

MADRAS RECORD OFFICE.

Government of Madras.

Marine DEPARTMENT.

G.O. No.

136

Press
Mis.

Dated

30-5-1860

Not to be folded or roughly handled

*Proceedings of the Madras Government, Marine Department,
for the month of March 1860.*

Read the following papers :—

No. 27. Extract Minutes of Consultation, in the Public Works Department, dated 10th January 1859, No. 80.

*Forwarding copy of a letter and its enclosures
from the Officiating Chief Engineer on the
subject of description of boat best adapted for
the Navigation by Steam of Indian Rivers.* (Vide Consultation, Public Works Department,
11th January 1859, Nos. 163 & 164.)

No. 28. From Colonel A. COTTON, Commandant of Engineers, to T. PYCROFT, Esq.,
Chief Secretary to Government, Fort Saint George, dated Sépákkám, 21st March 1860,
No. 58.

In reply to your letter of the 27th July 1858, No. 288, respecting the best kind of boat for
rivers in India, I have the honor to state that the materials I hoped for, from which to form
more certain conclusions about river boats, were the results of the boat experiments now in
hand ; but I have been entirely mistaken as to the time required for obtaining satisfactory data
from them. I see now that it will take a much longer time than I anticipated, for it is a very
complicated question.

I am at present therefore entirely without any new data on the subject, beyond those upon
which Captain Rundall has written his report, and as he has had the best opportunities of draw-
ing conclusions, so far as they can be obtained from the present boats, I have nothing to offer
beyond what that Officer has said.

The leading point in our rivers is the exceeding cheapness of fuel, making a higher speed
than in other countries the most economical, consequently that in all the arrangements, of
form of boats, &c., a considerable speed, 10 or 12 miles an hour through the water for goods,
should be kept in view.

I may also mention that it seems to me plain that we are now on the eve of great improve-
ments in River Navigation, both as respects mode of propulsion, kind of boiler, management of
the steam, and resistance of boats ; and I think we should be prepared for the use of novelties
in all those respects, and that it is most important that arrangements should be made for obtain-
ing the latest accounts of the working of Rivers in America, England, the Continent, Bengal,
&c. The magnificent flotillas now being built by the Railway Companies for the Indus and
Ganges, will, I have no doubt, help greatly to put the whole matter of River Navigation on an
entirely new footing.

I would particularly urge that Captain Haig should be left at liberty to try a variety of
boats and Engines, as respects form, material, boiler, steam-pressure, mode of propulsion, &c.

No. 29. ORDER THEREON, 30th March 1860, No. 136.

Ordered that copies of the above letters be forwarded to the Government of India, in
reference to Mr. Secretary Beadon's letter, 11th June 1858, No. 942.

Copy of Colonel Cotton's letter will likewise be furnished to the Public Works Department.

(Signed) T. PYCROFT,
Chief Secretary.

No. 30. To the Secretary to the Government of India, dated Fort Saint George, 30th March
1860, No. 137.

*From the Chief Engineer, 25th November 1858,
No. 5758.*

*From the Commandant of Engineers, 21st March
1860, No. 58.*

I am directed to transmit to you, to be laid
before the Government of India, in reference to
Mr. Secretary Beadon's letter, 11th June 1858,
No. 942, copies of the letters, noted in the mar-
gin, on the subject of the description of boat
best adapted for the navigation of Indian rivers.

*Proceedings of the Madras Government, Marine Department,
for the month of March 1860.*

2. Appended to the Chief Engineer's letter are a Memorandum on the subject by Captain Rundall, District Engineer of the Godavery Division, and letters from the Executive Engineer in charge of the Eastern coast canal, and the Executive Engineer, Godavery Division. Colonel Arthur Cotton states that he has been entirely without any new data on the subject, beyond those upon which Captain Rundall has written his report, and he has nothing to offer beyond what that officer has said. He explains that the materials from which he had hoped to form certain conclusions about river boats were the results of the boat experiments he has had in hand, but that he has been entirely mistaken as to the time required for obtaining satisfactory data from them.

(Signed) T. PYCROFT,
Chief Secretary.

PUBLIC WORKS DEPARTMENT.
Marine.

No. 80.

Extract from the Minutes of Consultation under date the 10th January 1859.

Read the following letter from Lieutenant Colonel E. LAWFORD, Officiating Chief Engineer; to W. H. BAYLEY, Esq., Acting Secretary to Government, dated 25th November 1858, No. 5758.

SIR,

In laying before Government as directed in Extract Minutes Consultation under date the 27th July 1858, No. 288, the accompanying

1 Memo. from Captain Rundall, 11th October 1858.
1 Letter from Mr. Kennedy, No. 41 of 6th September 1858.
1 Do from Mr. Tuke No. 59 of 25th September 1858.
2 Drawings.

papers from Captain Rundall and Messrs. Kennedy and Tuke, on the subject of the description of boat best adapted for the Navigation

by Steam of Indian Rivers, I have the honor to state my opinion that, as the characteristics of the Rivers of this Presidency are very similar to those of the upper portions of the larger Rivers of Europe, where Steam Navigation has been brought to the utmost perfection under the guidance of consummate Mechanical Science, assisted by experience, it is vain to look for any suggestions of improvement from this country.

2. The characteristics of the Godavery, which may be considered our only navigable stream, are in the dry weather when alone any peculiar difficulties of Navigation exist, a wide shallow bed, divided into many channels by sand banks or rocks, and having a moderate current except at the three well known barriers, or where sudden bends cause local sets; and as these, with the exception of the impassable barriers, constitute obstacles exactly similar to those experienced in the Navigation of the Danube between Donanworth and Linz, and of the Rhone above Lyons, as described in the report of the Commissioners appointed to visit and report on the boats actually in use on those rivers. I believe that the same description of boat, proved to be the best there, will be found to answer best here, where, the rivers having little or no tidal channels, greater draft would not be advantageous.

3. Without therefore attempting to follow Captain Rundall into a recapitulation of the well understood elements of construction for ensuring carrying capacity with light draft and minimum midship displacement, and thereby combining great speed with economy of working, or questioning the correctness of his dictum as to the preponderating influence on speed of surface friction, I will merely state the few points which appear to me necessary to be attended to in designing such boats as will be most useful on our rivers, premising that, the Screw being inapplicable to a shallow draft of water, the system of paddle wheels should be adhered to.

I. As experience has every where demonstrated that passengers cannot with advantage be carried with goods, separate boats should be provided for each and adapted to the speed at which the two descriptions of traffic can be most profitably conducted.

II. For passengers the boats should be of 250 or 300 feet in length, by 25 in breadth to draw, with every thing on board, not more than from 20 to 24 inches of water, and fitted with Engines capable of propelling them at not less than 14 miles an hour.

III. For the conveyance of goods powerful Tugs of 120 feet in length by 15 feet in breadth, drawing not more than 2 feet with water and fuel on board, and fitted with Engines to give a speed of 8 miles with three or more barges of 100 tons each in tow, will be preferable to Cargo Steamers, which, to carry a load of 300 or 400 tons with the requisite light draft, would require to be built of unwieldy length.

IV. All the Steamers and Cargo boats should be of iron, as nearly flat bottomed as the necessity of collecting and getting rid of bilge water will allow, and with rounded, combined with sharp water lines, so as to reduce resistance at the same time that, by the somewhat spoon shape of the ends, the difficulty of getting off banks may be diminished.

V. The Engines should be high pressure, non-condensing, to work expansively with the Steam cut off at any part of the stroke, and the Boiler, for the sake of lightness, should be tubular on exactly the same principle of construction as that of a Locomotive.

4. With instructions embodying these main points, any respectable Engine and Iron Ship builder in England will be far more likely to turn out such a boat as is required, than if he be hampered by stipulations founded on the necessarily crude conceptions of Non-Mechanical professional Officers, comparatively destitute of the experience which in Europe has led to such successful results; the great essential being that the manufacturers, whoever they may be, shall be bound down by the heaviest penalties to deliver boats capable of fulfilling all the conditions of capacity, draft, speed &c., stipulated for.

Memorandum regarding the kind of Steamers required for the Navigation of Indian Rivers.

The Principal points which require to be considered in discussing this subject are

- 1st. The nature of the rivers to be navigated and
 - 2nd. The duties to which the boats navigating them are to be applied.
2. The first point divides itself into the two different conditions presented by all Indian rivers during the Monsoon and Summer months, thereby requiring such a construction of vessel as shall be effective under either condition.
3. To design a vessel solely for Summer navigation i. e. to draw the smallest amount of water possible, without at the same time rendering it capable of being loaded to a greater depth, would be to lose the advantage of a great depth of water during 6 months of the year; for it must be remembered that though the Indian rivers are shallow for 6 months of the year, yet that during the remaining 6 the volume discharged is sufficiently large and constant to maintain a fair depth of water.
4. As regards the river itself the following points must be kept in view.
- 1st. The degree of shallowness in the Summer season.
 - 2nd. The available depth in the main channel during the Monsoon.
 - 3rd. The average velocity of the current during the two states of river and
 - 4th. The greatest velocity to be overcome at any one point.
 - 5th. The general direction of the Stream whether tortuous or straight and the available width of channel at the different seasons.
 - 6th. The prevailing winds, whether with or against the stream, as on this it will be necessary to provide power for propelling the boat against a heavy head wind or for taking advantage of it when favorable.
5. My experience having been confined to the Godavery I can only enumerate its peculiar characteristics. Its depth in the Summer season in its *unimproved state* will admit of vessels drawing 2 feet as the present shoals can by a very little management be overcome, so as to allow of boats of that draught navigating as far as Budrachellum 137 miles from the sea all the year round.
6. The available depth of the main channel for the remaining 6 months would admit of boats drawing 6 feet.
7. The average velocity during the Summer would be about 1 mile per hour. The greatest velocity $2\frac{1}{2}$ miles.
8. The average velocity during the Monsoon that boats with a *light* draught would have to contend with would be about $2\frac{1}{2}$ miles, but for boats drawing 6 feet, 4 miles per hour.
9. The greatest velocity at any one point for either would be 8 miles per hour.
10. The general direction in both seasons is straight, the width of channel varies from 300 yards to 1 mile in the Summer, and from $\frac{3}{4}$ to 3 miles during the Monsoon.

11. During the season of the freshes that is from the middle of June to the middle of October the prevailing winds are West and North-West, generally following the windings of the river. During the remainder of the year they veer from South-West to South-East and East.

12. The above are the principal points to be taken into consideration in planning Steamers and Boats for the Godavery.

13. One important point however connected with this river which I must not omit to mention is the inexhaustible supply of wood fuel for miles along its banks, and the cheapness at which it can be procured viz., 1 Rupee per ton deposited on the margin of the river.

14. The second point to be considered is the service to which the Steamers are to be applied.

15. Without doubt the general principle that different classes of goods must travel at that rate of speed which each can afford to pay for is the correct one, which ever mode of transit is employed, and as weight for weight. Passengers are the freight that can afford to pay the highest rates for speed the separation of goods from Passenger boats should always be maintained.

16. The question however whether Steamers should carry Cargo themselves or merely be used as Tugs depends on several circumstances but mainly on the cost of working them, on this the most important point in the whole subject, the cost of transport, the report of the Danube and Rhone Commissioners, is strange to say quite silent!

17. In the Navigation of all Rivers by steam hitherto, the main expense has been the cost of the fuel, and the question has arisen whether the employment of a certain power in tracking a large amount of goods at a low speed is not more economical than in propelling a vessel carrying a certain fractional amount of those goods at 3 times the speed, and so making treble the number of voyages.

18. In the latter case there is a greater expenditure of fuel but the interest on first cost, the wear and tear, and cost of Navigating the Cargo Barges is saved.

19. Another consideration is, which way the great mass of traffic tends, whether up or down river, and as in all the Indian Rivers $\frac{2}{3}$ of the Traffic must be down stream, I am induced myself to think that Steamers themselves might be adapted for the carriage of Cargo or what would perhaps be better for a combination of the two* duties by which the greatest amount of goods could be carried in the shortest time and at the least cost. But this must be regulated by the cost of fuel. On the Godavery where wood fuel is so cheap equivalent to $2\frac{1}{2}$ Rupees or 5 per ton of coal the expenses of fuel form a small item on the whole cost, as will be seen in calculations which will appear below.

20. For very bulky goods of small value which can only bear the smallest cost of Transit, Tugs for drawing boats at very low velocities will be the most economical arrangement.

21. For the conveyance of Passengers however, I am decidedly of opinion that the accommodation should be on board of the vessel itself, and that the fastest boats of this description may be used for all classes on the Godavery, as the expense of working them will be, under a properly organized system, so very small. The fact of the cost of fuel being so very low, and therefore bearing a comparatively small proportion to the other items of expense in the cost renders a high speed the most economical rate of working.

22. For Boats in the Godavery I would therefore arrange as follows.

23. Passengers Steam Boats to travel at the rate of 20 miles per hour through the water, or averaging 15 over the current Cargo Steamers 13 miles through the water or 8 over the current Tug Steamers to tug their barges ordinarily 2 miles over the current or 7 miles through the water, but with of course extra available power to enable them to pass the pitches in the river where the current runs 8 miles an hour.

Classification of Boats for the Godavery.

Form.

24. As regards the particular form of Boat. I am of opinion that the model given in the Commissioners Report is as good as can be adopted for Passengers, with the exception of the rounded water lines. The wave line combined with the rising bow and stern appears to me calculated to offer the least resistance as thereby the water is displaced both laterally and vertically. The arrangements for the accommodation however I would reverse, for a boat travelling at a high speed always creates air for itself and hence all the heat and smell from the Engine room are carried aft and render the stern accommodation intolerable to Europeans.

25. The proposals regarding ventilation and cleanliness seem well adapted to secure those ends.

26. For Cargo Steamers I would increase the proportion of beam from $\frac{1}{8}$ to $\frac{1}{6}$ of the length for the purpose of increasing their buoyancy and carrying capacity, giving them sufficient depth of hold to admit of their being loaded to 5 feet during the monsoon months.

27. The Tug Boats should be of such dimensions as to carry on the lightest draught the greatest amount of power of Engine with only accommodation for Captain and Crew, and stowage for sufficient fuel.

28. The Cargo boats I would build on the exact model of the Cargo Steamers as being the one calculated to afford the least resistance.

Material.

29. The Material of which the Steamers and boats should be built is an important consideration.

30. In vessels of great length where the surface is so greatly disproportioned to the displacement, $\frac{2}{3}$ ths of the resistance arises from surface friction. It becomes therefore a most important element of consideration. For if the frictional resistance can be reduced one half, the power and so, both the first cost of construction and the subsequent expense of working will be proportionally reduced.

31. From observations made by Colonel Cotton and myself we have deduced that the resistance due to a painted surface to double that of a coppered surface. Such being the case the employment of Iron boats instead of wooden ones coppered seems questionable. The reasons which have led boat builders in England to substitute Iron for wood I am not aware of, or whether any minute experiments on the resistances due to various surfaces have been tried, but I think it is a subject which should be thrown open and thoroughly sifted as on it hangs the whole question of commercial results. It is possible that the superior degree of stiffness and rigidity obtainable in an Iron vessel may render the wear and tear of the Machinery as well as of the vessel itself so much less as to compensate for the cost of the extra power required for its propulsion, but until such has been demonstrated by actual experiment or the superiority of the Iron over the wooden boat, commercially as well as Mechanically established, it would appear to me premature to decide arbitrarily on the material which should be used in construction.

Machinery.

32. With respect to the Machinery to be used there can be no question that simplicity of arrangement and lightness of construction are to be preferred and that these two are combined in H. P. non-condensing Engine is universally allowed, notwithstanding the instance alleged in the Commissioners' Report to the contrary. As to the comparative safety of H. P. Engine over low pressure ones, there can be no question, all the accidents that have occurred in England have been with Low Pressure Boilers. No one ever hears of a Locomotive Boiler bursting on a Railway and the reason is obvious.

33. The boiler intended to work at 100 lbs. is proved to 400 that to work at 10 lbs. is proved to 30 or 40 lbs. The safety valve may often stick with a pressure of only 40 lbs. but never with that of 400. The late lamentable accident in England is an instance in point. The Boiler was not suffered to leave the maker's yard until subjected to the severest test, and as there was an unlooked for flaw, the accident occurred in the very locality (viz. the Manufacturer's yard) where there was likely to be the least extent of injury. But to obtain the full effect of High Pressure steam, all Engines should be constructed so as to allow of the steam being thoroughly

expanded, to attain the fullest effect of which expansion, it appears that there should be separate Cylinders surrounded with a jacket to receive heated air (not steam) for preserving the full temperature of the steam throughout its expansion and so obtaining the greatest amount of power.

Improved Boiler.

34. It would be well also if the principle advocated by Mr. Symes of increasing combustion by means of forcing compressed air through the boiler furnaces was employed, as that talented gentleman

* Or in other words, with an equal consumption of Fuel there would be obtained a greater amount of power.

has undeniably demonstrated the immense loss of heat which occurs even in stationary Boilers with large stacks; with his process of economizing heat the consumption of fuel per H. P. would be greatly reduced.* I am induced to advocate the adoption of all the recent improvements for since we are starting quite afresh in a new country, why should we not avail ourselves of the experience already gained, instead of going through the old beaten track and buying experience for ourselves?

35. Having stated above that the dimensions recommended by the Commissioners are such as are well adapted for the purpose, I would only add here the resistance that such a boat offers according to the results and the calculations arrived at from experience with boats on the Godavery.

	lbs.
36. If built on the wave line her displacement resistance at 2 feet draught would be, 35' 4 sq. feet at $\frac{1}{2}$ lb. per foot...	17
Surface measurement 11,600 sq. feet, painted Iron at $\frac{1}{3}$ lbs. per sq. foot...	773
Total.....	790
Add for slip $\frac{1}{2}$	263
Total at $2\frac{1}{2}$ miles per Hour.....	1,053

or 7 Horse Power

37. With Engines working up to 800 I. H. P. her speed would be $2\frac{1}{2} \times 3\sqrt{\frac{800}{7}} \times 2\frac{1}{2} \times 3\sqrt{114} = 12\frac{1}{2}$ miles nearly.

38. The same boat if built of wood and coppered would have its surface friction reduced to 386 lbs.

The total resistance would then be,

Displacement	17
Surface Friction.....	386
Total.....	403
Add for slip $\frac{1}{2}$	134
Total Resistance.....	537

or $3\frac{1}{2}$ I. H. P. at $2\frac{1}{2}$ miles 800 I. H. P. would then drive her at $2\frac{1}{2} \times 3\sqrt{\frac{800}{537}} : 2\frac{1}{2} \times 6.1 = 15\frac{1}{2}$ miles.

39. The same boat fitted with High Pressure Engines which when working at the full stroke indicated 800 H. P. would, if arranged for fully expending the same quantity of steam, afford treble the power, the speed of the boat would be increased by $3\sqrt{3}$ and the Boat (wooden and Coppered) would be propelled at 21 miles per hour.

Cost of Working.

40. I would now attempt to give an idea of the cost of working the above steamer on the Godavery, though in the absence of any statement of the cost of the vessel my calculations can of course be only approximate.

41. Supposing however that the vessel measures 600 Tons, the cost and of the hull landed in this country and fitted to be £50 per Ton measurement and that the Engines are £30 per I. H. P. The total cost would for the Vessel itself be..... Rupees 3,00,000

For the Engines.....	"	2,10,000
Interest at 5 per cent per Annum...	"	5,40,000
Depreciation 5 per cent.....	"	25,000
Repairs 2½.....	"	25,000
	"	12,000
Total per Annum.....	"	62,000

Or per month say..... Rupees 5,200

Crew.

Captain.....	Rs.	
Mate.....	300	
2nd Mate.....	100	
Engineer.....	50	
Assistant Engineer.....	200	
2 Engine Drivers @ 15 each...	100	
16 Stokers at 6.....	30	
20 Lascars at 8.....	96	
3 Steersmen.....	160	
1 Syrang.....	24	
	20	
Total...	1,080	1,080
Fuel at the rate of 30 lbs of wood per I. H. P. or 11 Tons per hour or 132 Tons per day at 1½	4,950	
Total expenses per month.....	11,230	

42. With a speed of 13 miles or 8 over the current, she would make the voyage to Chandah in 4 days returning in 1½ day allowing for loading and discharging say 4 trips per month.

43. The expenses incurred would thus be Rupees 2807 per trip or 2-8 Rupees per mile over the whole distance travelled so that as she is estimated to carry a whole Regiment at a time, she would convey then supposing them (1,000 strong) at 2-8 Rupees per mile or at the rate of about ½ pie per man per mile or supposing her adapted for cargo she would carry 200 Tons up stream and 400 Tons back again which would make the expense of carrying 600 Tons at that speed about 75 annas or 900 pies per Ton being less than 1 pie per Ton per mile.

44. From the above will be seen what a vast difference there would be, if the same boat had its resistance reduced by one half and its power trebled simply by using the steam expansively, instead of a speed of 8 miles over the current there would be one of 16, so that double the number of voyages would be performed in the same time and consequently the cost of Transport reduced one half.

45. It will be seen also that the cost of fuel is less than one half of the whole cost and that as in an expansive boat the items for interest, depreciation, &c., are very heavy, it is greater economy to work at a high speed so as to reduce the proportion that these items form on each trip, than to save the consumption of fuel by working at a lower speed.

46. It would have been curious to have had the opportunity of comparing the cost of Transport on the rivers in Europe with that on the Indian rivers. Though I will not assert that the calculations above given are not free from error, yet I think I may safely state them to be a close approximation, and sufficiently near to shew what great loss the country is sustaining for the want of well regulated steam transport.

(Signed) F. H. RUNDALL, Captain,
District Engineer, Godavery Division.

Since writing the above a Number of the Engineer and Architects Journal has reached me containing remarks so pertinent to the superiority of High Pressure steam used expansively over that of Low Pressure, that I do not hesitate to append it to the report for the information both of unprofessional readers and of those who cannot overcome the long established English prejudice and antipathy to the very name of High Pressure steam. The following remarks are taken from Lectures given by Mr. Conybeare, Civil Engineer; the Gentleman selected for lecturing before the Royal Engineer establishment at Chatham.

Extract.

"1st. The steam should be admitted into the Cylinder at as high a temperature, and pressure and in as anhydrous a state as possible."

"2nd. * * *

"3rd. The principle of expansion should be pushed to the utmost."

"4th. To eke out the gain from expansion and to prevent loss of heat * * *
"the steam should be superheated in its passage from the Boiler to the Cylinder." * * *

"The economy of High Pressure steam is in fact so enormous and so obvious, that notwithstanding the bigoted adhesion to precedent that forms our worst national characteristic its use is daily gaining ground. Within the last ten or fifteen years the working pressure of locomotives has been increased from 60lb to the inch to 120 and they are now occasionally pushed to 200lb. And in the Marine Engine the ratio of increase has been equally great, for 20lb to the inch is now as common in such Engines as 10lb was fifteen years ago. No doubt can exist amongst experts of the ultimate adoption of steam of the pressure of 1,50,200 or perhaps 300lb to the inch for all purposes, but our progress towards such clearly foreseen consummation has been, and still is, most unscientifically slow considering that theory and practice have long established the advantage, the practicability and the safety of using Steam at the pressure at present usual in locomotives. There is no pattern of Engine manufactured in such vast numbers as the locomotive;—there is no form of boiler in which the pressure is so high as the locomotive;—and there is no form that is so exempt from explosion. There is no reason whatever against the adoption of steam of the locomotive pressure in a Marine Steam Engine; on the contrary, in every particular, a condensing Engine, working at from 120 to 150lb to the inch pressure will have the advantage over one working at 20lb for marine purposes; it would cost only half as much, it would occupy only about a third the space, it would consume only one-third the fuel, and it would require scarcely more than one third as much condensing water."

"It is obvious therefore that there is no difficulty in practice in so far reducing the diameter of the Cylinders composing the high pressure boiler as to render them perfectly safe at any imaginable pressure. Faraday, in his experiments on the manufacture of gas, hands glass tubes filled with gas imprisoned under a pressure of 50 atmospheres, or about 750lbs. per square inch, about a crowded lecture room!—yet no one exclaims at the danger."

"In fact it can be easily demonstrated that high pressure boilers, when specially constructed for the pressure at which they are worked, and previously proved—as they always are on the Continent—to three times such working pressure, are infinitely safer than low pressure ones; that in the first place they are less liable to burst and secondly, from their comparatively small dimensions they cannot do any serious harm when they do burst. Dr. Ernst Alban, justly observes, "As the strength of the metal is adapted to the working pressure, the proper elasticity for which the vessel is constructed must be exceeded before an explosion can occur; but there is an advantage on the side of the high pressure engine, for the elasticity must be increased in a much higher ratio than with the low pressure Engine, before it overcomes the pressure at which the boiler is proved (usually three times the working tension) and therefore a much longer time will elapse before absolute danger arises. For example in a boiler working at 8 atmospheres it will take a much greater lapse of time for the pressure to rise to 24

"atmospheres than it would to reach 24lb. per square inch in a boiler working at 8lb. and those would be the points at which danger may be supposed to arise in the respective cases." "M. Arago notices the same fact and characterises the fear of high pressure boilers as "mere prejudice."

"And not only is the high pressure boiler less liable to accident, but when an accident does occur the consequences are seldom serious, owing to the comparatively small amount of the boiler contents and their subdivision amongst a number of small Tubes or Chambers. The great principle of ensuring safety in boilers—the only absolutely sure method—is so to construct the boiler that its explosion may not be dangerous; and this principle is carried out in all properly designed high pressure boilers."

(True Extract.)

District Engineer's Office, Godavery
Division, Camp at Dowlaisweram,
11th October 1858.

(Signed) F. H. RUNDALL, Capt.

District Engineer Godavery Division.

Letter from Mr. R. KENNEDY, Executive Engineer, 3rd Class; to Major E. LAWFORD, Officiating Chief Engineer, dated Adyar, 6th September 1858, No. 41.

SIR,

I have the honor to acknowledge receipt of Extract from the Minutes of Consultation No. 288, dated 27th July and No. 1550, dated 6th August, with resolution No. 2773, dated 13th August of the Officiating Chief Engineer, in which I am called upon to submit my opinions on the question of Indian River Navigation, in connection with the Report of the Commission appointed by the Honorable Court of Directors, to examine into and give a conclusive opinion on that subject.

Having carefully studied the Report to the best of my ability, I feel bound to say, that it is not in my power to supplement it with any additional suggestions of my own.

What I do know of the principles of Boat and Steam Machinery construction for such a purpose, fully bears out the conclusions of the Commission, in which are laid down the latest improvements arrived at, coupled with the professional skill and knowledge of the most eminent Engineers of the day.

The shape of boats; the single pair of Paddles in preference to two pairs, (except where power is of more consequence than economy); disapproval of screws in shallow water; working of engines by condensation and expansion; as advocated in the Report, are all in accordance with my own opinions in the circumstances, and so far as I see, any additional information of value to be had in this Presidency, can only be supplied from a knowledge of the physical conformation of the rivers, which unfortunately I do not possess.

Into the financial part of the question the Commissioners have not entered, as probably it was no part of their duty to do so, besides, whatever may have been the pecuniary results elsewhere, practical experience alone can decide this point in connection with this Presidency.

An experiment on a limited scale has been tried on the Godavery, about which the most contradictory statements are put forth. On the one hand very high dividends,—ranging from 25 to 55 per cent I understand—have been paid; and on the other hand, it is said on good authority, that these dividends have been paid out of capital.

However likely it may be that large profits will accrue to such undertakings, preliminary calculations must be in a great measure speculative. Of the advantages to be derived therefrom by the impulse they would give to commerce, and to the development of the resources of the country, I believe there can be but one opinion.

Supported by the Honorable Court; having at their command the best known sources of information; gathering the facts and opinions recorded from actual observation at the scene of operations, where the practical experience of many years, combined with the pecuniary interests of those concerned prompted every exertion to success; the Commissioners in the discharge of their

duty, had advantages of which the most has been made; and if I may do so without presumption, I would earnestly urge the giving a practical effect to their recommendations, whenever it may be determined to commence operations.

With such a Report before the Government, it is of no consequence that it is not in my power to add to its value, I must therefore throw myself on your indulgence for not entering into details which have been discussed by the Commission, with a completeness and ability, that seem to me to exhaust the subject.

Letter from G. P. TUKE, Esq., Executive Engineer Godavery Division; to Captain F. H. RUNDALL, District Engineer, Godavery Division, dated Camp at Cocanada, 25th September 1858, No. 59.

SIR,

With reference to the communication I received from you on the subject of Steamers for the Indian rivers, I have the honor to state that in my opinion powerful Tug-Steamers with a fleet of iron boats (of say 80 tons each) will answer the best. A Steamer to carry a cargo, draw only two feet of water, and pay, would necessarily be of much larger dimensions than the river Godavery, (I have not seen any other Indian river) in its present state, would allow; for there are many rocky places in it, through which the Tug and her jointed fleet could be winded through, where as a longer boat could not be, besides the former has the advantage of being able to cast off parts of her fleet at any goods Depôt as convenient, the man in charge of such station on the approach of the Steamer simply hoisting a signal, say a white flag with No. of tons of goods in deposit in black figures on it, the Commander of the Tug when a little up stream of the station, leaves as many boats as the goods require and proceeds on his voyage towards the great object the Cotton Mart, Chandah, the boats so left at the station when loaded could proceed to Dowlaisweram by themselves. I have no doubt that large quantities of goods, of all kinds would be brought to the different Depôts on the Godavery, and a brisk trade follow, the inhabitants of the country would then find it worth their while to cultivate hundreds of miles of ground now lying waste. The iron Tug-Steamer I propose is 195 feet long over all, 189 at her two foot load-line, 32 beam, and 4½ feet deep, plates in bottom and sides up to load-line ¾ of an inch and above water-line, ½ of an inch in thickness, with fine one foot square hollow kelsons, running along the whole length of her flat part to strengthen her, her power 200 horse nominal, two pairs of Engines disconnected, that is one pair of Engines to each wheel, diameter of wheel 28 feet, breadth of do. 14 feet, length of stroke 4 feet, diameter of cylinder 33 inches expansive gear, cut off at ⅓rd the stroke, 4 boilers with 6 inch tubes or even larger, fire places 8 feet long, fire bars 2½ feet from crown of fire box, 4 chimnies 3 feet in diameter. The keel rises from 40 feet from the bows and 25 at the stern, the rest of the boat a dead flat. Her Engines are 5 feet before the centre, as the crew, stores, &c., will be generally aft, besides the tug of the boats will tend to put her by the stern. There are 2 cabins forward, one for the Commander the other for the Engineer, one cabin aft for the crew, and the rest for the boat. I would use good tarpaulins for a covering in wet-weather, for if properly spread the stokers and engines would be as well protected by these as by a wooden house, besides getting more air in fine weather, the tarpaulins could be furled on their ridge rope and a plain awning spread in its place; with these arrangements, I calculate the Steamer will draw 2 feet, which depth should not be exceeded on the Godavery. It will be seen by the plan that there is a great deal of spare room about the Engines, but I mean her for a tug and tug only, and that she should have as little cabin room as possible, for cabins entail weight to the hull.

The iron boats should be say 5 feet deep, and open with eye bolts along the gunnales for hooking a rope net work to, for preventing the cotton or other cargo heaped up some 7 or 8 feet above the boat from falling overboard, eye bolts also outside the boat 6 inches below the gunnale for fastening tarpaulin covers to.

To guard against the danger of the boats of the fleet running into and damaging the Steamer in case of her grounding, I would propose that buffers and spring bows such as are on the

Railway Engines and carriages at home be used, the Steamer having a spring bow on her stern, and the boat next to her buffers on her bow and so on through the fleet, the buffers are then all brought close up to the springs, and the boats fastened together by a chain on each bow.

The boats should have an overhang of 5 feet in their bow, this with buffers 4 feet in length will keep them perfectly clear of the Steamer's rudder.

With this letter I forward to you a plan &c. of the Tug-Steamer I propose. I regret that other duties have prevented my sending it before.

Ordered that the above letter and its enclosures be forwarded to the Marine Department with reference to an Extract Minutes Consultation in that Department dated 27th July 1858, No. 288.

(A true Extract.)

J. H. Williamson
Secretary to Government.

To the Marine Department, with 2 Drawings.
Exd. J. H. Williamson.

Recd 13th July

A. H. H. H. H.

Proceedings of the Madras Govt.
Read the following -

Chief Engineer's letter,

ter, 25th Nov. '58 No. 158 - Recorded in Cons;
10th Jan'y. '59 No. 80. Pub.
Wks. Sept.

Letter from the Com-
mandant of Engro. - Jntes 21st Mar. '60 No. 58.

Order - 31st March 1860, No. 136 -

Ordered that copies of the above
letters be forwarded to the Govt.
of India in reference to Mr. Se-
cretary - Bax don's letter, 11th June
1858 No. 942.

Copy of Col. Cotton's letter will
likewise be furnished to the
Public Wks. Dept. for records.

The Pub. Wks. Dept. Supd. J. J.

Con 27th July 1858 No. 17-18

SC. No. 136
L. 137

Memor. 1859. Sept.

Extract Minutes foramt.
- tation in the Public

under Sept. 1860.

2/10
2/13 Jan'y/59.

4/13. 20/13. 20/13.

Forwarding copy of a letter
his excellency from the
Chief Eng. Engineer on
the subject of description
of boat built adapted for
the navigation by steam
of the river Kaveri.

C 24th Nov 1858

C. 24th March
1859

of boat best adapted for
the navigation of the
of Indian Rivers.

Dup. 9th
Encls. 1-

Marine.

N^o. 137-

The Secretary to the Govt. of India.

Sir-

From the Chief Engineer,
25th Nov. 1858,
N^o. 5758.

the Commandant
of Engineers, 21st Mar.
1860 N^o. 58.

I am directed to transmit to you, to be laid before the Govt. of India in reference to Mr. Secretary Beadon's letter, 11th June 1858 N^o. 942, copies of the letters, noted in the margin, on the subject of the description of boat best adapted for the navigation of Indian Rivers.

Appended to the Chief Engineer's letter are a Memorandum on the subject by Captain Rundall, District Engineer

11
Engineer of the Godave
ry Division & letters
from the Executive En-
gineer in charge of the
Eastern Coast Canal,
& the Executive Engi-
neer, Godavery Division.

Colonel Arthur Cotton
states that he has been
entirely without any
new data on the sub-
ject, beyond those
upon which Captain
Rundall has written
his report, & he has
nothing to offer be-
yond what that of-
ficer has said. He ex-
plains that the ma-
terials from which he
had hoped to form
certain conclusions
about

River Boats were
the results of the Boat
experiments he has
had in hand, but
that he has been entirely
mistaken as to the
time required for
obtaining satisfac-
tory data from them.

For C. S. George,
30 March, 1860.

[Signature]

79
C230

Boats for Indians

No of boats 31 March -
Marine 1800 (Deposits)

No 134

To the Secy of the Comfy
Native

29 March 1860

Refers to 29 8th June 1860.
29 22 29

C24 March
229 "