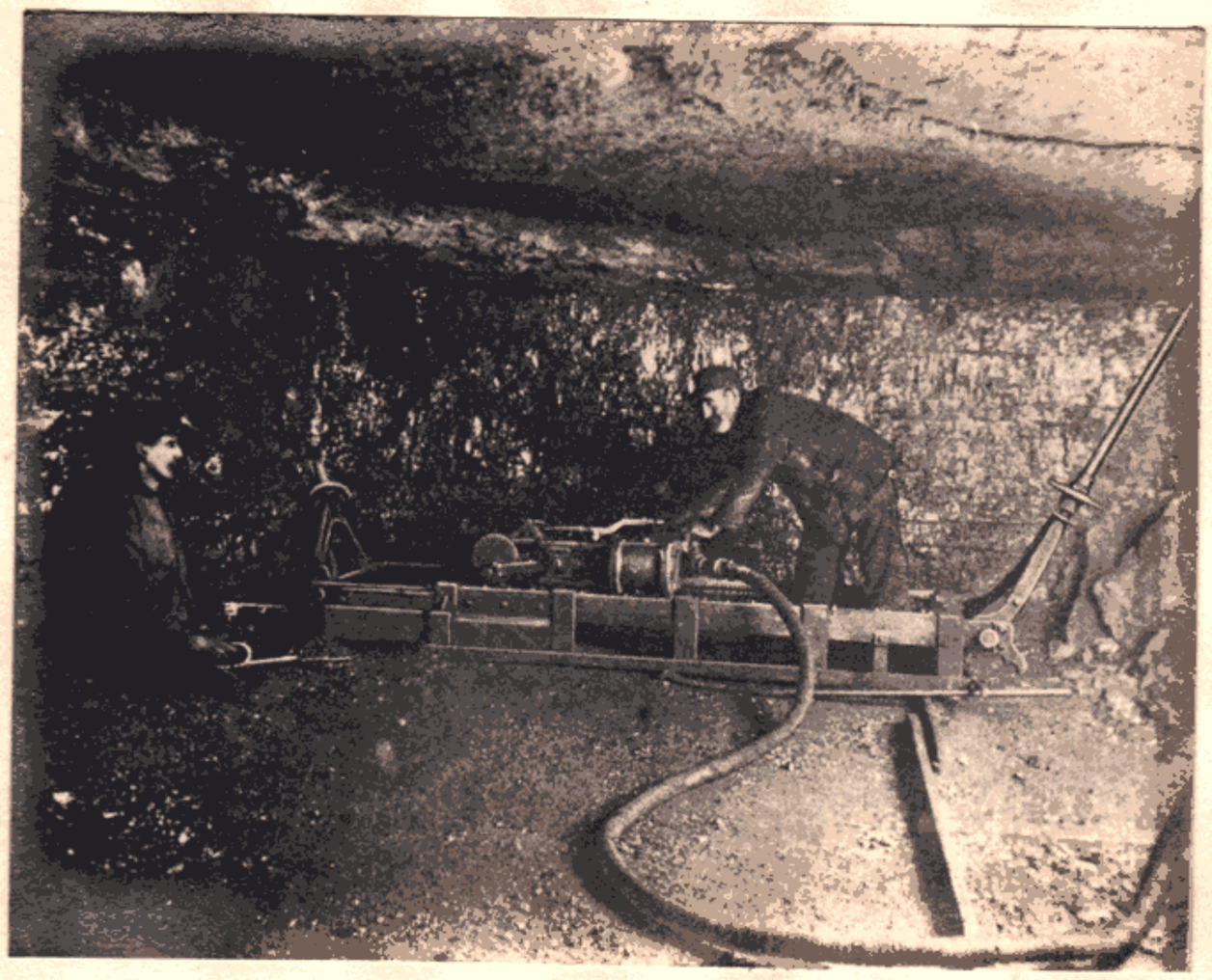
In very steep parts of both the second and third seams, I would strongly recommend the method shown in Fig. 4.

In the flat parts of the highest seam it will probably be expedient to use coal-cutting machines, and to arrange the face as shown in Fig. 5.

The coal-cutting machine shown in Figs. 6 and 7 is very largely used in America for working seams according to the method shown in Fig. 2, and might be most usefully employed for this purpose at Tkvartchely mines. It can be actuated either by compressed air or electricity.

The haulage underground would be best effected in waggons, carrying at least one ton each, by means of electric locomotives, such as the one shown in Fig. 8.

FIG. 7.



Assuming that these or similarly well-arranged methods of working and mechanical appliances are adopted, I estimate that the cost of working will not exceed 5s. per ton, delivered to the railway. The cost of timber will be very small as there is an inexhaustable supply of timber on the ground for which the Government charge is only 4s. 3d. per cubic sagen or per 12·7 cubic yards. And if the workings are approached by a tunnel at the lowest point as suggested above, there will be little or no drainage required by pumps, and the coal will all gravitate downwards to the railway.

The cost of carrying the coal to the port of Otchemchiri in railway waggons, at the rate of 500,000 tons a year, will probably amount to a little over ½d. per ton per mile, or to a total of, say 1s. per ton; that of screening and hand-picking the large coal to 3d.; that of washing the small coal to 6d.; that of loading into ships, including the expenses at the Port to, say 8d.; making together a total of 1s. 11d. per ton for large coal and 2s. 2d. per ton for small coal. Adding this to the cost of working we get the cost of the coal f.o.b. at Otchemchiri as:—

Large coal	6s. 11d. per ton.
Small coal	7s. 2d. „

I have compared these estimated costs with those given by M. Tchernevsky, and find that they differ from his in detail, but the totals are not dissimilar, M. Tchernevsky giving a total cost of 7s. 1d. for large and small coal, screened and washed, delivered at Otchemchiri, but without including the costs of the Port. I have included in the cost of 5s. per ton delivered into waggons on the railway all the costs incurred on the estate, such as offices, hospital for workmen, and so on. I am of opinion that the cost of working these seams will be very moderate, and that it may be even less than 5s. per ton on the average; and when I mention that the cost of working a seam 8 feet thick, lying at an angle of 45°, according to the method shown in Fig. 4, is only 2s. 0·7d. per ton delivered in the bottom level in one of the German collieries, it will be perceived that there is here a great margin for the additional costs of the thinner and more difficult seams, and for the more difficult parts of the thick seam.

These estimated costs are based upon an assumed output of 500,000 tons a year. But there will be no difficulty in raising the output to 1,000,000, or even 1,500,000 tons a year, if the necessary plant and railway and dock accommodation are provided; and

FIG. 8.

in that case, all the costs would be reduced to some extent, and the profits would become correspondingly higher.

NATURAL WATER POWER.

The various rivers on the estate are capable of supplying as much power as may be required for ventilating the mines by means of mechanical ventilators, actuating coal-cutting machines, Figs. 6 and 7, and drilling machines, Fig. 9, hauling the coal underground, Fig. 8, and pumping, if necessary, in any depressions in the seams. For these purposes the power may be transmitted from the turbines, either in the form of an electric current or in that of compressed air, or partly one, partly the other. If it should be deemed expedient even to employ electric locomotives on the main railway to Otchemchiri, there is ample power available to work the locomotives also. This last is a consideration which must be determined by the engineer who constructs the railway.

RAILWAY TO OTCHEMCHIRI.

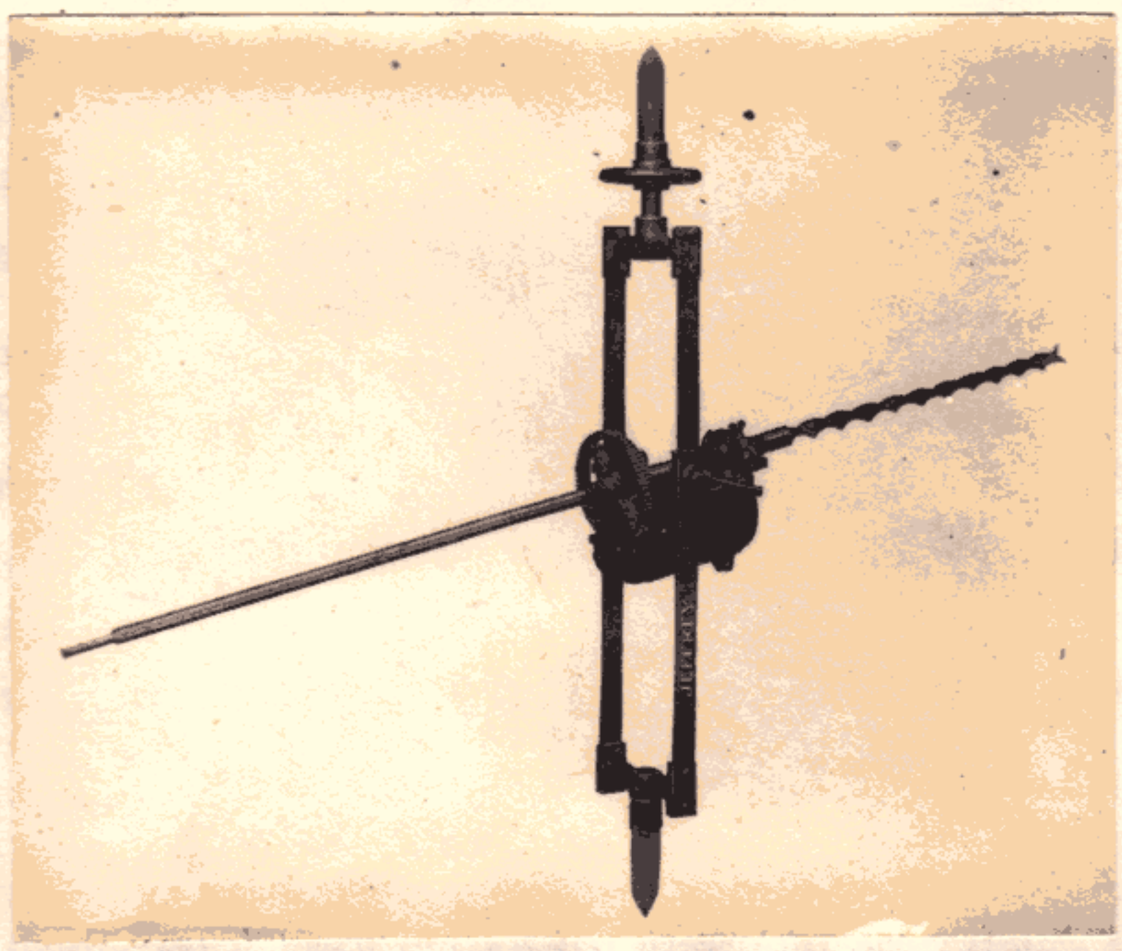
The construction of the railway from Otchemchiri to the mines will be simple and cheap enough as far as the gorge or port of Tkvartchely, but between the entrance

to that gorge and the mines it will be more difficult and expensive. It is proposed to lay the rails with a gauge of one metre or less. The cost will be less than it would otherwise have been, in consequence of the abundant supply of timber suitable for making sleepers, building bridges and houses, and for all other works in which timber can be employed.

PORT AT OTCHEMCHIRI.

As the Black Sea coast is exposed at Otchemchiri, it will be necessary to construct a harbour of some kind, in order that ships may be protected while loading during stormy weather. With this object it is proposed to construct two breakwaters of concrete blocks, with an entrance passage between them, from a point at which the water is 22 or 23 feet deep, to the shore, thus forming an entrance basin, and to excavate a dock in the shore, large enough to allow several ships of 1,000 tons or more to be loaded at the same time. A portion of the coast near Otchemchiri is shown on sheet V., in which some depths of the water are also given. I have also drawn upon the same plan a suitable position for the breakwaters and for the dock,

FIG. 9.



The screening and coal-washing establishment can be set up in close proximity to the dock, with appliances for loading the ships directly from the screens and from bunkers, or they can be set up at the entrance to the mine, and the railway waggons would then bring the coal to the ships and be emptied in the usual manner. It will be for the engineers who finally consider the question to determine where it is best to screen and wash the coal, but I am of opinion that this will be best done at the mine, so as to save the cost of transporting large quantities of shale on the railway.

STEAM COLLIERS.

It is proposed also to acquire a number of steam vessels to transport the coal from Otchemchiri to Odessa, and the other ports on the Black Sea. These ships are to be owned by the Colliery Company, and would take their cargoes to the ports and return empty, or with such freight as might be required for Otchemchiri, a comparatively very small quantity in any case. I consider this to be a wise provision, as it would be impossible to reckon upon the arrival of ordinary steam or sailing vessels with sufficient regularity to keep the mines at work; and it would be very expensive to store the coal at Otchemchiri and to load it into ships at irregular intervals.

DEMAND FOR COAL AND COKE.

For two or three years there has been a great demand for coal in Russia, and in all the ports of the Black Sea amounting to the proportions of a famine. So great has the pressure been that the Russian Government appointed a special Commission to examine into the question in the end of last year, and that Commission reported that there had been a regular deficit in the output of the Russian mines in the Donetz coalfield, amounting to about 800,000 tons a year, or more than one-ninth of the whole output of the coalfield, which could not be overtaken in less than five years' time. The reasons for the deficit in the supply of coal are to be found in the great extension of railways and industrial works; that for the deficit in the supply of coke to the building of many additional blast furnaces in the Government of Ekaterinoslav, more especially in the Donetz basin.

For this reason, that is to say, the existence of the coal famine, the Russian Government has temporarily remitted the tax upon the importation of coal in the case of several large towns as well as in that of some of the Railway Companies. The amount of this tax is sufficient to enable the Tkvartchely mines to compete successfully with foreign coal and to make a very handsome profit in Russian ports. Further the fact that the collieries of the Donetz basin, from which coal of a quality suitable for steam-raising can be obtained, are all situate in the north and west of that coalfield at a distance of over 100 miles by railway from the ports in the sea of Azof, and 400 or 500 miles from Odessa (see sheet I), will prevent these collieries from being able to compete successfully with coal from Otchemchiri.

The total quantity of coal consumed on the Black Sea and in the coast towns round about it is about 4,000,000 tons a year, so that Tkvartchely Collieries have a very great future before them, since they are in the unique position of being able to sell coal at 18s. or 20s. per ton (the present selling price in the Black Sea ports is about 30s. per ton) and to make a profit of 8s. or 10s. per ton in ordinary times. If the Tkvartchely mines were at work at present they could easily earn a profit of 18s. or 20s. per ton.

FINANCIAL STATEMENT.

As you have prepared a very elaborate financial statement showing the estimated cost of opening the mines, constructing the railway and the port, providing steam colliers, workmen's houses, hospitals and all other necessary buildings, plant, and appliances, and setting forth the benefits expected to be derived from the opening up of the mines, I will refrain from entering into these particulars in this report. I will merely add that the figures in that statement appear to be carefully prepared estimates, and that they will doubtless be subject to modification, some one way, some the other, when the time arrives to scrutinize them more closely, after the magnitude and relative importance of the various works have been finally determined upon.

I will add in conclusion, however, that your property is in my opinion an exceedingly valuable one, and that it cannot fail to be opened up within a very short period of time, with the aid of capital obtained from one source or another.

I have the honour to be,

Gentlemen,

Your obedient Servant,

To M. Boutmy & Cie,

APPENDIX I.

In execution of the order of your Excellency a trial of the Tkvartchely coal, received at Otchemchiri, was performed on the torpedo cruiser "Captain Saken" and on the torpedo boat No. 256.

I. Trial of coal on the torpedo cruiser "Captain Saken" during a four hours' run at a speed of 8 knots (110 revolutions), the following result was obtained :—Steaming with two boilers the consumption of coal was 160 poods, air pressure (Ellis suction draught) 0·4 in. (and the ash-holes partly closed), this makes 42¼ poods per hour. After the four hours' trial the quantity of slag was set down at 4 poods, and that of cinders 10 poods; colour of smoke B., transparent smoke.

During a few hours' run at a speed of 12 knots (165 revolutions), the following result was obtained :—Steaming with two boilers the consumption of coal was 363 poods, air pressure 1·4 in., which makes 91 poods per hour; colour of smoke B., transparent smoke. After four hours' trial the quantity of slag was set down at 9½ poods, and that of cinders 14 poods. At the trial at full speed steaming with three boilers, tubes being not cleaned owing to the absence of appliances for cleaning them by steam, the following result was obtained :—During 2 hours the engines were run at 200 revolutions at the highest speed of the cruiser, steam was kept easy at an air pressure of 1·3 in. according to the air gauge. The consumption of coal being 206 poods or 103 poods per hour; colour of smoke B., transparent smoke.

II. Trial of coal on the torpedo boat, No. 256, "Kotra," gave the following results :—

During the 8 hours' trial at a speed of 8 knots, the consumption of coal was 77 poods or 9·6 poods per hour. After 8 hours' run a result was received: 7 poods slag, and 17 poods ashes. The far engine did not work. Colour of smoke during the stoking, thick smoke, A, afterwards, transparent smoke, B, At a speed of 12 knots during a 9½ hours' run, the comsumption of coal was 266 poods, or 27 poods per hour, air pressure, ½inch water column. After 9½ hours' trial a result was received: 10 poods of slag, 80 poods of ashes, and 7 poods of soot for the whole 17½ hours' run. In comparing the Circassian coal with coal received from the South Bay, the former gave an economy of 25 per cent. at the speed of 8 knots, and 10 per cent. at the speed of 12 knots. The colour of the smoke was the same as at the speed of 8 knots.

The trial at the highest speed on the torpedo boat, No. 256, during a run of 1½ hours at a speed from 16—16½ knots, with the regulator full open, and at 2 inch air pressure, according to the air gauge, gave a consumption of coal of 59 poods per hour. Comparing with steam coal received from the ironclad "Sinop" (from the store house of Kilen Bay of the port of Sebastopol), the Tkvartchely coal gave an economy of about 10 per cent. The coal delivered from Tkvartchely by its appearance, is coal from a fresh mine, from the upper layers, in its fracture it is plastic, contains some admixture of argillaceous slate, and produces a small quantity of easy smelting slag, but comparatively a large quantity of ashes.

Sebastopol. The 1st September, 1900. Signed by—The president flag mechanical engineer Von Vouras, and members; Assistant of the senior mechanical engineer Bakin, Saizeff, and the junior mechanical engineer Neveiniff.

NOTE.—The Coal here referred to as having been received from the ironclad "Sinop" from the store house of Kilen Bay of the port of Sebastopol, is from the Donetz coal basin, over which the superiority of the Tkvartchely coal is very marked. This is the only coal, other than English coal, which can come into competition with the Tkvartchely coal.

W. GALLOWAY.

APPENDIX II.

In execution of the order of the Chief Commander of the fleet and of the ports of the Black Sea from the 20th September of this year, No. 591, a trial of coal from the district of Tkvartchely, situate near Otchemchiri, was performed on the transport of the Imperial Navy "Boug." The quantity of coal received was 346 poods in 69 leaded bags.

On the 26th September, at 8 o'clock in the morning, at the time when the anchors were hoisted and the transport started under all four boilers—the burning of the coal which was to be tested had been begun, and for which purpose 57 poods 24 pounds was used. At 9 o'clock in the morning, when the working of the engine was adjusted and the furnaces being exclusively charged with Tkvartchely coal—this coal has begun to be exclusively used—the trial of the remainder of 288 poods 16 pounds of this coal was performed, which trial lasted three hours and forty minutes.

After the trial was finished we came to Evpotory, where we anchored; we then cleaned the furnaces of the boilers and began to burn coal from the Government Stock, which was delivered by Geftman from Markovsky Pits, with the view of comparing it with the coal of Tkvartchely, which had already been tested.

The trial of the coal from the Government Stock lasted the same time, viz., three hours and forty minutes, and was performed under the same conditions of working of the engine and boilers. The trial was commenced at 4 o'clock in the afternoon, and was finished at 7.40 p.m., on the way from Evpotory to Sebastopol.

Hereunder we give a comparative table of the results obtained during the trial of both coals:—

	Tkvartchely Coal.	Coal from Government Stock delivered by Geftman.
The speed of the transport "Boug"	10·04 knots ...	9·12 knots.
The distance which was passed during the trial of three hours and forty minutes	36·8 miles ...	33·45 miles.
The mean number of revolutions of the engine per minute during the trial of three hours and forty minutes	117 revolutions ...	107 revolutions.
The mean consumption of coal per mile in an hour ..	7·80 poods ...	7·94 poods.
The indicated horse power	1·562·12... ...	1·216·59.
The quantity of coal consumed in an hour on one indicated horse power	2·013 Russian lbs. ...	2·380 Russian lbs.
Regulator	Full open ...	Full open.
Ratio of expansion of the high and intermediate cylinders	0·6	The same as by the Tkvartchely coal.
The draught in boilers	Natural	Natural.
Steam pressure in boilers	130 lbs.	130 lbs.
The consumption of coal during the trial of three hours and forty minutes	258 poods 16 lbs. ...	265 poods 17 lbs.
The quantity of cinders in poods and in percentage ...	27 poods or 9·5 % ...	37 poods or 14 %
Slag —	14 poods or 5 % ...	8 poods, 24lbs. or 3·2%
The consumption of coal per hour...	78 poods 25 lbs. ...	72 poods 15 lbs.

	Tkvartchely Coal.	Coal from Government Stock delivered by Geftman.
Steam was kept	Easy	With difficulty.
Ash holes	Partly closed ...	Not closed at all.
Flame	Medium length ..	Long.
The colour of smoke	Light grey ...	Black.
Caking of the coal	Slight	Great.
The fracture of coal	Unequal... ...	Flaked.
The weight of cask	3 poods 2 lbs.	3 poods 6 lbs.

The Tkvartchely coal is fresh from the mine, while Geftman's coal has been lying in stock at Sebastopol from the 1st of July, and was taken on the transport "Boug" on the 16th of September.

In view of the possibility of a further comparison in case of a new delivery of Tkvartchely coal, one leaded bag sealed with the seal of the ship has been sent to the Sebastopol Port Offices, joined to a Report of the Captain of the transport "Boug," from the 28th September, No. 1,327.

(Signed)

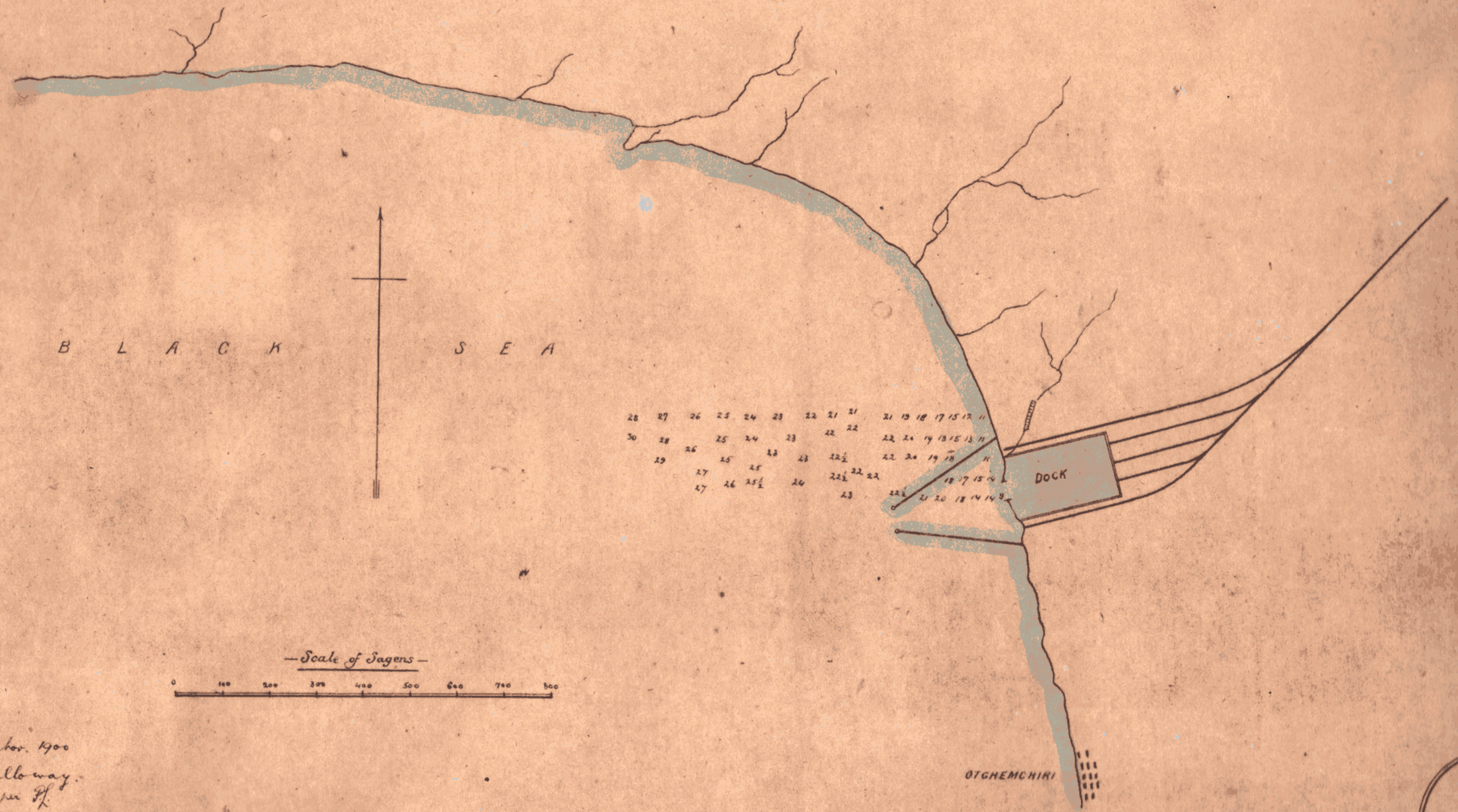
ASSISTANT OF THE CHIEF ENGINEER, N. ZVETVOFF.
ASSISTANT OF THE CHIEF ENGINEER, ORECHOFF.
CHIEF ENGINEER, KOUSNEZOFF.

29th September, 1900,
SEBASTOPOL.

W. GALLOWAY.


SEA OF AZOV
BLACK SEA
CASPIAN SEA
KHERSON
Odessa
Akerman
Ismail
Danube
Kustendji
Varna
Perekop
Melitopol
Berdiansk
Mariupol
Taganrog
NOVO-TCHERKASK
DONETZ COALFIELD
SIMFEROPOL
Sevastopol
Kerch
Kafa
Novorossiiskoe
Sinope
Otchemchiri
Poti
Batoum
KUTAIS
TIFLIS
ERIVAN
KATERINODAR
STAVROPOL
ASTRAKHAN
ANTINOPLE
SEA OF MARMORA
Scale of Miles
0
10

PROPOSED PORT AT OTCHEMCHIRI.



Cardiff 10th Nov. 1900
W. Galloway.
per P.L.