Cedric Belfrage - Staff

New York

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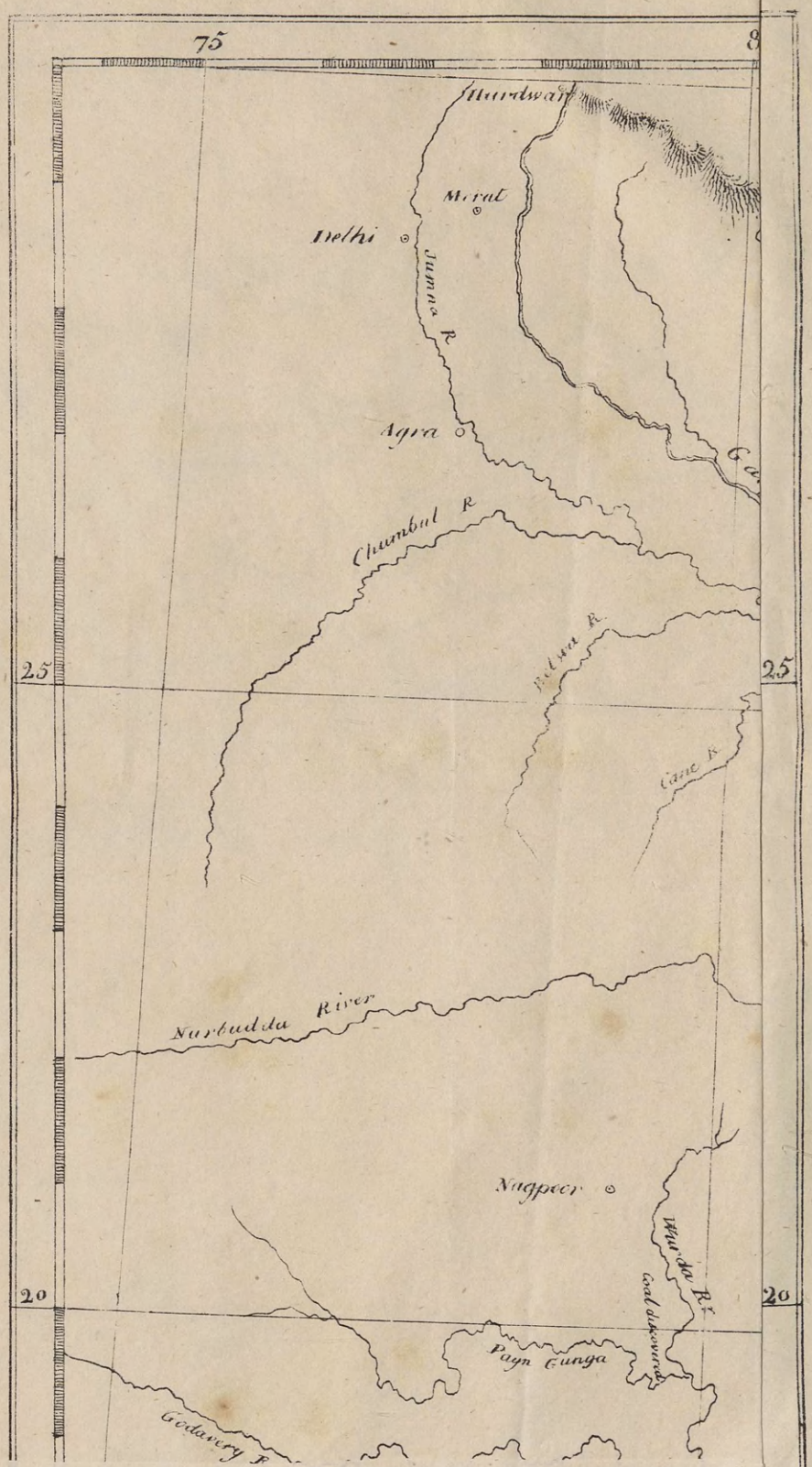
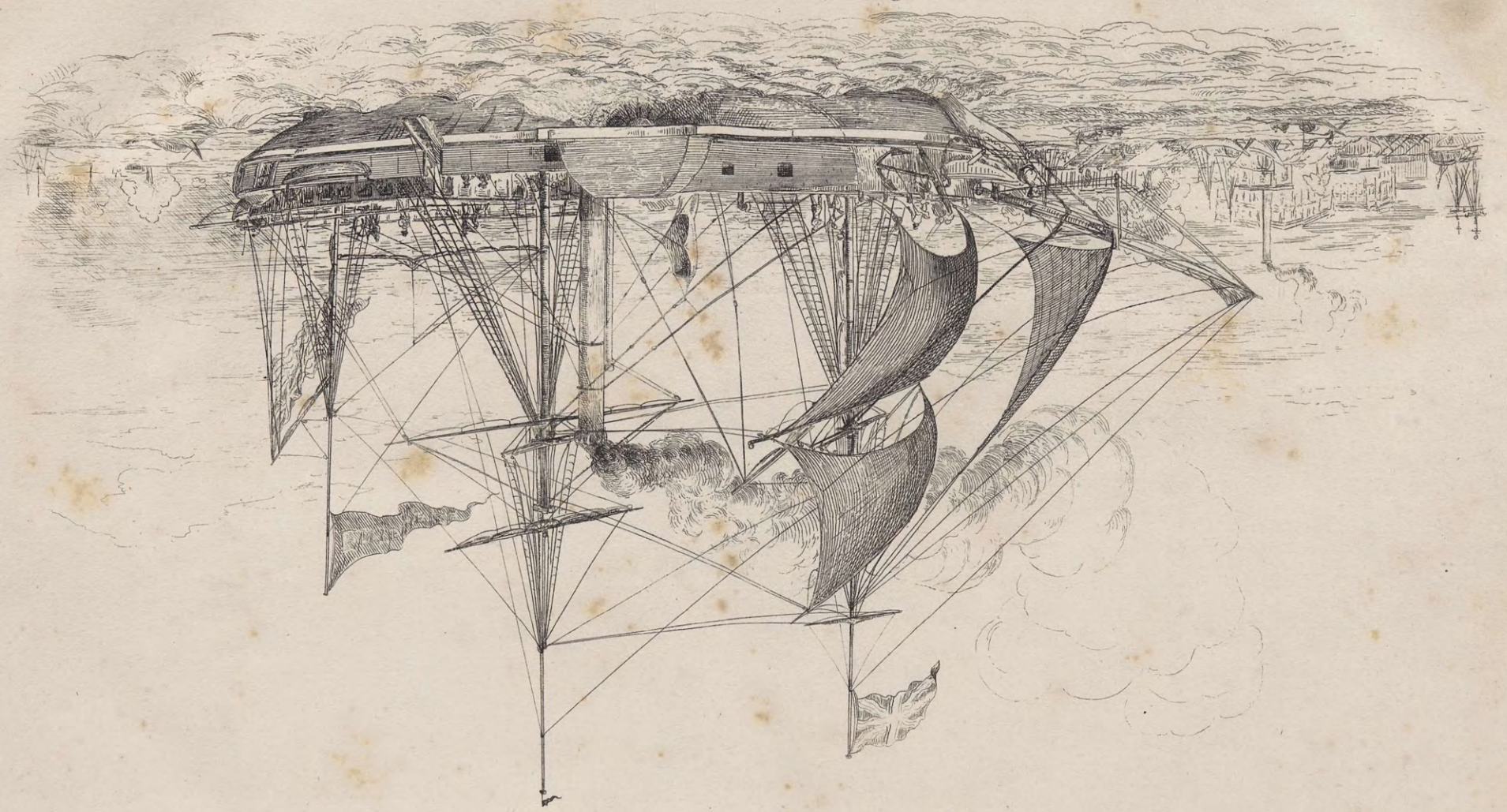
Sketch Map
of
Gangetic India

75 80 85 90 95

25 20

Hurdwar
Meerut
Delhi
Jumna R.
Agra
Chumbul R.
Betwa R.
Cane R.
Ganges
Rapti R.
Lucknow
Oude
Cawnpore
Allahabad
Benares
Patna
Kalmandoe
Gunduck
Kosie R.
Mahanudde R.
Purnea R.
Sanpoo
Brahmaputra R.
ASSAM
Gurrah
Jumnapoor
Seorma
Sylhet
Munepoor
Soane R.
Coal mines
Coal mine
Purnoodia R.
Bhagulpoor
Bhagurutty
Gangas
Jellinghee
Mallabunga
Jumna
Dacca
Kyendwen R.
Nurbudda River
Nagpoor
Wurdha R.
Godavery R.
Pain Gunga
Hyderabad
Harmasy R.
Kistnah R.
Vizagapatam
Ganjam
Cuttack
Pt. Palmiras
Balasore
Subunreeka R.
Dalkishna
Hoogly
CALCUTTA
Chittagong
Arracan
Akyab
Ramree
Cheduba
Prome
Irrawadi
BURMAN EMPIRE
Umrapoora
Rangoon
Bassein
Martaban
Amherst
Cape Negrais


75
Hurdwar
Meerut
Delhi
Jumna R.
Agra
Chumbul R.
25
Betwa R.
Cane R.
Narbudda River
Nagpoor
Wurda R.
Coal discovered
20
Payn Gunga
Godavery R.



The Enterprize coming to moorings.

AN ACCOUNT

OF

STEAM VESSELS

AND OF

PROCEEDINGS CONNECTED WITH

STEAM NAVIGATION

IN

BRITISH INDIA.

COMPILED BY

G. A. PRINSEP.

CALCUTTA:

FROM THE GOVERNMENT GAZETTE PRESS, BY G. H. HUTTMANN.

1830.

C. A. HARRIS, ESQ.

COMPILED BY

BRITISH INDIA

IN

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THE ORIGIN

STEAM VESSELS

OF

AN ACCOUNT

INTRODUCTION.

THERE is no department of science, in which it is not interesting to watch the progress of discovery, and useful to record experiments, whether successful or otherwise. Many valuable publications have been devoted to these objects as regards the Steam Engine; and the application of this wonderful agent, to promote the convenience and increase the powers of mankind, has been traced from the feeble efforts of the original inventors, in various descriptive Essays, with a minuteness of detail characteristic of the enquiring spirit of the age.

Of the purposes to which Steam has been applied, none will bear comparison in the scale of utility with the aids it has afforded to locomotion. Its other uses are matter of choice, a mere question of economy between that and other available means. But no rival power can make a ship, or a boat in a broad river, independent of winds and currents, and reduce a voyage to exact calculation of time. Since the adapting of Steam Machinery to vessels, the passage of men and merchandize has been facilitated in a degree far beyond the anticipations of the first projectors. Journeys, heretofore of months, are in some instances performed almost in the same number of days: where days were occupied, the passage is now reckoned in hours; and obstacles are overcome which had baffled the ingenuity of man, or produced delays and uncertainties altogether beyond his controul. Nothing seems to

be wanting, but that the efforts which are making in England to accelerate land journeys by the same agent, should be crowned with the expected success: it may then be said to have annihilated distance, diffusing over the world an activity, the effect of which, in extending the influence and power of civilization, the most sanguine would not venture to prophecy.

The pages which follow are intended to illustrate a small portion of this extensive subject. It is now barely seven years since Steam was first directed in India to the purposes of Navigation; but the exertions made in that interval have not been of the limited nature, or on the narrow scale which is usual in the execution of new projects. With the examples of England and the United States to stimulate adventure, capital has been freely embarked by individuals, and the local Government has not been slow to perceive that its own strength and efficiency might be very much promoted by the vast resources of so useful an agent. *Enough* has already been done, both substantially and in the way of experiment, to give interest to a record of the facts; and instead of feeling surprise that such a publication should now be offered, one might rather wonder at the entire absence of any account of Indian Steam Navigation, considering that it has absorbed so much private capital, and latterly so much occupied the attention of the Ruling Authorities. The very want of success, which unfortunately has attended more or less all the private undertakings, affords an argument in favor of an attempt to supply this deficiency; for in proportion as the losses have been great, must be the anxiety to know the causes of disappointment in each case.

Such is the object and such the only merit to which the present publication aspires. It has been invited by the Indian Government, whose records have been thrown open for the purpose, and at whose expense it is printed, that Government being fully sensible of the advantage which its own officers, as well as the public,

would derive from an accessible and digested compilation, shewing the result of past efforts and experiments in a branch of mechanical art avowedly still far below the point of attainable perfection. The work is not of a professional character, its sole pretension being, as above stated, to furnish facts and to relate occurrences with fidelity: these the Author has sought with industry, not only in official, but also in other equally authentic, although private sources. He undertook the labor of compilation at a moment of comparative leisure, partly in order to relieve more valuable time than his own, but mainly from a desire to see the whole matter collectively treated in some record of easy reference.

CONTENTS.

APPENDIX.

ERRATA.

Page 1, line 1, for "England" read "Great Britain."
—— id. —— 14, for "materiel" read "*matériel.*"
—— 6, —— 26, for "10,000" read "2,000."
—— 10, —— 11, for "should" read "would."
—— id. —— 33, insert "was" after the word "consumed."
—— 11, —— 10, for "services" read "voyages."
—— 13, —— 28, for "Trincomalie" read "Trincomalee."
—— 18, —— 5, for "the steamer" read "their steamer."
—— id. —— 19, for "some times" read "sometimes."
—— 22, —— 21, for "adventure" read "adventurer."
—— 23, —— 12, for "where" read "were."
—— 25, —— Note *, under column headed "Minden"—in the 4th and 5th line of figures, dele the four Zeros, and leave the spaces blank.
—— 26, —— 20, for "tenforward" read "ten feet forward."
—— 27, —— 1, for "It has being" read "It has been."
—— 29, —— 16, for "fourteen" read "fourteen days."
—— 30, —— 8, dele "general."
—— 32, —— 29, for "outward" read "outward bound."
—— 33, —— 2, after "the latter" insert "to the extent of."
—— 34, —— 35, for "last year" read "the present year."
—— 35, —— 12, for "the coals" read "fresh coals."
—— 37, —— 5, for "Burhampootra" read "Bruhmapootra.
—— id. —— Note*, for "Berhampootur" read "Burhampootur."
—— 39, —— 15, for "was ordered" read "were ordered."
—— 41, —— 3, for "country, when" read "country. When."
—— id. —— 12, for "site" read "sites."
—— 42, —— Note‡, for "Appendix (F)" read "Appendix (G)."
—— 44, —— 6, for "stoppages" read "stoppage."
—— id. —— Note*, after "at Benares" insert "during the same period."
—— id. —— Note †, for "Captain, Paymaster" read "Captain and Paymaster."
—— 46, —— 5, for "fiand le" read "and file."
—— id. —— Notes * and †, for "Appendix G" (in two places) read "Appendix H."
—— 48, —— *Note *, add the following words.*—"A set of Etchings, made for the purpose, is also given in the Appendix (A 4.")
—— 51, —— 17, for "Allahabad....16th October" read "Allahabad....1st October."
—— id. —— 19, for "Allahabad....5th October" read "Allahabad....3d October."
—— 52, —— 27, for "least" read "lest."
—— 53, —— 9, for "one engine" read "one boiler."
—— id. —— 9, after "down" insert "which was found sufficient to keep the engines."
—— id. —— 35, for "open" read "upon."
—— 55, —— 30, for "of twelve" read "from twelve."
—— 56, Insert an asterick before the first Note.
—— 58, —— 5, for "was directed" read "were directed."
—— 63, —— 21, for "Bittowlee" read "Bettowlee."
—— 65, —— 10, for "ascertain" read "enquire."
—— 67, —— 15, for "one hundred and ten, and one hundred and twenty feet" read "one hundred and ten feet, and twenty feet."
—— 68, —— Note *, for "Appendix J" read "Appendix I."
—— 69, —— 8, after "prejudice" dele "of."
—— id. —— Note *, for "Appendix K" read Appendix J."
—— 70, —— 31, before "lighter construction" dele "a."
—— 72, —— 30, for "to the ingenious" read "to be ingenious."
—— 73, —— 26, for "ascertain" read "discover."
—— id. —— 33, for "with" read "making."
—— 75, —— 33, for "A further took place" read "A further trial took place."
—— 78, —— 19, for "Both engines" read "Both boilers."
—— 81, —— 6, for "abundant and cheap. Material of" read "plentiful and cheap. Material and talent of."
—— id. —— 7, for "plentiful" read "abundant."
—— id. —— 9, for "Potamac" read "Potomac."
—— 84, —— Note ||, for "rate" read "ratio."
—— 85, —— 4, for "Philadelphi" read "Philadelphia."
—— 89, —— 19, for "less" read "fewer."
—— 91, —— 18, for "thirtieth" read "thirteenth."
—— 93, —— 8, for "supposes" read "believes."
—— 98, —— 2, Note †, for "eight inches" read "eight decimals of an inch."
—— id. —— 4, for "one foot seven inches" read "one inch and seven decimals."

ERRATA.

STEAM NAVIGATION, &c.

CHAPTER I.

Great Britain

In ~~England~~ and the United States, the art of Steam Navigation has, of late years, advanced with gigantic strides. On the coasts and rivers of those countries, the white sail of the packet and the tow rope of the barge, are fast yielding to the paddle of the steamer. In a distant dependency, deficient both in capital and resources, it could not be expected that the developement of a complicated and costly invention should keep pace with the march of improvement in places where every circumstance combined to urge it forward. But the countries we have quoted, are less prominently distinguished from other nations in the service they have obtained from the steam engine, to whatever purposes applied, than all other colonies and dependencies, Canada alone excepted, are behind the British territories in India. Nor indeed were the earlier efforts of the Americans, still less those of our countrymen at home, for the introduction of steam navigation, more vigorous or more rapid in their progress than those which, within an equal term of years, have been displayed here, under a combination of difficulties much enhanced by the necessity of importing all the matériel, both men and machinery, from Europe.

In the following pages it is proposed, in the first instance, by a historical sketch of the several vessels, and their performances, to give an outline of what has been done towards this object, both by individuals and by the local Government. However unsatisfactory the results, as matter of speculation, in the former case, the general tendency of the whole has been to facilitate our maritime and inland communications, and to strengthen the Military position of our territories in the East, with respect to the neighboring States.

The importance of the subject, in a political as well as in a commercial point of view, renders it desirable that the nature of the difficulties to be surmounted, and the extent to which they have been overcome, should be generally known. If experiment be the true

basis of philosophy, publicity is the pilot of science, and the best safeguard against the waste of time and capital in the repetition of errors. In the present advanced state of knowledge and of the arts, nothing can be expected from ignorant adventure. It is by recording facts, in a shape accessible to all, and thus affording opportunity of comparison to men of competent judgment, that we may hope for success. To Europe alone can we look for that concentrated skill, which, by the rapid march of invention, shall perfect the machinery we require; improvements must necessarily be slow, which are wholly dependent upon the local talent and resources of India.

Whether economy of labor will eventually be produced by the steam engine, in a country where labor is singularly cheap, and the use of that engine particularly expensive, is a question that does not affect the merits of steam navigation. Celerity of motion is of infinite value in many cases, and the Government at least must always be prepared for emergencies. If the object can be obtained by steam with certainty, in a degree much surpassing the effect of other means, steam must be adopted. It is probable, therefore, that Government will continue to recognize its utility, although it should not become a source of profit to individuals in any shape.

The attention of the Bengal Government has for some time been directed to the subject: but in this, as in all matters open to individual enterprise, private adventurers took the lead. The Enterprise, Falcon, Emulous, and Telica, from England, and the Diana, Forbes, Comet, and Firefly, the hulls of which were built on the river Hoogly, if they have not realized the hopes of the proprietors, have at least proved, that, in the trading community of Calcutta, there has been no backwardness to adopt improvements and to promote useful experiments. British merchants have also the merit of having built and navigated the first steamer in Java,* the only one that has yet appeared in a foreign settlement on this side the Cape.

In the year 1817 or 1818, Captain Davidson, of the Bengal Engineers, brought to Calcutta, an engine of eight-horse power, purchased by Messrs. J. and W. Gledstane, of Liverpool, the manufacture of Mr. William Brunton, of the Eagle Foundry, at Birmingham. It had an iron boiler, and was designed for a river boat; but remained some years neglected in a godown, until the late Major Schalch purchased it for a dredging boat, which Messrs. Kyd and Co. were employed to build for Government in 1822. The Pluto, the

* The Baron Vander Capellen, one hundred and twenty-seven feet long and nineteen broad, carrying two engines of twenty-five horse power each, by Fawcett and Co. She was built at Batavia soon after the war broke out in Java, and was engaged by that Government for two years, at ten thousand dollars per month, which more than repaid her cost. She proved very efficient in the transport of troops along the coast against the monsoon, and is still employed in the same service. Her speed is six knots in a smooth sea, with a draught of nine feet.

name she afterwards bore, was furnished with a double set of buckets to dredge on both sides. These were taken off, and paddles substituted on the breaking out of the Burmese war, when she was fitted out as a floating battery, and sent with the Expedition to Arracan. Although she was not used in that service, and her utmost speed was only four knots, much benefit was derived from her in the passage of troops over the creeks and estuaries of that coast. Her original form was that of a barge, perfectly flat-bottomed, and square at both ends: but when fitted out, as above described, a false bow was attached to her, and other alterations were made. She was sold on the termination of the war, and the engine being removed, the vessel became a coal depôt for Messrs. Alexander and Co., and was finally sunk in the gale of last May. The engine is now in the yard of Messrs. Jessop and Co., who purpose putting it up at their Colliery in Burdwan.

The boat* built at Lucknow by Mr. William Trickett for the Nuwaub, was the first vessel in India propelled by steam. The plans and engine were brought out by Mr. Henry Jessop in 1819. The latter, made at the Butterley works, was also a single eight-horse engine, said to have been of excellent workmanship, and to have given the boat a speed of seven to eight miles per hour. This little steamer, a toy of his late Majesty of Oude, was, like other playthings, soon laid aside, and suffered to go to ruin.

The Diana was originally a speculation of Mr. J. T. Robarts, a member of the Factory at Canton. Being in England in 1821, he suggested to the Court of Directors, that a steamer might be employed on the Canton river with great advantage to the Company; the annual charge for boats amounting to a large sum, owing to the extortions of the local authorities. The Court took the opinion of Mr. Rennie, who approved the idea, but apprehended that the Chinese would not allow the employment of such a vessel. The proposal was, therefore, declined by the Directors. Mr. Robarts, not agreeing with Mr. Rennie as to the sentiments of the Chinese, went into the scheme on his own account, and ordered a pair of sixteen-horse engines of Messrs. Maudeslay, with a copper boiler, and the other requisites for a fast vessel of one hundred and ten tons, which he sent out in frame.† The whole arrived after himself, early in 1822, and very much excited the curiosity and admiration of the people at Canton, by whom he was urged to put it together.

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* DIMENSIONS.

	FEET.
Length between perpendiculars,.....	50 0
Breadth, moulded,.....	8 10
Ditto, extreme,.....,.....	9 0
Depth,.....	4 0

† Dimensions per drawing.—Length eighty-five feet; extreme breadth sixteen feet; ditto, including paddles, twenty-six feet; estimated full speed nine knots, and intended to be fitted up as a yacht. The total cost, with freight, was about £7000 when landed in China.

But his health obliging him to anticipate his retirement, he abandoned the design of launching and working the vessel in that river, and re-shipped the engines and materials for Calcutta, where they arrived in June of the same year, and were, by his desire, immediately tendered to the Government of the Marquess of Hastings, for sixty-five thousand rupees. Some time elapsed before an answer was given, which, being at length in the negative, the concern was taken up by the Merchants, and distributed in sixty-five shares of one thousand rupees each, chiefly among the Agency Houses. Part of this sum (fifteen thousand rupees) was applied to the building of a new vessel, in lieu of the English frame, which, being of oak, was not considered to have the desired durability, and the subscribers were subsequently called upon for five thousand rupees for extra work : so that she stood them in seventy thousand rupees when launched at the dock-yard of Messrs. Kyd and Co. on the 12th July, 1823. Her name was given to correspond with a figure-head of Diana, which accompanied the English frame.

The new vessel* was fifteen feet longer, a little broader, and fifteen tons larger than the original. Her speed has not been exactly ascertained, but is supposed to be nearly equal to that of the Hoogly and Burhampootur. She has frequently made the passage to Kedgeree and Saugor-roads in nine and ten hours during the north-east monsoon, when plying for hire under the charge of the late Mr. Anderson,† who had superintended her building, and she was found extremely useful as a passage boat for the Port of Calcutta in all seasons. As, however, she was not calculated for a ship-tug, the receipts, arising from passengers alone, did not cover the expences, and the share-holders were glad of an opportunity to sell her to Government for eighty thousand rupees in April, 1824, soon after the commencement of the Burmese war. A member of the Committee of Management had offered to engage her the preceding September for a trip to Benares, expecting to arrive in a fortnight, which could scarcely have been accomplished, unless she had steamed at night. As she draws full six feet, she could only attempt such a voyage during the rains. Prudential considerations, however, prevented the trial.

The Diana was purchased by the Bengal Government at the strong recommendation of Captain Marryat, who then commanded H. M. ship Larne, and conducted the Naval part of the Expedition to Rangoon, to which she was attached. There her services were found so important, that she never quitted the Irrawaddy during the war. She suffered some injury at first, from too much reliance on her capabilities, when unchecked by the personal influence and experience of Captain Marryat; being sometimes overloaded with

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* The dimensions of all the steamers, with the power of their engines, and other particulars, will be given in a general statement in the Appendix (A).

† Mr. Anderson was engaged by Mr. Robarts in England, and went with the machinery to China.

troops, and having, besides, a gun-brig and a number of boats in tow. She was employed in reconnoitering the enemy's positions, and in chasing and capturing war-boats, and once towed a frigate to sea from the port of Rangoon.* She was also a very useful transport, and much facilitated the advance of the army to Prome. The novelty, too, of this engine of war, produced an effect analogous to that of the Spanish horses in Mexico. A flotilla of steamers, if then available, would, no doubt, have greatly accelerated the termination of the campaign, and the additional expense might, perhaps, have been saved an hundred-fold in the value of their services.

The services of the Diana, as a Government vessel, having been wholly performed on the coasts and in the rivers of Ava, are of sufficient notoriety, by the many accounts that have been published concerning the Burman campaigns and the recent embassies to that Court. During almost the whole time she depended entirely upon wood fuel, which was found to answer very well. She carried Mr. Crawford five hundred miles up the Irawadi, as far as Umerapoora, drawing six feet: but was nearly lost upon a sand bank in descending the river in the month of December,† when the stream had fallen considerably.‡ She has since received substantial repairs, with a poop, and other material alterations, at Moulmein, and is still a very useful steamer for the inland navigation of those rivers, some of which have a tide of six knots, and a powerful current in the rains. The vessel is at present under the orders of the Commissioner in the Tenasserim Provinces: but it is in agitation to make her over to the settlements in the Straits of Malacca.

As the first steam voyage round the Cape of Good Hope forms an epoch in the history of Steam Navigation, it may be worth while to state the circumstances under which it was undertaken. In the year 1822, a meeting was held in London, headed by Mr. Joliffe, for the purpose of forming a General Steam Navigation Company. Lieutenant J. H. Johnston, of the Royal Navy, being present, was nominated on the preliminary Committee. The enquiries which he was led into at once inspired the idea of a Steam Communication between Great Britain and her Indian Territories, by the most direct route of the Mediterranean and Red Seas.—The advantages of this route and the facility of effecting the passage out and home, to every part of India, within one hundred and twenty days, he described in a printed prospectus,§ for circulation among his friends, detailing

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* His Majesty's ship Larne, of twenty guns, in September, 1824.

† 12th December to 17th January.

‡ "The Irawadi which, swollen by the periodical rains, was deep and broad in coming up, was found in descending to have fallen from twenty to thirty feet, and the navigation consequently proved extremely intricate and tedious. The steam vessel was in all aground fifteen days, and frequently ran the risk of being totally lost. The voyage to Rangoon occupied thirty-five days, which, in a small boat, suited to the river, ought to have been performed in ten." —*Narrative of the proceedings of the late Mission to Ava*—see Government Gazette of 1st March, 1827.

§ Captain Johnston estimated that a capital of £120,000 would provide the dead stock of six steamers, of four hundred tons, fitted with engines of one hundred horse power, (two fifty's each) and the depôts of coals; which

the distances of each place of stoppage, and the necessary arrangements for fuel, &c. Warm with this project, which at the time did not enter into the views of the General Company, he withdrew from that Association, and addressed himself to Mr. Horsley Palmer and other influential men connected with the Indian Trade, who promised their support, if backed by their friends in Bengal, and recommended a personal appeal to them.

Thus encouraged, Lieutenant Johnston presented himself in Calcutta the following year, with a proposal to form a Steam Company, either independent or associated with a Company in London, in order to raise a fund for the purchase and equipment of two steamers, of four hundred tons and two fifty-horse engines each, which he calculated might be procured from England for about £33,000. These he proposed to place on the Suez line, depending upon his supporters in England, to complete the route. But the cause of steam had, in the mean time, suffered much in its popularity with the resident merchants by the ill success of the Diana as a speculation, and so large a sum could not be raised. The public attention was however awakened to the general importance of the object, and a meeting was held at the Town Hall on the 5th November, 1823, at which resolutions were passed, inviting subscriptions from all parts of India to the extent of a Lakh of Rupees, which it was agreed to hold as a premium for the first double voyage by steam out and home, not averaging above seventy days each, between a port in England and Calcutta, by either route of the Cape or Red Sea; to be performed before the expiration of the year 1826. If a single voyage only were accomplished, half the premium was to be given, and the balance, or the whole amount, if no successful claimant should appear, was to be distributed at the end of that period in donations to meritorious competitors, or returned to the subscribers.* Captain Johnston obtaining no direct or exclusive support in Calcutta, returned to England in command of the ship Eliza. The sum collected fell considerably short of a Lakh, being only Rs. 69,903-12-5, of which Lord Amherst's Government gave 20,000, and the King of Oude ~~10,~~ $\frac{2}{}$000 Rupees. The rest of the money was principally obtained in Calcutta. The other Presidencies and Ceylon were applied to by the Committee of the Fund, but no subscriptions were received therefrom, nor even an acknowledgement of the letters, except from Bombay, where, however, the Society took no interest in the matter, regarding the scheme as not planned to benefit them. On his arrival in England, Captain Johnston found his project taken up by a "Captain J. E. Johnson, of the Hon'ble East India Company's Service," who had issued a pamphlet, referring to the proceedings in Calcutta, and circulated a prospectus inviting the formation of an "Indian Steam Packet

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number of steamers, he conceived, might make ten complete voyages in the year, at a current annual charge of £70,000, including the mess of twenty-five passengers each trip. Experience has shewn that he then underrated the consumption of fuel full one-third, which would add about £20,000 to the dead stock, and £12,000 to the annual charge.

* See resolutions in Appendix (B) as finally adopted at the third meeting held on the 17th December, 1823, with the substance of what passed at that meeting.

Company." But the presence of the Original Projector immediately dissipated the schemes of the other.

Mr. J. W. Taylor, whom Captain Johnston had seen in Calcutta, was also engaged in a similar undertaking, and had already laid out above £12,000, having been admitted to a three-fifth share in a steamer building on their own account by Messrs. Maudeslay and Messrs. Gordon and Co., who were the first to act upon the temptation of the Bengal fund. Mr. Taylor might not have the merit of originality, but we must allow him that of being early in the field, and beyond comparison the boldest to adventure capital in this way.

The vessel in progress was destined for a voyage round the Cape. This was not the favourite route of Captain Johnston; but yielding to the apparent wishes of the other parties, he associated himself in the speculation, it being agreed to give him the command, and to call the ship by the appropriate name of the *Enterprise*. The concern was then more subdivided, and the London East India Agency Houses became the principal share-holders. Some discussion arising between Mr. Taylor and the contractors, that gentleman withdrew by consent, and the shares he still held, were taken over by Mr. Saunders, who succeeded him as Actuary.

The Enterprise* was launched from the Dock-yard of Messrs. Gordon and Co. at Deptford, on the 22d February, 1825; she had three masts lugger rigged, and received a pair of sixty-horse engines by Maudeslay, with a copper boiler in one piece, weighing thirty-two tons, which alone cost about £7000. Her seven furnaces consume ten to twelve tons of English, or from thirteen to fourteen tons of Burdwan coal, in twenty-four hours. Her cylinders have a diameter of forty-three inches, and a stroke of four feet. At full speed the engines make twenty-four strokes per minute, being one less than Maudeslay's estimate. Her paddle-wheels are fifteen feet in diameter and have fourteen arms each, the breadth of the boards being seven feet and their depth seventeen inches; she is able to carry thirty-five days fuel of best English coal, and with that quantity and her sea stores, will draw† fifteen feet six inches, with the bosses of the wheels then close to the water. At that draught she is capable of steaming five knots in smooth water: with three hundred tons of coal, at a draught of fourteen feet, her rate is six knots: and with two hundred to two hundred and fifty tons, drawing twelve feet to twelve feet six inches, which Captain Johnston considers her best draught at sea, her speed will be six and a half to seven knots, under favorable circumstances. According to his report, her rate has suffered

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* Appendix A.

† Fifteen feet three inches without the water in the boiler. She has been loaded nearly to sixteen feet. Her draught in different states of lading is given from Captain Johnston's letter to the Marine Board, dated 4th September, 1820. It does not appear that she was ever at so small a draught as twelve feet at sea. The builders' drawing allowed her thirteen feet when moderately loaded.

a little since her first voyage, which he attributes to the copper becoming partially ruckled, and the body of the vessel heavier by soakage.

From the above description, it will be evident that the Enterprise was not calculated to win the prize of the Bengal Steam Fund; since at her greatest speed of seven knots, she would occupy above seventy-one days in traversing twelve thousand miles, the shortest distance to which the route round the Cape can be reduced,* without reckoning stoppages for fuel and for cleaning the boilers. At her mean fair-weather rate of six knots, the same distance would occupy eighty-three days and eight hours. Her speed seems to have been over estimated by the builders ;† but is very respectable with reference to her capacity for stowage and the power of her engines; and she does not ill combine the qualities of a sailing vessel with those of a steamer, except that she is rather dangerous in bad weather. Great pains were taken in adapting the form and size of the vessel to the objects of the voyage, and she was elegantly fitted up with a double tier of cabins, on a new plan. The whole expense, with various alterations and contingencies, including insurance and advances to the crew, and a depôt of coals at the Cape, amounted to about £43,000, when the account was finally made up.

After several postponements of the date fixed for her departure, the Enterprise, under command of Captain Johnston, started from London on the 6th August, 1825, and from Falmouth on the 16th of the same month. Only one depôt having been provided, contrary to the suggestions of the Commander, who had urged the adoption of at least three stations for fuel, (at the Cape de Verdes, Cape of Good Hope, and Mauritius,) it was deemed necessary to load her with as much coal as she could take—three hundred and eighty tons, which brought her down to sixteen feet, in hopes that it would last her to the Cape; and a quantity for immediate use being stowed in bags over the boiler, very nearly caused the destruction of the vessel by fire.

Besides her coal boxes, she was furnished with a number of iron tanks to be filled with water as ballast, when the coal they contained should be expended. The apertures of these being small, rendered the labor of shifting the coal very heavy, and the men actually fainted in extracting it from some of the tanks placed near the flues. Finding

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* By the map it would appear to be eleven thousand two hundred; but some allowance must be made for necessary deviations in bad weather.

† " The engines will burn about thirteen bushels of coals per hour, and will give an average speed per hour of about nine miles: according to which data, pursuing the most direct route that can be followed via the Cape to Calcutta, she will reach Table Bay in twenty-eight days from leaving England, and the Sand-heads in twenty-five days—after clearing from the Cape. Should she be obliged to steam all the way, she will burn between England and the Cape, three hundred and twenty-five tons of coals, and she has capacity on board to stow three hundred and eighty tons, extra her engines, boiler and sea stores."—*Extract from the Prospectus laid before a Meeting of Proprietors in London, on the 27th September,* 1824, *as furnished by Mr. Taylor.*

his crew knocked up with the fatigue of this duty, Captain Johnston determined to call at the Island of St. Thomas, and anchored there on the 17th September, at four P. M. That evening and the two following days were employed in shifting coal, cleaning the boiler and watering. On the 20th, at day-light, he weighed anchor, and continued under steam till the 29th, when in Lat. 17½ S. and Long. 7½ E. as the fuel was nearly expended, he ordered the fires to be put out, and the ship proceeded under canvas in the usually south-westerly direction; having recourse to her paddles only one day afterwards in calm weather, until Saldanha Bay hove in sight on the 12th October. The steam was then again got up, and at nine A. M. the next day, she ran into Table Bay. Of the eight days spent at the Cape, it appears by her log, that only two could have been economised: during more than two of the remaining six, south-east gales prevented communication of boats. So that four days was the time actually employed in shipping two hundred and eighty chaldron of coals, destined to complete the voyage to Madras. No delay occurred in sending them off—all the boats of the place were put in requisition, and the coals arrived alongside as fast as they could be taken in. Steamers, which require a large provision of fuel, must, therefore, reckon upon a detention of at least four days at the rough anchorage of Table Bay, and not less than two days at every other depôt.

To relieve the English sailors, some Malays were engaged at the Cape, for the duty of shifting the coal; and on the 21st, at nine A. M., the vessel put to sea, steaming with little advantage from wind, until the evening of the 25th, when a strong N. W. breeze coming on, the fires were extinguished. They were not lighted again till three A. M. on the 29th, and were dispensed with during half the remainder of the voyage. The season being unfavorable, the digression to Madras was abandoned, and the ship coming on direct, obtained a Pilot on the 7th, and on the 8th December arrived off Calcutta, where she had been long and anxiously expected.*

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* The following is an extract from the Statement published by Captain Johnston on his arrival.

"The Enterprise left Falmouth on the 16th August, at five P. M. and arrived at Diamond Harbour on the 8th "December, at nine A. M., having made the passage in one hundred and thirteen days and seventeen hours. Of this "time were passed at anchor—

	Days.	*Hours.*
At St. Thomas,	2	17
At the Cape,	7	22
	10	15
Under steam,	62	23
Under sail,	40	3
	113	17

The result of this experiment much disappointed the public, as well as the Shareholders, who were represented by the Calcutta Agency Houses. On analysing the voyage, it appeared hopeless with the Enterprise to perform the Cape passage, either out or home, in less than eighty-five days, under the best arrangements and most favorable weather, and it seemed utterly impossible to devise any plan by which it might be completed in seventy days. As a speculation too, independently of the loss of the premium held out for success, the Enterprise was a complete failure. Instead of commanding passengers at an extra price, she had brought but few, and the inconvenience they had suffered from the heat and coal dust, especially when the coals were handed up from the after-hold, and from the unexpected length of their confinement, rendered it unlikely that she should earn on the home passage by this, her only source of profit, even enough to pay for the fuel she would consume. Fortunately for the proprietors, Government had learnt to appreciate the services of a Steamer in military operations, and were predisposed to engage those of the Enterprise. The owners prudently refused to accept a Charter, and tendered her for sale at the price of £40,000, payable in England. The tender was made at an auspicious moment: important events were occurring in Ava, and it was of the utmost consequence that news and orders should be quickly interchanged. The price was given, and the Enterprise was despatched for Rangoon on the 7th January.

Government have no reason to regret the purchase, *although the war* was so near its close. The certainty of her passage to and from Rangoon was so great, at a season when the north winds protracted the arrival of sailing vessels, that she was constantly employed in carrying despatches, and in no instance failed to out-run every other vessel. She made two entire voyages within the first month. Her accommodations, too, proved highly useful to sick officers and others re-joining their regiments, or returning from the campaign. She has also been used as a transport, and has sometimes mustered three hundred men on board.

" The greatest run under steam alone, two hundred and twenty-five miles in twenty-four hours, was on the 25th " November, Lat. 0° 14′ S. Long. 76° 17′ E. where we were under the influence of a current running from seventy " to eighty miles per day. The least run by steam, September 5th, was eighty miles. The greatest run under " sail two hundred and eleven miles in twenty-four hours: the least thirty-nine miles."

" The distance traversed by the Enterprise during this voyage, was about thirteen thousand and seven hundred " miles. The quantity of coals consumed five hundred and eighty chaldron, and including one excursion at the " Cape of Good Hope, we steamed altogether about sixty-four days, making the daily consumption of coals nine " chaldron, or about twelve tons. The greatest speed under steam was eight miles, or seven knots per hour. The " average rate under steam and sail six minus one-twelfth (knots.) The average rate under sail five per hour."

N. B. The rate of going was ascertained by Massey's Patent Log.

On one occasion, having brought the news of the first cessation of hostilities, many days before Captain Snodgrass arrived with the despatches in His Majesty's ship Champion, although the Champion had sailed before the Enterprise even reached Rangoon, she saved the Treasury above six lakhs, by preventing the transmission of stores, fresh contracts for transports, and other expenses, which a delay of twenty-four hours would have incurred.* Again, the final news of the peace, despatched under similar circumstances by His Majesty's ship Alligator, was anticipated by the Enterprise.† Such a vessel at the commencement of the war, would have avoided much of the severe suffering of the troops at Rangoon, which aggravated the mortality among the Europeans, while their distresses were unknown and unsuspected in Calcutta. A statement of her services, while in the pay of the Bengal Government, will be given in the Appendix (C.)

Captain Johnston was continued in the command until last year, when the Enterprise was made over to the Bombay Government at their request, and sent round to that presidency under charge of Lieut. Denton, of the Bombay Marine,‡ it being intended that she should lead the way in opening a communication with England by the shorter route, which Captain Johnston was the first to recommend. As to her fitness, however, for that particular service, when called upon for his opinion, this Officer observed that a vessel of greater speed seemed to be requisite, her average steam rate in the public service not having exceeded five knots, although carrying less fuel than when she left England. Other opinions less unfavourable, and entitled to much weight, with a natural anxiety to have for the experiment a vessel of such high reputation, the Bengal Government having at the time no object in detaining her, influenced the choice which was offered to the authorities at Bombay. But it is understood they are greatly disappointed, having depended too much upon her maximum speed. The ship suffered much in the passage round, which she vainly attempted in the month of May. She was compelled to put into Trincomalee a second time, after starting from thence, and did not accomplish the voyage until the change of the monsoon.

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* H. M. ship Champion, Captain Stoddart, left Rangoon on the 10th January, with despatches, reporting the cessation of hostilities by the Treaty of Melloon. The Enterprise, with the duplicates, left Rangoon on the 14th, and reached Calcutta on the 20th; but Captain Johnston landing at Diamond Harbour, had delivered his dispatches in the night of the 19th. The Enterprise started again on the 21st, and on the 22d met the Officers of the Champion crossing over to Kedgeree, the ship being just arrived in Saugor Roads.

† *Extract from the Government Gazette Extra of 5th April*, 1826.

" At a late hour on Tuesday night the Enterprise reached Calcutta, having on board His Excellency Sir Ar-
" chibald Campbell, Mr. Robertson and Mr. Mangles; the return of whom to Calcutta is the consequence of peace
" with the Burmese. The public despatches, announcing the ratification of the treaty, were forwarded by Col. Tidy
" and Captain Snodgrass' on board the Alligator, which left Rangoon a week before the Enterprise arrived there,
" and may therefore be hourly expected. The Arachne sailed at the same time for Madras.

The Enterprise had started from Rangoon on the 28th March.

‡ Now called the Indian Navy.

Captain Johnston's intelligence and great zeal in the cause of Steam Navigation, early established a warm interest in his favor among the Calcutta Society. Neither as a share-holder in the Enterprise, nor as her Commander, had he, strictly speaking, earned any claim to the Subscription Fund; but as there seemed to be no claimants entitled to it, otherwise than under the discretionary clause of appropriation for meritorious services, a feeling prevailed that a portion of it would be well bestowed on the man who had so much exerted himself to accomplish the object of the subscription, especially as he had incurred a pecuniary loss in parting with his own vessel for a share in the Enterprise. A general meeting of the subscribers, which took place at the Town Hall on the 17th January, 1827, assigned him a moiety of the fund, and Company's paper, to the value of about 36,000 rupees,* was accordingly made over to him by the Government Agents, with whom it was lodged. The other moiety was claimed on behalf of Mr. J. W. Taylor, whose adventurous spirit and meritorious exertions were admitted; but it was agreed to reserve the rest of the money two years longer for the chance of other more successful trials. We shall not pursue the subject of this fund, nor enter into the question of its appropriation, the matter being still before the public.

Mr. Taylor's chief motive for withdrawing from the Enterprise concern, was, that he might have the sole merit of opening the other line of communication, which further enquiries induced him to prefer. He probably thought it the only chance of gaining the prize, which, while it seemed a desperate hope by *the Cape route, appeared to be of* easy attainment by the Egyptian. His new plan was to employ steamers of great power, as tugs for sailing vessels, in which his passengers were to be accommodated. These were to carry an entire lading of coal for the tugs, and they were to help each other alternately, as the wind should be favorable or adverse. By this arrangement he hoped to make the whole passage in fifty-five or sixty days. His projects were always on a grand scale. When connected with the Enterprise, he announced to the public that packets would start for India the first day of every month. The Suez Scheme had the same magnificent design, and he lost no time in preparing for its execution. An Agent was sent to Egypt to make preliminary arrangements, and secure the good will of the Pasha, whose cordial co-operation was promised, with the aid of his steam boat on the Nile. And the brig Norval was despatched with two hundred tons of coals, for the Cape, and an equal quantity for Calcutta.

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* Six per cent. paper Rs. 25,700, worth 25 per cent. pm.
Five Do. Do. Rs. 3,500, at par.
Cash, Rs. 135

The money had been invested when Company's paper bore the very highest rate of premium, and chiefly in Six per Cents. bought at Rs. 39-10 pm. per cent.

The first steamer put in hand was the Emulous,* destined for the Indian and Red Sea Navigation. This beautiful vessel was built by Evans, and launched in London, on the 28th October, 1825: her engines were made by the Horsley Company, and have a stroke of thirty-eight inches: they work up to twenty-eight strokes per minute. The Calcutta Surveyors have constantly pointed her out as a model for a smooth water tug, but she was utterly unfit for the object in view, being too low and too long to contend with a heavy sea, or even safely to tug a vessel below Saugor in the south-west monsoon. The recent China voyage of the Forbes and Jamesina; the former a sea-going steamer, of greater strength, size and power; the latter, a vessel only one-third larger than her consort; has proved the good qualities of the Forbes, not the superior advantages of the tug system for long passages in the open ocean. Bad weather must compel the tug to cast off her companion. When the Enterprise towed the Herald yacht to the Line, with Lord Amherst on board, in March, 1828, the two vessels were more than once in danger of collision, although they met with no bad weather. A probable separation at night may distress the steamer at a distance from land, and would, in most cases, defeat the objects of the voyage. Another serious objection is the delay and difficulty in trans-shipping coal at sea, which can only be effected in boats, and during fine weather. The Emulous, as a tug, would have required fresh fuel every fifth or sixth day at furthest, her consumption† being about equal to that of the Enterprise.

The fitting of the boilers and machinery delayed her till the end of January: she then steamed down Channel alone, with orders to fill up her coals at Falmouth, and proceed to St. Jago, there to wait for her intended consort, the ship Juliana, of five hundred and twenty-one tons. She reached Falmouth in safety, though "rather deep:" but within a few hours after quitting that port on the 1st February, was obliged to put into Fowey, the carelessness of the engineer having damaged the boiler. This accident, which he hoped to repair in a few days at Falmouth, induced Mr. Taylor to despatch the Juliana to a more distant rendezvous at Colombo. But the season being against her going there, she touched at Trincomalee, and proceeding on to Calcutta, arrived in August. The Juliana was chartered for three years, and had been laid out entirely for passengers at Mr. Taylor's expence, and provided with wines and cabin stores for twelve months. She was found

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* Appendix (A.)

Description by Mr. Taylor.—"This vessel has been built expressly for despatch. She is two hundred and thirty-"five tons, builder's measurement, and has two fifty-five horse power engines on board, with an iron boiler. Her light "draft, with thirty hours' coal, is six feet six inches, and at that draft she beats every thing on the River Thames. "Her loaded draft, with ten days coal, and four months' provisions and sea stores, is eight feet."

† Of Burdwan coal, eighteen maunds per hour, or about half a ton of English coal.

however to require extensive repairs, which when at last they were given, involved so large a sum that she was sent back, heavily mortgaged, to England.

In the mean time it had been judged necessary to order the Emulous round to London, and to incur fresh expenses upon her, which caused her also to be mortgaged, and delayed her final departure till May. This altogether disconcerted Mr. Taylor's arrangements. He therefore took off the paddle-rings and arms, and sent her out direct to Calcutta under canvas, with three masts, schooner-rigged, authorizing his agents to sell her or employ her as a river tug at their discretion. Captain Tregear, to whom the command was now confided, was an Officer of the British Navy. It is much to his credit that he brought such a vessel in safety round the Cape, in the winter season, with her long engine shafts and main beams projecting most inconveniently, and threatening a severe strain with every roll. If the Steam Fund Meetings had voted him a reward for his masterly skill and intrepidity, it had been well deserved, and the money not inappropriately bestowed.

The Emulous reached Calcutta in September. Not finding a purchaser, she was fitted out by the owner's agents as a river tug and passage boat, and during the first six months was so successful in that employment, that she excited considerable interest, and tempted the merchants and other residents to buy her and work her as a joint stock concern. The speculation has not answered, owing to unforeseen delay and expense of repairs;* the competition of other steamers, as well those of Government as private steamers; the decline of freights, and general depression of the shipping interests. The paddles of the Emulous have been reduced to eight feet, their unusual breadth of ten feet having been found to increase the tremulous motion, and render her more liable to strain. This must have affected her speed as a tug, which, at full power, when alone, was ten statute miles, or eight and a half knots per hour. The ordinary rate was about eight knots, and when tugging four to six, according to the size of the vessel.†

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* A new set of iron boilers, indented for to replace the old ones, which were radically injured by the accident in the Channel, cost, with freight and charges, twenty-four thousand eight hundred rupees, and the labor of nearly five months to put them in.

† Mr. Taylor's growing embarrassments obliged him to suspend his operations, and abandon his other steamers. He had reported the following built and ready for starting:

Corsair—for the passage up the Mediterranean, with a single engine of fifty-horse power.

Sophia—for the same object, with a single engine of the same power.

Gunga Saugor and *King of Oude*—each of one hundred and five tons, with a pair of twenty-horse high pressure horizontal engines, and calculated to move in twenty inches water. The two latter were intended for the inland

The Falcon was a London speculation, resting on the probable demand for such a vessel as a packet during the Burmese war. The project was of later origin than those we have described. She arrived under canvas in March, 1826, and might then have become the property of Government, if the price at which she was tendered had been moderate. As the opportunity of selling her failed by the termination of the war, her two twenty-four horse engines and iron boiler were taken out, and she has preserved her character as a sailing vessel, which, in fact, she had never ceased to be. She is a bark of one hundred and seventy tons; was formerly Lord Yarborough's yacht, and is now one of the prettiest and fastest opium traders belonging to the port of Calcutta.

The Telica was a very pretty compact little vessel, well calculated for a steam packet to make short runs. She is described in the following terms in an official report to the Marine Board in Calcutta, by Commodore (now Sir John) Hayes, and Captain Ross, of the Bombay Marine; Captain Forbes, of the Bengal Engineers, Superintendent of Steam Engines; and the Company's Surveyor of Shipping, Mr. Seppings, in December 1828.

"The Telica was built at Liverpool, in 1824, by Messrs. Hunter and Hurry, and "measures as per margin* one hundred and thirty-four tons. The hull is constructed "of oak and fir, fastened with iron bolts, nails, and trenails, above the load water line: "below it copper is substituted, where through bolts are driven."

"*The formation of the Telica's bottom would* assure the beholder of her speed either "under sail or steam pressure, were such superior qualities not otherwise established by "her voyage from England, round Cape Horn to South America, and thence to Calcutta, "under the one, and by her subsequent performances under the other, in the river "Hoogly."

"The Engines, &c. were constructed by Fawcett and Co. of Liverpool; are well "finished, and substantially fitted: they are of the power of twenty-five horses each. "The boilers and funnel are of iron, and are now in a condition to last three years. The "engines may be expected to remain serviceable ten years."

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navigation of the Ganges. He expected they would perform the passage from Calcutta to Cawnpore in twenty-five days, during the dry season. They were furnished with two false keels, removable when used on a river. The trials of the King of Oude, the first launched, were not satisfactory, and she drew four inches more than had been calculated; viz. three feet six inches, including the keels, which measured one foot six inches.

* Vide General Table of Steamers in the Appendix (A)

" The machinery is at present in good order, and capable of propelling the Telica in " moderately smooth water at her ordinary draft, say nine feet six inches, at eight and a " half knots per hour."

" The Telica, having but little space for coals and stores, is adapted only for short " voyages. Working the engines about twelve hours per day, she would carry from eight " to nine days fuel."

Her capacity, however, allowed a provision of English coal for that period, working night and day, her ordinary consumption having been about a third of a ton of Burdwan coal per hour,* while employed upon the Hoogly. Her trial-speed in May 1827, rather exceeded ten statute miles, being fully equal to that of the Emulous. Her engines then made thirty-two to thirty-four strokes per minute, but in ordinary trips they have rarely exceeded twenty-seven.

This vessel was originally sent out to the Coast of Chili, where the paddles were fitted on, and for a short time she steamed with wood fuel, carrying passengers between Callao and Valparaiso. A singular accident occurred to her in the port last named. The Supercargo, in a fit of lunacy, (it was supposed) fired a pistol into the powder magazine, by which himself and several passengers were killed, and the after-part of the deck was blown off: but the hull and the machinery received no injury. A new *deck* was given her abaft, she having a sunken-*poop, and as there was no profitable employment for her* on that coast, she was sent to Calcutta for sale, and arrived in April, 1827, having performed the whole voyage under canvas, rigged as a galiot. She was immediately tendered to Government for rupees one lakh and thirty thousand, and being much approved by the Officers of Survey, on the part of the Marine Board, who then valued her at seventy thousand rupees, was accordingly recommended as a useful vessel for the public service. But Government declined to purchase, as they were building steamers of larger size on their own models. She was therefore employed on the owners' account, in competition with the Emulous, and performed much better as a tug than was expected, with reference to the great difference in the power of her engines. In this service she paid her way at a monthly charge of one thousand and two hundred rupees, exclusive of coal. But the orders of the owners being peremptory to sell, she was tendered to the Penang and Bombay Governments at a reduced valuation, and ultimately accepted by the latter for sixty-one thousand sicca rupees. The transfer was made in Calcutta, in February, 1829; but the Bill of Sale was not executed till the middle of March. This and other causes of detention exposed her to a rough passage to Madras,† and a gale, off Ceylon, which

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* One hundred maunds per day.

† She started very deep from Calcutta, with the bosses of the wheels actually in the water, and labored very much in consequence.

considerably injured the hull and machinery, and obliged Lieutenant Peters, of the Bombay Service, who commanded her, to bear up for Coringa, and she remained on that coast until the change of the monsoon. In her, as in the case of the Enterprise, the Marine Department at Bombay have been disappointed. She was found to want repairs: her engines were considered inferior and defective, and she was reported not suitable for the purposes for which she had been bought. These purposes, however, had not been explained. The surveys and descriptions furnished at their request were supposed to have satisfied them of her competency. Captain Forbes has shewn the defects of the machinery to be either imaginary and unimportant, or of easy remedy. In the mean time the engines were taken out, and the vessel has been fitted up as a sailing yacht for the Governor.

The Forbes is a fine well-built steamer, launched at the New Howrah Dock Company's Yard on the 21st January, 1829,* she has two sixty horse engines, by Bolton and Watt, with a copper boiler. They have a stroke of four feet, and make from twenty-two to twenty-four revolutions per minute at full speed. Her light draft for sea, with two and three days coal, her best running trim, is ten feet, and her loaded draft twelve feet on an even keel, with eleven days fuel,† and her boats and stores. She has the speed of the Emulous, and considerable advantage over her in rough water: but the Emulous, with that exception, has more power as a tug. The Forbes, however, was specially designed for this service, the scheme having originated with the talented Officer‡ whose name she bears; and certainly combines all the desirable qualities of a ship-tug for the port of Calcutta, more than any other vessel which has been so employed. The plan was laid before the Emulous had possession of the field: the long delay of execution occurred chiefly in getting out the machinery from England. As the former is of teak, she may be expected to survive her fir-built § competitor many years. Messrs. Mackintosh and Co. however, to whom she belongs, have been ambitious to employ her in distant voyages. The China experiment was a spirited undertaking, and merits our particular notice.

It is well known that in the China seas the same monsoons prevail as in the Bay of Bengal. The north-east winds are perhaps more steady in the former region, and stronger than in the track followed by ships proceeding to Calcutta from the southward. Opium vessels, being generally of small size, can seldom make the voyage to China against the

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* Appendix A.

† One hundred and forty tons of coals. When launched, her draught was eight feet seven inches on an even keel, with eighty-three tons of machinery and ballast before coppering. The drawing sent from England gave ten feet three inches, as the draught in her best trim.

‡ Captain Forbes, Bengal Engineers.

§ The timbers of the Emulous are oak: her planking fir.

not improbable that she might have returned to Bombay ten days sooner, and thereby have rendered her success more decided.

When the Diana ceased to ply upon the Hoogly, it occurred to Mr. Anderson, that smaller vessels, steaming at little expense of fuel, might answer better as river passage boats. He accordingly planned and built, with the aid only of native carpenters, two sister steamers, the Comet and Firefly,* which were begun upon in February, 1825, and launched in September, 1826, the joint property of Messrs. Alexander and Co. and himself. Their engines, a pair of ten-horse for each boat, were procured expressly for the object from Messrs. Maudeslay, of London. They have a stroke of two feet, and make thirty-two to thirty-six revolutions per minute, consuming six maunds of coal per hour. Their accommodations for passengers are spacious and well-contrived, occupying about half the vessel below, and an equal space upon deck. The poop of the Firefly has since been taken off, to render her more suitable for rough weather. These vessels draw four to five feet, according to the quantity of fuel, and have capacity for three hundred maunds of coal. Their performances, in regard to speed, are very respectable, as much as seven miles per hour; and there are few persons in Calcutta who have not derived benefit from the pleasant trips and comfortable conveyance they have afforded. It is much to be regretted that the place cannot yet support such kind of craft. Individuals gladly hire them to bring up their relatives or friends, whose arrival they see announced in the Kedgeree Report; or to convey a sick family to a ship departing. They have carried the passengers to many a ship at Kedgeree, and many a party of pleasure to Fort Glo'ster, and into Channel Creek. But there is no constancy of demand, and much of their peculiar service is done by the large steamers. Nor can they always contend with the wind and sea, below Fultah, in the south-west monsoon. One of them has, for some time, regularly started for Chinsurah every Sunday morning, returning the next day to Calcutta; and many persons have been induced, by the cheapness of the charge, to make a sort of Cockney excursion to the villas and settlements up the river. Even this well-conceived plan of Mr. Anderson does not yet command sufficient passengers to pay more than the expenses of the day, notwithstanding the recent erection of barracks for a depôt of soldiers of the King's Regiments at Chinsurah. In justice to the memory of that much esteemed individual, whose useful career terminated last year, it should be stated that his demeanor was never soured by the ill-success of his speculation. He took personal charge of the Comet, as commander, pilot, and engineer, and dexterously managed her with scarcely any assistance. Night and day he was always ready, and never objected his own fatigues to the convenience of the party on board.

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* Appendix A.

These two vessels have been found useful, occasionally, in longer trips up the river. The Comet, immediately after she was built, accompanied Lord Amherst's fleet as far as Malda, on the Great Ganges, and was then chiefly employed in towing the pinnaces which could not keep up. They are competent to ascend the river in the rains, and during a great part of the dry season.

A steamer, on a still smaller scale, has lately been constructed at the Fort Gloster Mills, for the use of that establishment; in length forty-three feet; in form and accommodations nearly like a Bauleah. It is furnished with a single four-horse high pressure engine, made entirely at Fort Gloster by the ingenuity of Mr. Macnaught; which merits particular notice, not only as being the first instance of the application of the high pressure principle to a boat in India, but because it is also the first boat engine* manufactured in the East. Mr. Macnaught is now engaged in contriving a larger boat on the same principle, for the private use of a gentleman near Calcutta. Its length is to be fifty feet. The engine will have the power of six horses, and will work up to a pressure of forty-five pounds to the square inch, and occupying only seven feet square, will leave twenty-two feet by nine for cabin accommodation. The calculated draught of water is seventeen inches; the speed of the boat nine miles per hour, and its capacity for fuel thirteen days. With these qualities it might steam up to Benares with facility at a single stretch, and proceeding night and day, would arrive in a week. The boat is to be completed in December, at an estimated cost of only ten thousand rupees, and will furnish one of the most interesting experiments which has yet been tried upon the Ganges. It were premature to offer an opinion upon the probability of success, before the Fort Gloster boat shall have been submitted to a fair trial. Much may be expected however, from the known abilities and approved skill of the engineer, under whose personal direction every part of the machinery will be made and adjusted.

We have now traced up to the present date the various speculations and efforts of individuals connected with Steam Navigation in the seas and rivers of India, and the subsequent employment of those steamers,† built on private account, which have been transferred to the public service. The notice which the projects of Mr. Waghorn, and the revived scheme of Mr. Taylor, have lately attracted on both sides of India, although they had not the recommendation of novelty, or of any peculiar excellence in the arrangements proposed, may perhaps do good, by stimulating capitalists and men of ingenuity

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* Small engines have been made in Calcutta for other purposes. Mr. Toulmin made a high pressure engine for a soda water manufactory, and two condensing engines have been turned out by Messrs. Jessop and Co., at the Phœnix Foundry.

† Diana, Enterprise, and Telica.

and science in England. We want no fresh sacrifice of money to prove the possibility of making the Cape voyage, by steam, in eighty-five days.* With such a result we are not satisfied, while the other route is feasible in sixty : much less are we satisfied with a mere display of personal zeal and intrepidity. Until some important improvement shall have obviated the necessity of intermediate stoppages, by greatly diminishing the consumption of fuel, and the weight and size of the machinery, it is quite hopeless that the voyage will be reduced to seventy or even seventy-five days, and the expenses are much beyond the value of the advantages which steamers can afford.

The rapid progress of invention at home will do more towards this than a subscription fund in Bengal, devoted to the repetition of a costly and now useless experiment. The extraordinary success of Braithwaite's Steam Carriage, owing, it is said, to a new principle, the application of a bellows to the furnace, encourages the hope that the desired improvements will, 'ere long, be accomplished without the aid of Indian contributions : and when the Cape passage shall thus be rendered practicable in sixty-five or seventy days, means and enterprise will not be wanting in England to give us an example. Steam packets will then, as on the coasts of Britain, carry the Government mails, although they should not answer for commerce or passengers ; and the advantages of this uninterrupted route, especially in time of war, will counterbalance the saving of a few days under ordinary circumstances by the route of Suez. In the mean time, a just preference is given to the latter by the Marine Department at Bombay, to whom, rather than to a private adventure or a Steam Company, we look with confidence for that combination of resources which is necessary to perfect the channels of communication, and establish them with sufficient frequency and regularity.

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* The Company's ship Marquis of Wellington, reached the Sand-heads last year in eighty-six days.

CHAPTER II.

THE Government of Bengal, we have already said, did not trust to the casual supply and fitness of private steamers for the exigencies of the State. Early in the Burmese war, it strongly recommended to the Court of Directors, to send out engines for at least two armed vessels, with all expedition. The Court approving the measure, applied immediately to Mr. Maudeslay, who having none ready, suggested an application to the Admiralty for two pair of his forty-horse engines, which were in store at Deptford, intended for two ten-gun brigs of war of the same size and description. These engines were in August 1825, transferred to the Company, and Sir Robert Seppings, at the request of the Chairman, furnished plans of the vessels, with dimensions of their timbers, &c. The engines were shipped off without delay in the Eliza and Clyde, free traders, with their copper boilers, and arrived at Calcutta soon after the termination of hostilities in 1826. The drawings where handed over to the Marine Board, who, at the recommendation of Mr. Seppings,* the Company's Surveyor of Shipping, advised that the two vessels should be built by contract at Messrs. Kyd and Co.'s yard, with poops and forecastles, to improve their accommodations, and render them more fit for general service in a tropical climate. The contract was settled at one hundred and twenty-five thousand rupees for each, and two sister vessels were accordingly constructed, under the direction of Mr. Seppings.

The Irrawaddy† and Ganges, the names given to the new steamers, were launched respectively on the 1st January and 14th February, 1827. They were found to draw more water than was calculated in the plans, which allowed them ten feet eight inches.‡ Much has been said and written on the subject of this difference, which has excited a warm controversy among the Officers connected with the Marine Department. In the building of

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* Son of Sir Robert.

† Appendix A.

‡ Supposed to be their best trim, not their load water line on a long voyage. The Ganges only drew ten feet nine inches on an even keel (eleven feet six inches aft, and ten feet forward) when she entered Trincomalee.

steamers, however, it commonly happens that the draught of water exceeds the calculation,* and in this case there were obvious causes which have been summed up by Sir Charles Malcolm, quoting the report of Captain Crawford, "in the massiveness of their timbers and over-built upper works." In what degree the poops and forecastles have increased the draught has not been accurately shewn: these too have been accused of impeding their velocity under sail, as well as under steam; but it may fairly be questioned, whether any disadvantage arising therefrom be not fully compensated by the accommodation they afford in a tropical climate. It would seem, perhaps, that as teak is lighter than oak, the line of immersion given by drawings made in England, should be above the water line of vessels built in India. This, however, is not the case even at Bombay, where no other wood than teak is introduced. But Bengal-built ships have their frame of saul and sissoo; one, if not both of them, much heavier than oak; while on the other hand, much of the inside plank, and the decks of ships built in England (even the upper decks of men of war) are commonly made of fir, which is much lighter than any timber used in India.† It is therefore usually calculated that these differences compensating each

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* The Enterprise draws considerably in excess of the builder's estimate. The plan sent out for the river steamers, gave them only three feet; whereas the Burhampootur, which was built in exact conformity thereto, has a minimum loaded draught of four feet forward and three abaft. The Hoogly, of the same length and breadth, but of lighter construction, draws as much as the Burhampootur; the only difference being a small advantage in her capacity for fuel.

† Specific gravity of

Saul Wood, fresh, (seven specimens,) 1211 to 1320: mean	1247
Saul Chowker, (six specimens,) all,	1000
Peer Saul, (four specimens,) 1000 to 1020: mean	1011
Old Saul Beam, (nine specimens,) 888 to 1008: mean	982
Mean of the whole,	1061
Sissoo, seasoned, (six specimens,) 777 to 833: mean	816
Teak, seasoned, (six specimens,) 684 to 789: mean	743
English Oak, old, (four specimens,) 812 to 940: mean	861

The above are from ~~Colonel~~ Captain Baker's experiments, as given in the Gleanings of Science for August, 1829.

Experiments made at Kidderpore by Messrs. James and Robert Kyd, above twenty years ago, give the following specific gravities, corresponding with the weight of a cubic foot in ounces. (See also Appendix D.)

Teak, (used in Bengal,)	672	all well seasoned wood.
Saul,	1008	
Sissoo,	878	
Oak, English,	743	
Fir Batta,	552	

Malabar Teak is said to be heavier than that used in Bengal, and nearly on a par with English Oak.

other, a London and a Calcutta ship of the same model, will have nearly the same draught of water.* In the frame of the Ganges and Irrawaddy, a great deal of saul and sissoo was necessarily used. If these vessels had been constructed in England, besides their decks, they would probably have had a portion of their frame timbers of fir;† so that the whole body of materials, independently of the upper works, would have had less specific gravity than those which have been actually employed.

The qualities of both vessels are exactly alike. When the Ganges was launched, she was submitted to every sort of trial. As a tug, her powers were reported to be feeble against a head wind; but her Commander, Captain Jump, found her stiff under canvas and an excellent sea-boat, and approved her sailing qualities and accommodations. Captain Forbes was well satisfied with the engines, which worked fully up to their power, making twenty-four strokes against a moderate wind and twenty-seven when sailing before a favorable breeze. They have the disadvantage that the paddle-wheels cannot, as in the Enterprise, be disconnected, and that the shafts are set too low. Captain Jump has further remarked, that the paddles would be more efficient at sea, if their breadth were reduced, and the diameter of the wheels were proportionally increased.

Barlow, in his "Essay on the strength and stress of Timber," quotes specimens of English Oak as low as 770, well seasoned, and one at 743, which was 1113, when fresh cut. The reduction of specific gravity, by the process of seasoning, carried to its maximum, has been found to exceed one-third. In the same work, specimens of Teak, cut from the timbers and spars of old ships, are variously quoted, from 606 to 860. The same tree is stated to contain timber of unequal strength and specific gravity, at the butt and at the top, differing also in the heart and near the bark; and trees of the same kind have been found to differ much according to the soil and localities of their growth. It must, therefore, be very difficult to estimate the draught of a ship built of timber, known only by its name and general classification.

* The difference however is in favour of the Europe vessels, as will be seen by comparing the Hastings, seventy-four, the only ship of the line ever built in Calcutta, with a similar ship, the Wellington, built of oak, at Deptford. The Minden, the first seventy-four built at Bombay, appears also to exceed the Europe draught of a corresponding vessel.

	Wellington.		*Hastings.*		*Minden.*	
	Feet.	*Ins.*	*Feet.*	*Ins.*	*Feet.*	*Ins.*
Length between perpendiculars, ..	176	6	176	10½	171	4½
Breadth, ...	47	8	47	9	47	11
Depth of hold, ...	21	0	20	0	20	3
Draught when launched forward,..	13	3	13	9½	~~0~~	~~0~~
Ditto ..... abaft, ...	17	7	18	2½	~~0~~	~~0~~
Ditto ..... mean, ...	15	5	16	0	16	0

† "The best wood for building steam vessels is the Tyrolese and Alpine Larch, which has a decided superiority on account of its buoyancy and durability."—*Treatise on Navigation by Steam, by Captain John Ross, K. S. R. N. as quoted in the United Service Journal of March*, 1829.

Soon after they were built, the Bombay Government requested information about these vessels, with a view to ascertain whether it might not be expedient to add a Steamer or two to the Marine force on that side. To give them the best means of judging, the Ganges was sent round, and they were offered the transfer of both or either; which, after seeing the Ganges, they declined, finding her speed only five to six knots under steam; a rate much less than they considered necessary for purposes of war, or for forcing a passage to Suez against the north winds of the Red Sea; or even for general service, on the neighboring coasts.* During eight months of the year, however, the difficulty of making the passage up the Malabar Coast, is chiefly owing to daily calms and the northerly direction of the sea breezes when they set in: and it appears by extracts from Captain Jump's Log Book, that meeting with this kind of weather, he steamed up to Bombay in only seven days from Point de Galle; a passage usually requiring three weeks, and rarely less than a fortnight. The whole voyage to Bombay and back occupied twenty-two days under steam, each way, and was performed between the 26th September and 11th December. She started with seventy tons of coals, which scarcely lasting to Trincomalee, she was obliged to make two stoppages in going round, but called only at Point de Galle on her return: One hundred tons of coals was the largest quantity she could receive: her draught of water was then twelve feet six inches aft, and ten feet six inches forward; and when the coals were all expended on entering Trincomalee, eleven feet six inches aft and ten forward.

The objection of want of adequate *velocity for purposes of war* is of less importance in these seas than it would be elsewhere, considering the kind of service for which the Indian Marine is usually destined. As transports, the Ganges and Irrawaddy are most efficient vessels, and they would not fail to make a formidable impression in any attack upon the ships and settlements of the native maritime powers of India. For that purpose

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* "I conceive her quite unfit as a passage vessel, even up and down the Malabar Coast, as she would not steam above two or three knots against a common fresh breeze, and I doubt her steaming ahead in a strong breeze and head sea, which becomes extremely dangerous on a lea shore."

"I should also say she was unfit for a vessel of war in the open sea, from the above defects: as in a fresh breeze an enemy would easily run alongside of her, and from the present exposed state of her paddles, she must be disabled. The great advantage to be derived from a Steam Vessel of War is, that from her swiftness she may take up a position at pleasure to annoy the enemy with her long guns, having only her bow or stern exposed; and should they attempt to close, that she may, by her superior velocity, retreat, and so keep choosing her distance; for in close action her paddles would soon be disabled. No vessel is fit for war that cannot steam between eight and nine knots in favorable weather, and from five to seven, head to wind, in a moderate breeze."—*Letter from Sir Chas. Malcolm, Superintendent of Marine, addressed to the Governor in Council at Bombay, dated 16th July*, 1828.

It may be proper to mention that the British Government have a colonial vessel of the same class, the Africa, at Sierra Leone.

they were designed. It has being doubted indeed, whether the Burmese war being at an end, it would not be good economical policy to lay them up, and the Enterprize also. But Government wisely judged that the difficulty of commanding competent skill at a moment of emergency, if the Engineers were discharged, would risk the entire loss of all the advantages of their possession. It was therefore determined to render them available for general service, and when not engaged on public duty, to let them be hired as tugs for merchant ships. In this manner the monthly charge of the Ganges and Irrawaddy, after some economical reductions, has been covered in a great degree by the value of their services and earnings. In two months of the cold season of 1828-29, (besides intermediate employment) they effected the relief of an entire Regiment* on the Coast of Arracan, one making five, the other four trips; a service which would have occupied from twelve to fifteen hundred tons of transport shipping, for the same space of time, on a single trip, at an expense of full thirty thousand rupees, exposing the men to all the hazards and inconveniences of a much longer voyage.

Even as tugs, they have not been found without utility. Before the end of April, 1828, the Ganges had been engaged in towing fifteen vessels up and down the river, half of them to sea, which, however, only occupied her thirty-three days: among them were the Company's Bengal ships Minerva and Thomas Grenville, towed out in January and March. She has, subsequently, rendered the same service to their China ships Berwickshire, David Scott, George the Fourth, Thomas Coutts, and Inglis, and to His Majesty's ship Undaunted, in the months of July and August. She brought up the large free trader Carnbrea Castle to Calcutta, against the freshes of October, and the larger Company's ship Rose, in the beginning of November.

The Irrawaddy, as soon as she could be got ready for sea, was ordered to Moulmein, to be there at the disposition of Sir Archibald Campbell. She was armed with ten long nine-pounder brass guns, besides a long brass twelve-pounder mounted on the forecastle, and traversing in all directions. Both vessels are pierced for guns fore and aft, and ten guns is their complement; but the Ganges has not yet carried them. The Irrawaddy was drawing twelve feet six inches aft, and eleven feet forward, when she started. Her utmost capacity for fuel, with her guns and sea stores, was found to be, in Europe coal, sufficient to last ten days. She has been almost entirely employed in sea trips, chiefly on the Tenasserim Coast, under the orders of the Commissioner; but has occasionally rendered assistance as a tug. The Company's ships Moffat, in January, 1829, and Princess Charlotte of Wales in March last, were towed by her to sea, and she has been employed on the same duty with the China ships of the present season.

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* The 47th Bengal Native Infantry was sent to relieve the 68th.

Captain West, who has been in constant command, has reported her merits in less unqualified terms, than even Captain Jump with respect to the Ganges. At the end of his first trip, he wrote, that she proved very lively and buoyant in a heavy north-wester off the Sand-heads, and fully answered his expectations, after being a day or two at sea; going six miles per hour, and the engines working up to twenty-two and twenty-four strokes: at starting, when very deep, they made but fourteen against a head wind and sea. Her masts were both struck with lightning shortly afterwards; but she suffered no other injury from the accident.

To sum up the qualities of these vessels, it must be admitted that they draw rather too much water, with reference to their power and the situation of their paddle shafts, and have not the speed which was anticipated; and that they are capable of but little progress against a strong head wind. But as with these defects they have always made good passages, their general efficiency cannot be denied. At a much less charge than the Enterprise,* they are better adapted, as safe and comfortable sea-boats, to keep up the communication with our new possessions on the Eastern side of the Bay, which, without them, would be at once more difficult of protection, and productive of large uncertain expence for the transport of troops and supplies. They facilitate the collection of the revenue from the maritime provinces, and enable the Commissioner to make his circuits of controul, at seasons when it would otherwise be impossible to proceed, and they abridge greatly the term of their duration at all times. By means of one of them (the Ganges towing the Nereid yacht) the Commander in Chief made his tour of inspection to Chittagong and the stations on the Arracan Coast, in March, 1829, which could not have been effected in double the time by a sailing vessel. They carry treasure to that coast, and fetch it from Cuttack or Chittagong, and more than once have been usefully employed in making remittances to and from Madras or Masulipatam. They are able at all times to bring up troops from the China ships, when the weather is too rough for the river steamers, and can proceed with them to the Depôt at Chinsurah, if required. Although not comparable with vessels built expressly for tugging, they are competent to that service in ordinary cases, and are especially useful in this way when the regular tugs (such as have hitherto been employed on the Hoogly) could render no assistance whatever. They can steam at one stretch, in all seasons, to Penang, Madras, or Ceylon; and were it desirable to devote them to such purpose, they might undoubtedly be very useful as steamers on the Pilot Establishment.

It has indeed been suggested, that the engines of one of them might be available

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* Comparing their respective establishments: but under certain circumstances, the Enterprise might have been cheaper in the end.—See Appendix E.

for a boat which it was in contemplation to build as a river tug, and that the vessel deprived of her poop and forecastle should be converted into a pilot brig. But, independently of the very questionable policy of the sacrifice in a pecuniary as well as in other points of view, their length of one hundred and ten feet, and other peculiarities of their hulls, would prevent their riding so well at anchor as the class of shipping now employed.*

The great facility obtained by the aid of the Emulous in the despatch of ships from the port of Calcutta, and in bringing them up to town against the freshes, suggested to the Marine Board the idea of dispensing with a portion of the pilot brigs, and substituting sea going steamers of great power as tugs. The plan was submitted to Government in a letter, dated 19th April, 1827, which made it appear that the commercial interests of the Company were deeply concerned in the measure, as large sums might thus be saved in the shape of demurrage upon their ships. A detailed statement was given of the dates of despatch and departure of their China ships in 1825 and 1826, shewing that four, out of the fifteen ships, had been detained twenty-three, twenty-five, and thirty-three days, by losing the springs, which frequently happens; and that only one had sailed within five days after despatch, the average delay being fourteen; whereas, by the aid of steam, they might all have been at sea in four days on an average, and thereby have saved demurrage to the extent of forty-four thousand seven hundred rupees in the aggregate. It was also shewn, that the existing Pilot Establishment involved an annual loss of nearly four lakhs,† *which might,* in a great degree, if not wholly, be covered on the new plan by a quadruple consolidated rate, *which the Board conceived* the shipping might bear, as it would amount to only half the expense‡ of employing the Emulous to take a ship out in the south-west monsoon. They therefore proposed to do away with all the pilot vessels,

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* *Ganges and Irrawaddy.* *Pilot Vessels.*
Length 110 feet 80 feet,
Breadth 24-6 feet 24 feet.

† Expense of maintaining Pilots and Native Crews per Annum,..... Rupees, 394,008
Pension for February, 1827, ... 5138 } 61,656
say per Annum,..... 12 }
Rs. 455,664
Wear and tear ten per Cent. on eight lakhs, the prime cost of ten Pilot schooners, ... 80,000
Rs. 535,664
Average amount of Pilotage in ten years, ... 155,085
Loss, Rupees 380,579

‡ Then six hundred rupees per diem, while tugging, and half-rate back.

and substitute seven steam tugs, one of two eighty-horse, and six of two fifty-horse engines, calculating the annual charge at six lakhs and twenty thousand rupees.

The scheme being thought worthy of consideration, a Committee was appointed in June following, composed of the Captains of all the Company's ships, professional men and representatives of the principal houses of business and Insurance Offices, with the Master Attendant* at their head; and instructions were given them to report upon the question in all its bearings. The practicability of combining the more speedy and safe general navigation of the river, with a reduced expenditure, was among the points specially named for the investigation of the Committee. They were desired to state, what number of pilot vessels, and what other parts of that establishment might, on this plan, be dispensed with; what kind and what number of steamers would be requisite, and the probable expense thereof; in what manner the shipping interests should be made to contribute, whether by a compulsory or optional charge for using the tugs; and whether they might not be employed advantageously for the Company and for the Owners to bring up the large China ships from their precarious and inconvenient anchorage at Saugor to Diamond Harbour, and the Bengal ships from the latter station to Calcutta. On this subject they were requested to consult with the Commanders of ships and the Branch Pilots.

It is much to be regretted that the object of Government, in the appointment of this Committee, for the collection of detailed information, was almost wholly frustrated by the irregularity of its proceedings. Some of the most material points were apparently neglected, while some of the members, who took an active part in the discussions, seemed chiefly bent upon using their influence to get the Enterprise, Ganges and Irrawaddy cut down, and converted into tug vessels. A report of a Sub-Committee was first sent in to that effect, bearing date the 8th September, 1827, with the signatures of only three out of its five members, the other two dissenting. The general report was submitted without a date, five months afterwards. It set out with recognizing among the advantages of steam tugs—"Expedition in the passage up and down the river; ability to move up and down at a greater draught of water; less risk of grounding from the ship being under greater command, and a saving in anchors and cables." The plan of altering the stations of the Company's ships was approved. The three Government steamers, already named, were represented to be capable of performing the required duties if wholly deprived of their accommodations, and otherwise materially altered; but fit for no useful purpose in their present state. Their future earnings, as tugs, were estimated on a par with those of the Emulous, when she had a monopoly of the market, although the charge

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* Commodore, now Sir John Hayes, Knt.

and employment were not to be compulsory. If this suggestion were not adopted, and it should be preferred to build new vessels, six pilot brigs in place of nine,* the existing number, would be sufficient with three powerful steamers—two to be first built experimentally; one of them of two hundred and seventy or two hundred and eighty tons, with a pair of eighty-horse engines and copper boilers, to ply below Mud Point; the other of two hundred or two hundred and fifty tons, with two sixty-horse engines and copper boilers, to ply between Mud Point and Calcutta. The aggregate charge of this establishment was estimated at seven lakhs† and a half, being an increased annual disbursement of more than two lakhs. But the loss to Government, would be lessened two-thirds, if, instead of a pilotage rate of twelve annas per ton, every ship paid a consolidated charge of three rupees per ton. This rate was not considered excessive, because the charge for the use of the Emulous had averaged two rupees and four annas per ton, upon the twenty-six thousand six hundred tons which had been towed by her between the 1st November, 1826, and 31st July, 1827.

This report was signed by only twelve, out of the twenty-six‡ Members. Captain Forbes, Mr. Seppings, Mr. Jessop, and a majority of the Merchants objected to sign it, because they could not concur in the opinions and recommendations it contained regarding the Enterprise, Ganges and Irrawaddy, nor admit the justness of some of the calculations. Captain Forbes and Mr. Seppings being called upon by the Board, gave in their reasons and *opinions in detail*, with much useful information regarding the properties essential to a steam tug. *All the papers were then laid before Government*, which naturally expressed its regret that, for want of a better understanding among the Members, so unsatisfactory a report had been rendered, but justly commended the intelligence displayed in the remarks of the two Officers above named, and in an interesting memorandum which had been furnished by Mr. James Mackenzie. The general question was postponed for future consideration. It was declared to be inexpedient to make any alteration in the three Government steamers. These were directed to be held available for hire as tugs, when not otherwise engaged. No importance was attached to an objection of some interested parties, that such employment would interfere with the private steamers, and that the new tugs, when established, should, for the same reason, be confined to the lower part of the river.

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* The complement is ten: it was formerly twelve.

† There is great confusion in the calculations, the cost and destination of two steamers being given, and the crews and establishment of three.

‡ Thirty-two, including the Commanders of the six Bengal ships, which arrived during the sittings, five of whom signed: but all the China Captains were gone before the report was sufficiently in progress to obtain their sanction or disavowal.

Mr. Mackenzie had taken the trouble to analyse the Registers of the Custom House and Master Attendant's Office for the year 1822-23. He found that in that year two hundred and nineteen private vessels had arrived at Calcutta, and two hundred and fifteen had departed therefrom, none of which had experienced detention from or to the Sand Heads, except what attended the navigation of the river. Supposing that steam tugs would reduce the average passage of ships arriving from February to June inclusive, to three days; of those arriving in July, November, December and January to four, and of the rest to five days; also, that the average passage of ships outward-bound, would be reduced in November and December to three days; in October, January, February, March and April to four days, and in the remaining months to five; and estimating all further detention as equivalent to demurrage, at eight annas per ton per diem; he shewed that one hundred and fifty-five out of the two hundred and nineteen arrivals, had incurred such detention to the aggregate extent of one lakh, thirty-six thousand, six hundred and twenty-nine rupees, or two rupees, five annas, and eleven pies per ton, on fifty-six thousand six hundred and twenty-three tons, in the following proportions:—

		Per Ton.
Thirty-six ships, of five hundred tons and upwards,	Rupees,	2 11 0
Sixty-four ditto of three hundred to five hundred tons,		2 6 3
Fifty-five ditto of less than three hundred tons,		1 11 0

And that by a similar calculation, *every outward-bound ship except two, had incurred* demurrage, amounting, on two hundred and thirteen departures, to two lakhs, fifty-five thousand, three hundred and seventy-eight rupees and eight annas, or three rupees, four annas and one pie per ton, on seventy-eight thousand four hundred and five tons, as follows:—

Forty-five ships, of five hundred tons and upwards,	Rupees,	4 3 4
Ninety-four ditto of three hundred to five hundred tons,		2 13 11
Seventy-four ditto under three hundred tons,		2 7 9

If to these losses were added the value of the extra detention of forty-four inward and outward vessels, which he conceived might have been avoided by the use of tugs, the whole demurrage would amount to six lakhs, eighty-nine thousand, one hundred and seventy rupees; averaging three rupees and two annas per ton on the arrivals, and four rupees, six annas and nine pies on the departures; and three rupees, five annas and eight pies on both. There were besides, thirteen Company's ships in the list of arrivals, and a like number among the departures. On the same plan of calculation, the former had incurred unnecessary demurrage to the extent of fifty-three thousand, seven hundred and

thirty-nine rupees, ten annas and six pies, or per ton three rupees, eleven annas and six pies; the latter, eighty-seven thousand, seven hundred and sixty-seven rupees, five annas, or per ton six rupees and ten annas: thus augmenting the aggregate loss to eight lakhs, thirty thousand, six hundred and seventy-seven rupees, seven annas and six pies, without taking into account the delays incident to Government vessels not employed in commerce. During the same year three private ships were lost going out, which the aid of a tug might have prevented: these and their cargoes he valued at six lakhs, twenty-nine thousand, three hundred and four rupees. The annual loss of anchors he estimated at more than a lakh, and at an equal sum the injury sustained by the grounding of ships, beyond what even with the use of steam tugs might have been unavoidable. Summing up the various items, and making allowance also for the greater risk and expense of conveying cargo to and from ships at the lower stations of the river under the old system, Mr. Mackenzie conceived that an aggregate saving of eighteen lakhs of rupees would have resulted if all the vessels had had the assistance of steam tugs in that year, less the additional charge thereof; and he concluded that the merchants, ship-owners and underwriters would gladly contribute to the support of an establishment so obviously advantageous to all their interests. At the same time he would not have it compulsory to employ the tugs, but would make the full charge for their partial employment.

He considered that three steamers and six pilot brigs would be adequate to the whole pilotage and tug duties: two of the former should have engines of one hundred and sixty horse united power; the third should have the power of one hundred and twenty horses. The three he estimated to cost seven lakhs of rupees, and their annual charge at two lakhs, fifty-three thousand, two hundred rupees in excess of that of the three brigs they would displace. The extra annual disbursement might be covered by an extra pilotage rate of two rupees per ton, on vessels above five hundred tons; one rupee and a half on those of three hundred to five hundred, and one rupee on smaller vessels, both inwards and outwards. But were the additional rates fixed at two rupees fourteen annas, two rupees eight annas, and two rupees, respectively, which, in his opinion, might well be borne, there would be a gain of nearly two lakhs, or an extinction of half the present loss by the pilot establishment; perhaps more, should it be found that a portion of the forty row-boats,* and eventually a greater number of the cruizing brigs, might be dispensed with. The tugs should be adapted as much as possible to the exclusive purpose of towing, and not be furnished with accommodations for more than the pilots and officers requiring them.

Mr. Mackenzie's plan has been given in some detail, with the substance of his calculations; because, while the latter are in themselves curious, and perhaps valuable for

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* Their monthly charge is about two hundred rupees each.

future application, the former is the only digested scheme which the reference produced. It may be proper to remark, that in the present depressed state of shipping, the owners would be satisfied to earn a demurrage of four, instead of eight annas per day: but the saving of time in respect to the cargoes, worth at least ten crores of rupees, an item he has omitted, will go far to balance any over estimate on that account. There can be no doubt that the mercantile community are highly favorable to the tug system. Although it may be difficult so to regulate the charges of a steamer as a private speculation, that a profit to the owners shall result from her earnings in times of excessive competition, it may fairly be inferred that, in every case of her employment, her work is worth the hire, and in a great number of cases very much more. It is supposed that the Emulous, within the first year, fully repaid the mercantile portion of her present shareholders the cost of their shares, in the shape of increased dividends from the insurance offices. The dangers of a voyage were, in a great degree, within the river Hoogly: these became so much reduced by the practice of employing her, that no case of total loss or serious injury has yet occurred to a vessel proceeding under her charge, and if the Forbes had not unfortunately steamed with the Louisa at night below Kedgeree, the same remark would be applicable to her, and to every other steam tug of the port of Calcutta.

A difficulty has been started with regard to the proposed change in the stations of the Company's trading ships. Most of them have private owners, and are merely chartered for a limited number of voyages: these being insured at *Lloyds', would forfeit the* protection of their policies if exposed to a risk not contemplated by the underwriters. The difficulty however might be easily got over by previous explanation. The underwriters are not likely to object to a small additional risk in the passage to and from the new stations in tow of a steamer, coupled with the condition that the ships receive the same assistance every where within the Sand-heads. No such impediment could arise in respect to the Company's own ships and cargoes, as they are never insured.

We will conclude this chapter with some account of the first Steam Vessel built at Bombay, and of the interesting service on which she has been employed. Captain Sir Charles Malcolm, R. N., the present Superintendent of the Indian Navy, has the chief merit of planning and successfully executing the experiment of a steam communication with Suez from Bombay. We have already noticed the reference made by the Authorities of that Presidency to the Superior Government for the transfer of steamers from Bengal for that purpose. In the mean time, a pair of powerful eighty-horse engines being provided from England, a vessel of four hundred and eleven tons was built for them at Bombay, and launched in the early part of ~~last~~ *this* year, under the name of the Hugh Lindsay.*

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* Vide Appendix A.

Concerning the details of her construction we are not informed; but it would seem that capacity for fuel was sacrificed to speed; for she is said to be deeper than her proper draught, when laden with coals for more than five or six days. It was therefore considered necessary to provide a depôt of fuel at the nearest accessible spot, and the Bay of Aden, on the coast of Arabia, was selected in preference to the Island of Socotra, where equal facilities of arrangement did not exist, and to the more distant, though in some respects more convenient port of Mocha: a supply of fuel was, however, also provided at other depôts in the Red Sea.

After a few trials of speed in the harbour of Bombay, the Hugh Lindsay, under the command of Captain Wilson, started on the 20th March, deeply laden with eleven days' coals, and reached Aden on the 7th April. She was there detained nearly six days in shipping ~~the~~ fresh coals, for want of boats to bring them off. A similar detention occurred on her return, and considerable time was also lost in the same way at other places of stoppage. It has been suggested, that this inconvenience might, in a great measure, be obviated by having the coals afloat, instead of keeping them stored on shore at the different stations; and we have little doubt that, in future passages, there will be much improvement in the arrangements. The following particulars of the voyage to Suez, and back, which terminated on the 29th May, have been extracted from the Bombay and Calcutta newspapers, the only sources of information at present within our reach.

"The Hugh Lindsay steamed the whole way there and back, without the occurrence of a single accident; having run against contrary winds and head seas, and part of the passage by a very intricate navigation, a distance of five thousand, eight hundred and seventy-two* miles, in forty-one days and a half, making an average of upwards of one hundred and forty miles per diem. She was only twenty-one days and a few hours actually steaming from Bombay to Suez, though she employed thirty-two on the passage: her stoppages therefore for coals amount, outward-bound, to more than a third; while on her return she has been thirty-one days, of which she has steamed only twenty days and a half: so that out of the whole voyage from Bombay, and back, which has occupied ten weeks, or seventy days, she has been nearly thirty days at anchor. It must be allowed therefore that, barring the provoking detentions she met with, she has made a very fair passage."

"On Saturday evening, the 29th ultimo, (we quote from a Bombay paper,) we had the pleasure of seeing the H. C. armed steam vessel Hugh Lindsay enter the harbour, and we are enabled to lay the following abstract of her Log † before the public. It

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* By Log, five thousand nine hundred and twenty-eight.

† Vide Appendix F.

appears that the Hugh Lindsay had to contend with one great disadvantage, viz. being too deeply laden on her departure from Bombay, from which circumstance no fair estimate of her speed can be made. She is two feet deeper in the water than was intended in the builder's draft, and consequently could not carry trimming ballast; so that when the greater part of her coal was expended, there was nothing on board by which she could be kept in proper trim, without which no sailing vessel, and more especially a steam vessel, can perform as she ought to do."

This trial voyage has by some been considered a failure, because it was less successful than it might have been: but it has perfectly accomplished the object in proving the practicability of establishing a quick communication with Europe by the Suez route. The opposing winds of the Red Sea appear to be obstructions little formidable to a powerful steamer. Whether the plan of vessels dependent upon depôts of fuel be persevered in, or the principle of a burthensome vessel like the Enterprise be adopted, which avoids altogether the necessity of stoppages for fuel; we may now safely assume that, hereafter, the ordinary passage will be performed in a month: and as the authorities in England are well inclined to support the measure, and packets appear to be in preparation for the Mediterranean line, we may hope, ere long, to have a regular post communication of sixty days, at the utmost, between London and Bombay, and seventy-five days between London and Calcutta.

CHAPTER III.

We now take up a distinct branch of the subject, the application of steam to inland communication, and shall proceed to shew what has been done, in the way of pure experiment, to introduce this grand improvement upon the rivers of India.

* "Soon after the conquest of Assam, the difficulties in the navigation of the Burhampootur (or Bruhampootra) from the strength of the current and prevalence of easterly winds, and the want of good communication by land with the upper parts of the valley, suggested to Mr. Scott, the Commissioner on the North-eastern Frontier, the expediency of applying steam to secure the desired facilities. It was reckoned that the troops in the valley might be more easily supplied in this manner, and that a great reduction might be made in the number kept up, if, through the use of steamers, the means were obtained of moving them quickly in every direction. The Secretary in the Secret and Political Department brought these circumstances under the notice of Government, in a Note recorded in the political proceedings of the 30th September, 1825, and it was resolved, with reference to the opinion of Captain Forbes and other intelligent persons, cited by Mr. Swinton, to request the Court of Directors to forward two pair of boat-engines, for vessels adapted to the navigation of rapid rivers. The power requisite was stated to be two twenty-horse engines for each vessel, and it was at first contemplated that both the steamers should be employed in the Assam valley.

The Hon'ble Court, in compliance with this application, forwarded the engines now in the Hoogly and Burhampootur; but, instead of twenty-horse power, Mr. Maudeslay made them of twenty-five, justly reckoning that the powers of steam had been somewhat over-rated. With the engines, came out drawings from England of the vessels to be built for them.

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* What follows, as far as the launching of the steamers Hoogly and Burhampootur, is extracted almost verbatim from a Minute of the General Secretary to the Bengal Government, dated 7th August, 1828.

Upon their arrival in 1826, Mr. Seppings, the Company's Surveyor of Shipping, observing that the vessels, if built by the plan sent from England, would exceed the required draught of water, and afford little accommodation for troops, recommended an increase of beam to the extent of two feet, and that they should be built with a projecting grating fore and aft. He further stated, that, to furnish proper grown crooked timbers for the sides in midships, according to the drawings, would be impossible in Calcutta, and therefore recommended that the floors should be quite flat and fastened to the sides at nearly a right angle; whereby a greater capacity of stowage for fuel would be obtained, with less draught of water. These alterations were approved by the Marine Board and sanctioned by Government. Whereupon Mr. Swinton laid a further Note before Council, pointing out, that the deviation from the original plan would require the main shaft of the paddle wheels to be cut and lengthened; a hazardous operation which, with the other alterations, might endanger the success of the whole design. He therefore urged, that one vessel, at least, should be built upon the European plan. At the same time he stated his opinion, that one boat would suffice for the purposes of the Commissioner, and that the other might be made applicable to general service on the Ganges and elsewhere. To meet the difficulty about crooked timbers, he presented a tender from Messrs. Kyd and Co. who offered to construct a vessel, exactly according to the English plan, for eighty-five thousand rupees. Government in consequence ordered one to be built by them at the price named, and, although at first authority was given to increase the beam of the other, that scheme was ultimately relinquished,* and the New Howrah Dock Company undertook to build her for sixty-five thousand rupees, in accordance with the drawings as to beam and length, but without crooked timbers in midships, and with nearly a rectangular section across. The Burhampootur is the vessel built by Messrs. Kyd and Co., the Hoogly that of the Howrah Company; the latter according to the diagonal system of Sir Robert Seppings. They have been declared to be equally well executed, as regards materials and workmanship, and in accordance with their respective contracts."†

The Burhampootur was launched on the 19th January; the Hoogly on the 29th March.‡ The latter it was intended to retain at the Presidency for conveying troops to the

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* If this had been done, the loaded draught might perhaps have been reduced to three feet. The motive for not adopting the alteration, appears to have been a doubt, whether the shaft could be lengthened with success. Messrs. Jessop and Co., the proprietors of the Phœnix Foundry, offered to take the job for three thousand rupees, including other necessary alterations. They have executed larger work, as regards welding.

† There was a slight deviation from the London plan, even in building the Burhampootur, by the addition of two feet to her length, which made her $6\frac{5}{94}$ tons larger: she has also four extra scuttles on each side, and a round buttock instead of a square one.

‡ Appendix (A.)

Chinsurah Depôt, and other duties, for which sea-going steamers are not so well adapted. The former was to have started for Assam in July. As it was calculated she would carry Burdwan coal in her coal boxes, sufficient for seventy or eighty hours' consumption, at from six to seven maunds per hour; and that she would move at the rate of nine miles through the water, it was not thought necessary to provide depôts of fuel, even during the freshes, at less distances than three hundred miles apart. Captain Johnston, however, who was consulted, recommended that they should be placed at distances not exceeding one hundred and fifty miles, to provide for the chance of meeting with occasional currents, which the vessel might not be able to stem at an advantage of more than two miles per hour. If wood fuel were employed, he stated that, besides what she might carry on deck, the coal boxes would only contain a provision for fourteen to sixteen hours; as her flues would consume nine cubes of six feet of dry soondry wood, the common firewood of Calcutta, in twenty-four hours, and probably a larger quantity of such other as might be procurable.

With reference to this information, the Marine Board was ordered to send fifteen hundred maunds of coals to Dacca, which it was expected the steamer would reach with what she received at starting; and Mr. Scott was instructed to provide similar depôts at the next station of Goalpara, and at such others as he should himself select. It fortunately happened that an extensive vein of coal had been discovered in Assam on the river Suffry, a stream which flows into the Burhampootur at a short distance above Rungpore, the capital of that country. Under the authority of Government, Mr. C. A. Bruce, who had been attached to the Flotilla during the war, was employed by Mr. Scott in exploring the Suffry, and opening a coal mine; from which, up to the time of its temporary abandonment in November, 1828, he raised between eight and ten thousand maunds, at an aggregate expense of Sicca Rupees 2167: 11: 5. By an estimate furnished at the desire of Government, it appeared, that this coal might be provided at the following rates, for every hundred maunds delivered at—

A depôt on the Suffry river, accessible for large boats, ...	Sa. Rs.	12
Dekhow, or Dekhanee Mookh, ...	„	15
Bisnath, ...	„	20
Gowahatty, ...	„	25
Gowalpara, ...	„	30
Dhobree, or Dooburee, ...	„	33
Bugmah, or Bugoowa, ...	„	35
Jumalpore, ...	„	38

The last seven stations are all on the great Burhampootur, and in progress towards Calcutta. At the last of them, situated at the point where the Jenye river branches off

the cost would only equal the present price of Burdwan coal in Calcutta, six annas per maund. Mr. Scott stated that the price at the depôt would be somewhat reduced if the mines were worked to an extent exceeding ten thousand maunds annually, as the charge of superintendence bore a large proportion to the whole expence. The quality is found to be much better than that of Burdwan and Sylhet, and to answer perfectly for smithies. In proceeding up the stream, it was assumed that the steamer would be able to take several empty return coal boats in tow, which, if left to themselves, would be six weeks or two months in getting up to Dekhow Mookh * from Narayengunge, although they would come down laden to Gowalpara in ten days. The price of river freight, according to Mr. Scott, would be ten rupees for every hundred maunds per month, with due notice. If the steamer could make good four miles per hour over the ground, he considered that, beyond Dacca, it would be sufficient to have depôts at Jumalpore, Gowahatty and Dekhow Mookh, with only a small provision at the intermediate stations of Gowalpara and Bisnath, for use in case of accidents.

The whole distance from Calcutta to Rungpoor must exceed eight hundred miles, of which above five hundred were to be traversed against the strong current of the Burhampootur. Judging from the two experimental voyages of the Hoogly to Allahabad, scarcely an equal distance, and the stream perhaps less rapid in the rainy season, we may infer that the passage would not have been made within a month or five weeks, as the strong easterly wind would have much impeded the progress of the steamer after entering the valley. At the opposite season, the shifting sands, which are reported to abound in the Burhampootur, would be serious obstacles to rapid progress : so little water exists in the upper part of the river at that season, that even light native boats are unable to proceed so high as Rungpore: the route from Dacca, via Mymunsing, is shut from the middle of December to the middle of April, and it is necessary to take the Jenye passage. To facilitate the intended communication, the Burhampootur had been surveyed from Gowalpara upwards, and from thence by Lieutenant Richard Wilcox, as far as Jumalpore. The survey has since been completed by that Officer, and the direction of all the important streams having been ascertained, a new map of that country, hitherto little known to geography, is now in course of publication.

The Burhampootur, above Goalpara, is stated, by Lieutenant Wilcox, to run through long dreary tracks of impenetrable jungle.† " Immediately below that place an

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* A small stream upon which Rungpoor is situated, within a mile or two of the great river.

† This jungle is as full of leeches as any part of Ceylon: the Sipahis suffer much from them on a march. Another annoyance, peculiar to the country, is the musk beetle, which is said to swarm on the banks of the Assam rivers. There is also in Sylhet a species of locust, called by the natives Malpook, not found in Bengal: this insect is very destructive to the Indigo plant.

improvement is perceptible; the churs are often open plains, on which proprietors of large herds of cattle take up their temporary residence during the dry season. Below Bugoowa extends a fine open and well-cultivated country,* when he passed down the river in May and June, it was so deep that with a bamboo of twelve or fourteen feet long, he was never able to reach the bottom: it had still to rise very considerably, and many of the islands and land-marks he then registered, would be under water. The wind was blowing strong from the east. Lieutenant Wilcox found the state of the river very much changed since the days of Rennell, whose map, accurate no doubt at the time, was so different from the actual state of things, that, instead of merely correcting it, he thought it better to construct a new one. The distances of his main points, however, very closely corresponded with those given by that celebrated geographer, while the freaks of the mighty stream had gradually changed the site of many villages a mile or two; a circumstance, perhaps, as common on the great Ganges, where it winds through the loose soil of the alluvial plains of Bengal.

It is well known that these rivers communicate with each other, not only by the bifurcation of the streams from the north between the Koosee and Burhampootur; but also below the latitude of twenty-five degrees, by a variety of cross channels, which, although (with exception of the Jenye) nearly dry during half the year, discharge a great body of water in the rains. That season, commencing a month earlier in all the extensive country drained by the Burhampootur and Megna, raises their level many feet before any rise is perceptible in the Ganges. The channels of communication then produce a material influence upon the level of the latter near its mouth, causing a partial fresh, and checking the current of the main river before the rains of Bengal and of Upper Hindoostan have begun to affect the streams which feed it from the north and west. Of late years the Jenye, which, quitting the Burhampootur, where it bends to the south-east, runs in one stream due south, almost till it joins the Commercolly river; has so much enlarged its bed that it is now the principal outlet of the former; and the old broad channel of the Burhampootur, immediately below this efflux, is observed to be gradually filling up. When that channel shall cease to carry off the waters of the freshes, an important change will take place in the Ganges: its periods of inundation will be accelerated, and the extent of the inundation will be increased, the eastern rains being much more copious, and of longer duration than the western: agriculture may, perhaps, suffer; the production of Indigo on low lands will become more precarious; but the navigation of both rivers, and the intercourse between them, will be greatly improved.

The bifurcation of the streams, so remarkable a feature of the Dinagepoor and

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* Extract from a letter from Lieutenant Wilcox to the Surveyor General, dated 23d June, 1828.

Rungpoor* districts, although not without example, under different circumstances, in the western continent, seems, in the present case, to have an explanation in the varying levels of the two great rivers. If between December and April, or at any period, the surface of the Burhampootur be lower than that of the Ganges, the torrents from the hills to the north, cutting their way through an uninterrupted plain, or winding round the low detached hills, which here and there present themselves, without effecting the general level of the plain, would naturally flow into the former; while the known fact of its earlier rise, from the operation of causes not acting with equal effect upon the minor streams in question, must throw back the current of these, and make them seek a vent in the Ganges. The exact relation of those rivers to each other, in regard to level, has not been ascertained. From the nature of the country they traverse, it may be inferred, that, from where they approach and pursue nearly a parallel course, their respective mean level is the same; and that, although the rains, commencing six or eight weeks† sooner in Assam, should continue until the same period of the year as in Bengal, or even a little later, its greater length of course will retard the floods of the lower Ganges after those of the Burhampootur shall have begun to subside.‡ If, indeed, the Sanpo be the main stream of the upper Burhampootur, as supposed by Rennell, who is followed by all later geographers,—a state of things, which would prove a very extraordinary break in the great Himalaya chain, this river may rival the Ganges in length, though not in the extent of its ramifications. Rennell considers it to be the larger stream, which might be inferred too from the present magnitude of the Jenye; and there is sufficient reason to believe, that its expenditure *in the freshes exceeds that of the* Ganges. Hence its somewhat broader channel and enormous outlets, which, on the cessation of the rains, must reduce its level with greater rapidity than the retiring waters of the rival stream. Accordingly, it is known, that the current of the interlocking rivers sets entirely towards the Burhampootur and Megna, when the Ganges is in full fresh.

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* There are two Rungpoors: that which we are now describing lies between the Ganges and Burhampootur: the name is given to an extensive tract of country, and its principal town, which have long formed a Zillah jurisdiction under British domination. The other Rungpoor is the Capital of Assam, about five degrees further to the East.

† The Megna began to rise this year on the 8th March, at Nursindee, about one hundred miles from the sea, and is always expected to rise before the end of that month. The extreme difference of level at that place, including tide, is thirteen feet, as observed by Mr. Bush, during a residence of two years.

‡ The kind industry of a scientific friend has furnished some interesting information regarding the subjects here discussed, which will be found in the Appendix (**G.**)

CHAPTER IV.

MATTERS were in a state of preparation for the voyage of the steamer Burhampootur to Assam, as described in the preceding Chapter, when the present Governor General, Lord William Cavendish Bentinck, arrived from England on the 3d July 1828. His attention was immediately given to the interesting subject of Steam Navigation, particularly as affording the means of quickening the communication with the Upper Provinces; and, as it appeared to him that no urgent necessity existed for sending a steamer at that particular time on the contemplated voyage; much less, for the permanent assignment of so expensive a vessel to the Assam Provinces, where an accident to her machinery would be beyond the reach of repair; it was deemed advisable to retain both the *Hoogly and Burh*ampootur for Experimental Service, with a view to ascertain their *applicability to Indian river navigation, the improvements of* which they were susceptible, and the advantages of steam as a general question.

By his Lordship's desire, the Secretary in the General Department* prepared a Note for his information, descriptive of the manner in which the navigation of the rivers was at present conducted, and the delays and accidents to which it was liable, and likewise of the objects to which the propelling power of steam might be most beneficially applied. To these objects we shall first advert, ranging them in the order in which he classed them, under the following heads: Conveyance of Treasure;—Saving of Boat Allowance to Officers;— Transport of Troops;—Banghy Dawk, or Carriage of Parcels to Towns on the River;—Distribution of Stamps, Stationery, and Medical and other light Stores, to the different Stations.

1st. It was brought to the notice of the Governor General that an entire Battalion had been employed in the preceding year, to convey, from Agra to Calcutta, thirty-eight lakhs of rupees, the amount of the Gwalior Loan, which was brought down in common native boats, and fortunately arrived safe. Among so many boats (for they composed a large fleet)

* Mr. H. T. Prinsep.

the loss of one or two would not have been an unusual occurrence at any season: two of them were actually sunk off Calcutta in a north-wester, the day after the treasure was landed. A Havildar's Guard would be more than sufficient for the protection of any amount of treasure which a steamer might carry. She would anchor out in the stream at night, instead of lying under a bank, and no party of robbers could calculate her places of stoppages between the fuel stations, for the purpose of making a combined attack: she might also be armed with swivels if necessary. The sea-going steamers have no extra guard when on treasure service. Much time might thus be saved; an item most material in the balance of advantages; and when steam conveyances should once have established a reputation for expedition and security, the specie remittances of internal commerce would pass on the Government steamers, and contribute, with the saving of boat-hire, batta, and other escort charges on public treasure, to defray their expenses. By the same means, the whole Mint Establishment at Benares* might be dispensed with; if, in twenty days, coin from the Mint of Calcutta could be delivered to the merchants in exchange for their bullion: a measure, which has since been carried into effect, without regard to that consideration.

2d. Every King's or Company's Officer, travelling by water on duty, receives a monthly boat allowance, according to a tabular rate, in which the distances in time are assumed†. Although it should be out of the question to deprive Officers, in the higher

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* The total charge for coinage and establishment, from the 1st March, 1820, to 31st August, 1829, was F. Rupees 9,75,116 15 8; and the receipts from the seignorage of two per Cent. on private silver, sent in for coinage, amounted to Rupees 6,22,749 4 7.

The following is the aggregate amount coined in Furruckabad Rupees at Benares; during the same period:

On Private account,	F. Rs. 3,23,62,789 6 7
On Public account,	1,88,22,678 15 0
Total,	F. Rs. 5,11,81,468 5 7

Besides copper to the value of about ten lakhs.

† RATE PER MONTH.

Colonel,	Sa. Rs. 930 0 0
Lieutenant-Colonel,	630 0 0
Major and Head Surgeon,	360 0 0
Captain, Pay-Master,	100 0 0
Cadet,	80 0 0
Conductor and Quarter-Master,	70 0 0
Medical Pupils,	50 0 0

grades, of the comfort of travelling independently with their families and baggage; the juniors would prefer a speedy passage at the public charge, to the allowances they received, especially Cadets and others recently arrived, to whom the economy of a joint mess would be an object: Government, too, would gain so much of their services as was now wasted in the tedious progress to their several stations. The aggregate charge for boat allowance sometimes amounted to many lakhs in the year, * and the bulk of the expenditure was incurred on the junior ranks.

3d. The transport of European troops and stores to the Western Provinces, is

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TIME ALLOWED, RECKONING FROM CALCUTTA.

	Months.	*Days.*
To Agra,	6	0
Allahabad,	3	0
Azimghur,	3	0
Baraitch,	4	0
Bareilly,	4	15
Benares,	2	15
Berhampore,	1	0
Bundlekund,	3	20
Burragong,	2	7½
Buxar,	2	7½
Cawnpore,	3	15
Chittagong,	2	0
Chunar,	2	15
Dacca,	1	0
Dalamow,	3	7½
Delhi,	7	15
Dinapore,	2	0
Do. via the Sunderbuns, in March & April,	2	15
Futty Ghur,	4	0
Ghazeepore,	2	7½
Goruckpore,	3	0

	Months.	*Days.*
To Gurmektesur,	5	0
Jughigopah,	2	0
Kairabad,	4	0
Kurnaul,	8	15
Loodeanah,	9	0
Lucknow,	3	15
Meerut,	5	0
Mirzapore,	2	15
Monghyr,	1	15
Moradabad,	5	0
Muttra,	7	15
Patna,	2	0
Pertaubghur,	3	15
Rajmahul,	1	5
Ramoo,	2	15
Secrora,	4	7½
Shahabad,	4	0
Sekundra,	7	0
Sittapore,	4	7½
Sultanpore, (Benares,)	3	0
Sultanpore, (Oude,)	3	15

The above rates, both as to time and allowances, have recently been revised, and some reduction has been made therein.

	* 1823-24.	1824-25.	1825-26.	1826-27.
To King's Officers, .. Rs.	52,500	57,579	47,754	74074
Company's Ditto, ...	106,768	6,73,154	223,615	310,260

always effected by water. The charge for sending a European Regiment to Cawnpore, was stated to be as follows :—

	Rs.
Commissioned Officer's boat allowance, (assuming the number of Officers then serving with His Majesty's 31st Regiment of Infantry,)	23,310
Tonnage for one thousand* men, rank fiand le, one hundred and twenty women, one hundred and eighty children, and one hundred and ninety camp followers, and for Hospital and Commissariat stores, ...	22,677
Total Rupees,..	45,987

The boat hire paid for the conveyance of troops in 1825-6, amounted to five lakhs, seventy-two thousand, four hundred and twenty-two rupees; and the following year to four lakhs, fifty-six thousand, nine hundred and twenty-two rupees.† It had not yet been ascertained in what space of time one of the river steamers could reach Allahabad; supposing that vessels, fitted out for the purpose, might make the passage both ways in a month, a Regiment would thus be conveyed in less than a fourth of the usual time, with a security, comfort, and healthiness to the men, very superior to what obtained in native boats. With respect to stores, the most bulky and heavy articles must, in all countries, be transported in the cheapest manner: *but the more valuable, and others also in times of emergency, might be sent by the steamers. With such* rapid conveyance, too, at command, it would be unnecessary to accumulate so large a quantity at the different depôts.

4th. It were hopeless to expect that steam would supersede the Dawk (or letter post) in any direction. But there is a Banghy, or parcel Dawk, which might eventually be assigned to the steamers, for the carriage of light packages to the various towns in the line of their route. The establishment kept up for that purpose, excluding stations beyond Mirzapore, and all others not upon the river, costs the Post Office nine hundred rupees per month. The receipts from the same source were estimated at seven thousand rupees per month, the whole Banghy postage being about eleven thousand rupees.‡

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* The estimate is fifty maunds per man in the common river boats, twenty-five maunds each for women, and ten for children. Vide Appendix H.

† Captain Johnston, in August, 1828, ascertained that more than twenty-eight thousand tons of boats had been employed by Government in the preceding year, for the conveyance of troops and stores, principally on the Ganges. The charge in this department was very small in 1827-8 and 1828-9, with reference to the sums stated above; (vide Appendix H.) but it should be noticed, that for a long interval of time, the troops, after reaching their several stations on the close of the Burmese war, were suffered to remain undisturbed. The removes are usually once in three years: the stations of many Regiments were changed last cold weather.

‡ Eleven thousand and forty-seven rupees were collected upon eight despatches in June, 1828.

Whether steamers would be applicable for such service, would depend upon the frequency and regularity, as well as upon the quickness of their voyages. If that department could be assigned to them, the Banghy receipts would be greatly increased by allowing additional weight to the packages, and many articles would be so forwarded, which, from their delicacy of fabric and liability to injury by rain, could not be entrusted to the common Banghy. But the river would not entirely supersede land carriage until a steam passage to Allahabad should be reduced to fifteen days, this being the present rate of the Banghy in the favorable season.

5th. Another minor object is, the saving of the expense of four large covered boats, kept in constant employment for the conveyance of Stamps to the district stations, at a charge of one hundred and eighteen rupees each per month. These boats, which originally cost sixteen thousand rupees, might wholly be dispensed with, as most of the stations are accessible to steamers. The boat charge upon Stationery and Medical Stores, which also might thus be economised, was not an inconsiderable item.

These were the useful purposes which immediately occurred to the Secretary's mind as deserving notice. He doubted not that others would present themselves, should the power of steam, in river boats, be found to have that decided superiority over the craft of the country, which was anticipated by those on whose judgment and professional skill Government was accustomed to rely.

Mr. Prinsep shewed, that the necessary charge of an experimental voyage to Allahabad, would not exceed three thousand five hundred rupees, as coals might be forwarded to the extreme station at one rupee per maund, including its first cost in Calcutta. But it might be desirable to engage the services of scientific men to record and report upon the occurrences of the voyage, the strength of the current, the depth and nature of the channels of navigation, and the obstacles they presented. The difficulties of the voyage, he supposed, would be found, at the same season, much to resemble those which the Diana encountered in the Irrawady, when she proceeded up to Umerapoora, at the rate of thirty miles per day, never drawing less than six feet. The comparison seemed to promise much greater progress to the new river steamers, drawing a third less water, with more relative power of engines.

Taking a general view of the importance of the Ganges and its tributaries, with their various ramifications, to the commerce of Hindoostan, he calculated that an extent of country, the most populous part of India, covering not less than forty square degrees, and embracing the courses of the Ganges and Jumna on the west and south, the Burhampootur and Megna on the east, was almost wholly dependent upon water communication. Major Rennell, in 1780, had reckoned that thirty thousand boatmen obtained a

livelihood upon the rivers within the province of Bengal. If his estimate was not then much underrated, the security of half a century, and the extension of the commerce of Bengal, must have produced an extraordinary increase in this class of people. Whoever has lived upon the banks of the great Ganges, and of the Hoogly above Calcutta, must have been struck with the rapid succession of boats, moving up and down at all seasons, and penetrating the country in all directions. All the large streams which rise in the northern hills, are navigable more or less throughout the year, nearly to the foot of the first range. The Ramgunga and Gurra, in Rohilcund, though comparatively small, are open above half the year. The Goomtee, Chowka, and Dewa or Gogra, in Oude; the Raptee, Gunduck, and Bhaguruttee, in Goruckpore and Behar; the Koosee, Mohanuddee and Teesta, (the Attri of the plains) in Purneah and Dinagepoor; and on the side of Assam and Sylhet, the Burhampootur, with some of its tributaries, and the Soorma and Megna, admit of navigation at all seasons. The streams which flow into the Ganges and Jumna from the south, have a different character; mere hill and upland torrents, dry most part of the year: even the Soane, the largest of them, is not navigable above Daoodnugur, situated only twenty miles from its entrance into the Ganges. The rivers of Bundelkund and Malwa have rocky beds and frequent falls and rapids, which render even the largest of them, the Chumbul, scarcely fit for navigation at a short distance from its confluence with the Jumna.

The boats used in this extensive commerce are of various forms and construction, influenced by local circumstances.* The *Patella*, or baggage boat of Hindoostan, is of saul wood, clinker built, and flat bottomed, with rather slanting outsides, and not so manageable as a punt or a London barge: its great breadth gives it a very light draught of water, and renders it fittest for the cotton and other up-country products, which require little better than a dry and secure raft to float them down the stream. The *Oolak*, or common baggage boat of the Hoogly and Central Bengal, has a sharp bow and smooth rounded side: this boat is the best for tracking and sailing before the wind, and is tolerably manageable with the oar in smooth water. The Dacca *Pulwar* is more weatherly, although, like the rest, without keel, and the fastest and most handy boat in use for general traffic. The salt boats of Tumlook are another distinct class. The light boats which carry beetul leaf; the wood boats of the Soonderbuns, of various forms and dimensions, from the burthen of one hundred to that of six thousand maunds; the Calcutta *Bhur*, or cargo boat of the port; the Chittagong boats; the light Mug boats, with floors of a single hollowed piece of timber, and raised sides, neatly attachedby sewing, with strips of bamboo over the seams; and an almost endless variety of others might be enumerated: besides the small *Dinghee* and the *Panswee*, the common Canoe, and the ketch-rigged *Pinnace*, the *Budgerow* and the *Bauleah*; the three last employed by Europeans for their

* A great variety of the boats used in Bengal, will be found faithfully delineated in Solwyn's Etchings.

personal conveyance. A native traveller, according to his degree and substance, engages a *Dinghee*, or a *Panswee*, a *Pulwar*, or an *Oolak*: the man of wealth puts his baggage and attendants in these, and provides a *Budgerow*, or a *Pinnace*, for his personal accommodation. Officers of high standing in the Civil or Military service, travelling with a large retinue of servants and a quantity of baggage, seldom have less than five or six boats, (one of them a cooking boat, another fitted with an oven for baking bread) and sometimes as many as fifteen, when they carry their horses and equipages, and the materials of housekeeping, for their comfortable establishment on arrival. The following rates of hire for the large boats will give an idea of the expense of travelling on the Ganges. Assuming a voyage to Allahabad to last two months and a half, the charge would be for a—

Dacca Pinnace, of 1st class, at 18 to 20 Rs. per diem, or for the trip, Rs.	1,200 to 1,400
Ditto, of the lowest class, at 12 to 14 Rs. per diem, or for the trip, ...	900 to 1,000
Budgerow, of 1st class, for the trip, ...	650
Ditto, lowest ditto, ditto, ...	450
Patella, of five hundred maunds, ditto, ...	150
Oolak, of ditto, ditto, ...	150
Pulwar, of ditto, ditto, ...	150

After giving these details respecting the mode of travelling, and the transport of goods upon the Ganges, the Secretary described the principal dangers to which they were exposed from eddies and gusts of wind, shifting sands, sunken trees, and falling banks, which often sink a boat, tracking along, or lying for the night under them. So precarious was the safety of the native boats in this navigation, that the premium of insurance, he observed, was no greater on a voyage to England than to Allahabad:* he might have added, that the gain to the Insurance Offices was less, with every precaution in the selection of their risks. But these dangers, he remarked, were not peculiar to the Ganges: they existed more or less on all great rivers. The Mississippi, though not within the tropics, presented many points of resemblance, as far as information was then available. The extraordinary success of steam navigation on that river, gave reason to hope it might be introduced, with equal advantage, upon the Ganges: he apprehended no important difficulty from the shallowness of the channels; for Rennell had calculated its average depth in the dry season to be thirty feet,† and there was no spot below Allahabad, known to be at any time fordable to an elephant. In the situation of

* Three and a half per cent. The charge, from Calcutta to London, is now reduced to three per cent. and one per cent. more if the ship touch at the Cape in the winter season.

† "At five hundred miles from the sea, the channel is thirty feet deep when the river is at its lowest, and it continues at least this depth to the sea."—*Rennell's Memoir of a Map of Hindoostan, third edition.* p. 338.

Calcutta there was, indeed, the inconvenience, that the Hoogly communicated with the main river by channels liable to be shut for navigation during part of the year: these consisted of the Bhaugurutteе or Cossimbazar river, the Jellinghee and the Matabhanga. From the middle of March to the end of May, the Jellinghee, the deepest of them, was reduced to less than two feet, while perhaps there would not be a foot of water in the others. Consequently, none of the steamers could pass into the Ganges in the dry season, except by the route through the Soonderbuns, a detour of a week to an ordinary boat. It therefore seemed advisable, on every account, that the first experiment should be made before the close of the rains.

The Governor General approving of the Secretary's views, which were supported by an intelligent Note from Captain Johnston, who had also been called upon for his opinion, it was resolved to undertake an experimental voyage to Allahabad without delay. The two new steamers, Hoogly and Burhampootur, being subjected to a trial of speed, with a view to the selection, the Hoogly was found to have a small advantage over her competitor. They ran the distance from the Bishop's College to Diamond Harbour, half the way against tide, in five hours and nine minutes, and five hours, sixteen minutes and a half respectively, and returned next day, with the tide, to Bankshall in four hours and thirty-seven minutes, and four hours and forty-two minutes. The advantage both ways was with the Hoogly, although she steamed only twenty-six to twenty-seven and a half revolutions, while the Burhampootur made twenty-seven to twenty-nine.. This was the result of a second trial on the 29th and 30th August, made in consequence of the unsatisfactory issue of a former one: care had been taken that their draught of water and the quality of the fuel should be equal. Captain Johnston afterwards ascertained that their speed did not exceed six and a half knots, and that thirty-two revolutions per minute was the maximum of their engines: Government had been led to expect a much greater velocity at the time they were building. As the Hoogly, besides being the faster vessel, had more capacity for fuel than the other, she was preferred for the intended voyage.

Coals were forwarded to Rajmahul, Mongheer, Patna, Benares, and Allahabad, and arrangements were made to secure the assistance of practised native boatmen at different stations, as river pilots. Mr. Warden, of the pilot service, late commander of the Governor General's yacht, who had been up the river with Lord Amherst, was put in temporary charge of the Hoogly, under the general direction of Captain Johnston, from whose judgment and experience much was expected. Captain Thomas Prinsep, of the Bengal Engineers, was also attached to the expedition, with the same view of extending the field of observation. Both these officers were instructed to notice every circumstance which might influence future voyages, as well as the incidents of their own.

They started on the 8th September. The coal boxes of the steamer then contained five hundred and four maunds of Burdwan coal, and three hundred and two maunds were carried on deck, and she was drawing three feet ten inches forward, and four feet six inches aft; an excess of ten inches beyond her best trim, which reduced her speed full a mile per hour. This, from accidental circumstances, connected with the supply of fuel, continued, in a varying degree, the whole way up, and delayed very much the period of arrival, the average progress being little more than three miles per hour over the ground. The upward voyage occupied twenty-four days, and the return fourteen, including two days' detention at Benares to refit.* The quantity of fuel consumed in the former was

* Left			Arrived at			Miles.	Hours steaming.	
Calcutta, ...	8th	September, ...	Moorshedabad,	11th	September, ...	161	45	10
Moorshedabad,	11th	,, ...	Rajmahul, ...	13th	,, ...	89	24	54
Rajmahul, ...	14th	,, ...	Moongheer, ..	18th	,, ...	123	39	7
Mongheer, ...	18th	,, ...	Patna, ...	20th	,, ...	87	28	46
Patna, ...	22d	,, ...	Ghazeepoor, ..	25th	,, ...	131	42	46
Ghazeepore, ..	26th	,, ...	Benares, ...	27th	,, ...	66	20	15
Benares,.....	28th	,, ...	Allahabad,..	1st ~~16th~~	October, ...	141	38	59
						798	239	57
Allahabad, ...	3d ~~5th~~	October, ...	Chunar, ...	5th	October, ...	119	15	20
Chunar, ...	6th	,, ...	Benares, ...	6th	,, ...	22	3	20
Benares, ...	8th	,, ...	Ghazeepoor, ..	8th	,, ...	66	9	52
Ghazeepoor, ..	9th	,, ...	Dinapore, ...	10th	,, ...	259	20	13
Dinapore, ...	11th	,, ...	Rajmahul, ...	14th	,, ...	99	39	25
Rajmahul, ...	15th	,, ...	Moorshedabad,.	15th	,, ...	89	12	30
Moorshedabad, .	16th	,, ...	Calcutta, ...	17th	,, ...	161	20	25
						815	121	35

The distances were all measured on the Charts of the river: the cause of the difference in the two passages is, that short cuts were taken in the former, whereas the steamer came down with the stream.

General Statement of Progress according to Captain Prinsep.

	Distance in Miles.	Time going.	Rate per Hour.	Time returning.	Rate per Hour.
Calcutta to Choka Mouth, ...	232	59 hours	3 93	45 40	9 0
Choka to Patna, ...	248	78 20	3 03	46 27	5 3
Patna to Ghazeepore, ...	127	42 36	3 0	21 25	5 9
Ghazeepore to Allahabad, ...	200	59 24	3 36	33 43	5 9
Total, ..	807	239 20	3 34	127 15	6 4

two thousand two hundred and forty-five maunds of Burdwan coals, and four hundred and eight of wood, which were reckoned equal to eighty maunds of coals. Many of the coal boats were overtaken before they had reached their stations, which contributed to the inconvenience already noticed. The steamer's rate in going up was about seven statute* miles per hour; Captain Johnston allowed five for the main current, which would have given a net progress of only two, had they not avoided it as much as possible by hugging the shallow side of the river, passing along the edge of the sand-banks, and occasionally through Nullahs and small channels. Captain Prinsep did not estimate the mean force of the current at more than four miles per hour. Little assistance was derived from native pilots: by attention to the soundings however, and by observing the bends in the river, a passage was always found without difficulty; but the steamer slightly touched the ground twice in the ascending voyage. The greatest obstruction she met with, was a sand-bank near the village of Lohain, about six miles below the Fort of Allahabad. This being reported to Lieutenant Smith, of the Engineers, Superintendent of the Works on the Jumna, with whom the party were directed to communicate on their arrival, he gave them for pilot on the way back an European Serjeant, supposed to be well acquainted with that part of the river, who went ahead in a boat. The river, in the mean time, had fallen considerably, and although the Serjeant signalled for shoal water on nearing the sand, the steamer took the ground. The anchor being let go, she swung to it in nearly her own water, while Captain Johnston went in the pinnace in search of a channel, which he presently discovered on both sides of the bank; but he was then too far off to give directions. The Serjeant, in the interim, made a signal for three fathoms, and the Hoogly got under weigh; but, in following the pilot, she again struck upon a spit of sand which held her fast amidships, with five feet water astern and six under the bow, the sand appearing above water close alongside. Captain Johnston then wrote to Mr. Brown, the Magistrate at Allahabad, for boats to lighten her, not venturing to throw the coals overboard, lest they should add to the impediment; after which he sent out a grapnell, two-thirds of a cable's length, on the starboard bow, the vessel being aground on her larboard side; and the grapnell rope served to haul out a kedge and a four inch hawser, and, by their means, the best bower anchor and forty fathoms of chain: this occupied several hours. The steam was then set on; but the only effect was to veer her round a couple of points, and force her more into the sand. She was now broadside to a current of five knots, and if affected at all thereby, would be moved into deeper water. To facilitate this, the kedge and grapnell ropes were taken in over the stern and hove well tort, and in that state she was suffered to remain for the night. The event answered expectation: at two A. M. the vessel

* In this trip all the measurements were by statute miles.

swung to the bower anchor in five feet water;* and at daylight, setting on the steam, they sheared her into two fathoms, and let go the small bower, in order to get up the other. The ropes on the kedge and grapnell parted, and these could not be recovered by creeping or sweeping, with the assistance of the boats sent by Mr. Brown. Finding it hopeless to expend more time in the search, they proceeded on their voyage at two P. M.

This was the only accident of any consequence, and the only instance of material detention from grounding. It was afterwards made a standing order, that, as soon as the water shoaled under two fathoms, the anchors should be dropped, and the boat sent ahead. As a further precaution, only one ~~engine~~ boiler was used during the passage down, which kept the engines working at sixteen to eighteen strokes in a minute, and the motion of the vessel through the water was reduced to two and three miles per hour, sometimes less. The full power was put on after re-entering the Bhagurutty, and kept up till their arrival. The steamer touched once more, but was extricated with facility.

Captain Johnston's report has furnished the materials for the above account of the expedition. He remarked, that the wind had been constantly in the south-east quarter, and sometimes very fresh; that the passage up had been commenced at the period of the year, when the current was supposed to be strongest; that its velocity had been found to abate at least half a mile per hour above Ghazeepore, which he attributed to the circumstance of the river not having reached its usual height this year, its greatest rise having been, at Benares eleven feet, and at Allahabad thirteen feet short of the average maximum, while at Rajmahul and at Colgong the difference was only a foot and a half; that the return voyage was performed in the most unsettled state of the river, when the waters were subsiding with a rapid stream, and before they had formed or fallen into their regular channels. Consequently the experiment, as such, was fortunate

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* The following is an Extract from Captain Prinsep's account of the accident, with his remarks thereon. "The vessel then sheered round, as before, with her broadside to the stream, and appeared to settle in the sand, with a dry bank forming immediately below, and the current eating away a channel under our bow and stern. In this predicament, with much delay and some difficulty against such a current, we carried out an anchor up stream, but failed in hauling her head sufficiently to the stream to enable the engines to work with effect. We then, before dark, likewise attached other anchors to the stern, holding the vessel to the three anchors, as it were on a pivot, with cables to the bow and stern. By dawn, we found her just at the lower end of the sand, afloat and riding to her heaviest anchor, the others having parted. The distance of sand, over which the current must have drifted us in the course of the night, was five furlongs. The way in which it may be accounted for is simple: it is sufficient to say, there will be few cases in which, if a steamer takes the ground on her return, in a rapid current of four to five miles, she may not, either by hauling upon her anchors, extricate herself by power of steam, or, in case of failure, manage by anchors, or some similar way, to drift into the channel, which must inevitably be formed by the mere force of the current under her bow and stern, and thus free herself."

both ways, in embracing almost every danger and difficulty, and the more satisfactory in shewing the manner in which they had been surmounted, notwithstanding a serious inconvenience in the bad steerage of the vessel. This was chiefly owing to an alteration in the rudder, just before starting. The boat being flat-bottomed, with a square stern, was originally furnished with a rudder, sinking nine inches below the bottom, (she had no keel) which was done to give it proper hold of the water: but Captain Johnston, naturally thinking it would thus be liable to injury, or to be unshipped in shallow places, had it cut even with the stern post, by which it lost nearly all power of steerage in a tide-way or strong current, and the defect was but partially remedied by widening it at the first station they came to. Captain Johnston suggested, that a remedy might be found by adding to the stern post, or by having a rudder on each quarter, or by fixing a small one in the bow, if it could be so placed without inconvenience. This, with other suggestions respecting an alteration in the position of the flues, the addition of a light poop and a lateral extension of the accommodations; and likewise his ideas regarding the superiority of the high pressure principle, the best form of a river steamer, and the advantage of making both ends alike, to give her the power of riding at anchor, with equal safety, by the head and by the stern, were referred by the Marine Board, for the opinions of those who were considered the most competent judges of such matters. Their answers will presently be noticed. Captain Johnston further recommended a permanent system of native pilots, selected from among the boat mangees, to be distributed in twenty-eight stations between the Bhagurutty and Allahabad, and that buoys, made of bamboos, or long poles, or gourds, or other light floating substances, should be laid down to mark the sand-banks and dangers; the buoys to be watched and shifted, when necessary, by the pilots. He concluded his letter to the Secretary, with some useful practical remarks on the precautions to be observed in navigating these rivers.

Captain Prinsep had taken the opportunity to compare the present channels of the river with the chart then in use, formed from the surveys of Rennell, with corrections by Major Colebrooke, between 1796 and 1801. His materials being thought valuable for a new chart, were ordered to be lithographed at the cost of Government,* which was done under his own eye, by a clever artist, Monsieur Tassin. In his report upon the expedition, he concurred with Captain Johnston, that the trial was made under every possible disadvantage, with the current at its maximum both ways, and the waters rapidly falling, on their return, at the daily rate of nearly a foot in the upper part of the river, where the chief danger was apprehended. The way in which the steamer had extricated herself from the sands, on the two last occasions of grounding, was evidence of her

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* One hundred and ninety-eight copies were struck off, including one hundred for Government, of which twenty were sent to the Court of Directors. The sale of the rest covered all the expenses.

strength and good qualities. He refrained from hazarding opinions upon the form and construction of vessels; but considered that the Hoogly, with some improvement in her steerage, was competent to the navigation of the Ganges, and that in future passages she ought never to exceed twenty days, of twelve hours' steaming, to Allahabad, when the rivers were full. He believed it would rarely happen, that she would not find the navigation open all the way up from Bogwangola, at the mouth of the Jellinghee, throughout the year: the Bhaguruttee was open to her four months, from July to October inclusive; the Jellinghee perhaps also in June and November: during the other months, the passage might be made by the Sunderbuns. The buoyancy of the Hoogly being four tons to the inch, and the weight of her two fifty-horse engines alone about fifty tons, there seemed to be advantage, with reference to buoyancy, in adopting a suggestion of Captain Forbes, to substitute a single engine of the power required, and to give it greater relative power by increasing the length of the cylinder, allowing the piston rods to work above the deck, as in the American river steamers.* He did not concur in his scheme of a double boat,† because it would necessarily be heavier in the materials and yet weaker, and it would be very liable to strain by grounding upon a bank.

Captain Prinsep's Memoir having been printed in an enlarged and improved form, to accompany the sheets of his map, it is the less necessary to give it in detail. There is however much matter in it that we shall have occasion to abstract in our concluding Chapter, when we endeavour to trace a comparison between the navigation of the Ganges and that of the North American rivers.

It had been contemplated that the experimental voyage should be extended to Cawnpore, provided, on the arrival of the Hoogly at Allahabad, such information should be furnished by Captain Smith, as might remove all apprehension of danger in proceeding. This depended upon the depth and strength of the river, from its confluence with the Jumna, at the Fort of Allahabad, to Papamow, which, for that short distance, flows in a race over a shifting channel in the dry season, and was supposed to have a very strong current in the rains. Captain Smith satisfied himself by a series of measurements, taken for the purpose, from the end of August to the end of September, that there was then every where a channel ~~of~~ *from* twelve to twenty feet deep, with an average stream rarely amounting to four miles per hour: at one spot only, and on but one occasion he found its rate increased to seven. As this survey was made after the river had begun to fall, it

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* A plan not peculiar to the United States.

† The principal advantage held out by this plan was, that when the steamer took the ground, it would be more easy to get her off, by shifting the coals and stores from one boat to the other, if she touched on one side only: the removal of the coals would, in general, be sufficient.

might be considered practicable for steam navigation, from the early part of July to the end of September. But as it had continued to fall nearly a foot every day, up to the date of the Hoogly's arrival on the 1st October, leaving only nine feet in the channels, which a short time before had contained fifteen, he recommended Captain Johnston not to attempt further progress; since, although there might still be sufficient water for the run, there was great risk without an adequate object.

The experiment had this satisfactory result, that, with better arrangements for fuel and pilots, and with the information it had produced regarding the courses and state of the rivers, the fact had been established beyond a doubt, that either of the steamers, constructed as they were, could make a complete voyage to Allahabad and back within a month, during the rains, at small hazard. The expense incurred in the acquisition of so much valuable information, was but a trifle, and scarcely more than the cost of the fuel, as the Officers employed, derived all their allowances from their other duties. It was thought necessary to examine the bottom of the Hoogly, and she was docked for that purpose, but did not appear to have suffered any injury.

We have said, that Captain Johnston's suggestions for improving the steerage and accommodations of the Hoogly, were referred to various individuals. These were, the Master Attendant, Captain Forbes, Captain Ross, (the Marine Surveyor General), Mr. Seppings, and Mr. Kyd. The first was of opinion, that the proposed alterations would cost twenty thousand rupees, and yield no correspondent advantage; and, although he thought the plan of backing the stern post, might somewhat improve the steerage, he did not consider it possible to make a vessel of her form steer well. Captain Forbes objected to reversing the position of the furnace grates, as a mode of diminishing the oppressive heat of the cabins; both because it would lessen the draught of air through the chimney and flues, and because the stokers would be separated from the eye of the engineer. In proof of the importance of that supervision, he stated, that he had ascertained, by repeated experiments, a difference of twenty to twenty-five per cent. in the consumption of fuel, between stoking managed by a practiced European, and over-stoking common with native Kalassees. Such an alteration in the boilers would also throw more weight forward, which was to be avoided, as the vessel was already too much by the head. The object of lessening the heat of the cabins might be better attained by a double bulk head,* stuffed with horse hair or wool, as in European passage boats. Captain Ross had not observed that the Burhampootur laboured under any particular defect of steerage;† he conceived

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* Captain Forbes was not then aware that the Hoogly was built with a double bulk head.

† It cannot, however, be said that she steers well; nor could it be expected, from the form of the two vessels, that she should steer much better than the Hoogly did before her rudder was first altered.

that the Hoogly would be much improved in that respect, by backing the stern post and using paddles on the quarters, as suggested: he objected to any alteration in the machinery that would increase the weight forward, and apprehended that Captain Johnston's plan of cutting down the after-part of the vessel and extending the cabins laterally, would weaken her, and cost more than to give her a light poop, which to him appeared preferable on every account. Mr. Seppings pointed out a way, in which the accommodations would be sufficiently enlarged and improved by a light poop, without the heavy expense that must be incurred upon Captain Johnston's plan, which interfered with some of the principal fastenings; and he proposed to add nine inches to the keel abaft, tapering it away forward, besides adding to the stern post: the whole work, he thought, might be done for four thousand rupees: he further recommended, that the windlass of the Burhampootur should be fitted on the plan of the Hoogly's, which gave it greater power to heave off in case of taking the ground. Mr. Kyd attributed the defective steerage of the Hoogly to a fault in the construction of her lines abaft, for which there was no complete remedy: some benefit, however, would arise from adding three or four feet to the stern post, giving her a keel of a foot in depth abaft, and fixing a Budgerow rudder to each quarter: the heat in the cabins might be mitigated by a water jacket to the chimney and a non-conducting bulk head. He objected to the other alterations, on the same grounds as Captain Forbes and Captain Ross; they would require an outlay of fourteen or fifteen thousand rupees: unless it were deemed advisable to increase her length, he did not think it worth while to alter a vessel, for the mere purpose of giving her the power of anchoring with equal facility by the head and stern: in building a new vessel, it would certainly be an improvement so to manage the height as to get a double tier of cabins as low as possible.

The Marine Board, in handing up these opinions, expressed themselves adverse to any expensive alterations. The bad steerage of the Hoogly, on the late expedition, might be partly owing to the eddies of the rivers; but with a flat-bottomed vessel of light draught, the dead water must extend so far aft, as to render it hopeless to make the rudder very efficient, however large: a rudder in the bow, seemed the best remedy, and a substantial tent made to fit the after-part of the boat, would answer every purpose of a poop, be easily removed at any time, and cost very much less.

The whole matter being taken up early in December, it was settled to limit the alterations in the Hoogly to the following,—the substitution of a sliding rudder, experimentally, of sufficient depth to hold the water, and give the same power of steerage which her first rudder had, and which that of the Burhampootur still possessed,—and to put on a light poop, similar to those of the river steamers: it was conceived, she would thus become a serviceable vessel, for the conveyance of six or eight Officers of the junior

grades, to their stations up the river. It was further resolved, that she should be fitted out for a second trip, in the same direction, with a view to ascertain the difficulties of the navigation in the opposite season; the voyage to be commenced as soon as time should have been allowed for supplying the coal depôts on the route. The Marine Board was directed to prepare accordingly, and to issue notices to the public, inviting freight of treasure and other valuable goods and light parcels;—and, as it was supposed the stream of the Ganges would have abated in force, two miles per hour, there seemed reason to hope that it would be found practicable for her to take a large Budgerow, or some other accommodation vessel in tow. It was therefore determined, that, in the meantime, experiments should be tried with the Burhampootur, to prove the degree of retardation produced by tugging.

These were commenced by Captain Clapperton in February, and followed up by Captain Johnston in April, on his return from a voyage in the Enterprise to the Straits of Malacca, with the Governor General; but, as the result was not obtained in time, it was arranged to despatch the Hoogly unencumbered, as before. The building of the poop at the Howrah Dock, and the construction of the new rudder at the Kidderpore Yard, on the plan approved by Government, were completed by the end of February: but the Board represented, that the progress of the coal boats to the distant stations would be so slow, some delay having occurred in their despatch, that perfect security of their arrival in time for the steamer might require that she should not start before the 25th March, or 1st April. By direction of Government, the coals were forwarded in detached boats, furnished with distinguishing flags, which were ordered to proceed with all expedition to their several stations, and there to wait for the steamer, without unloading, much inconvenience having attended the receipt from depôts on shore. The quantity and stations had been settled in consultation with Captain Prinsep,* and the Board hoped no disappointment would arise, even though the date fixed for the departure of the Hoogly should be as early as the 18th March. The surplus of what the steamer should take, would be landed for the return voyage, to avoid a heavy demurrage: this incon-

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* Jessore, Culna, ... 400 Maunds.
Commercolly, or Custee, ... 400 ,,
Rajmahul, ... 400 ,,
Monghyr, ... 400 ,,
Dinapore, ... 400 ,,
Ghazeepore, ... 400 ,,
Mirzapore, ... 400 ,,
Benares, remnant of former supply, ... 300 ,,
Culna, to be furnished for the steamer's return, ... 500 ,,
And she would start with a supply for eight days.

venience, it was observed, might be wholly obviated in future, by employing the flats of the Arracan expedition, which had been ordered back from that coast.

The Board asked the instructions of Government, whether it was intended to offer shippers of freight the advantage of a guarantee. As the nature of the risk was not understood by the natives, and the real danger of loss or damage was very small, it was deemed expedient to tempt them with an assurance of safe delivery, with the seals of packages unbroken. Even this did not induce the offer of a single package of value. No inference, however, can thence be fairly drawn, unfavorable to the aptness of this kind of conveyance, or the disposition of the natives to employ it: time is so essential an item in matters of remittance, that it could not be expected, that merchants and Shroffs would commit their treasure to a boat, whose safe arrival they regarded as little short of a miracle. No rate of charge was fixed: by enquiries in the Bazar, it was supposed, that a freight of two per cent. to Benares, and rateably to other stages, would be freely submitted to, when the certainty of these voyages should be sufficiently established. The actual expense of remitting a large sum in specie to Benares, by native boats, does not exceed two and a quarter per cent., insurance included; but the difference in time is worth half per cent. more. The usual plan is to send treasure in *Pulwars*, engaged for the purpose, with a numerous crew and strong guard of Birjobasses, under charge of a Jemadar, or other dependent of confidence. Although such arrangements may be economically managed on a large scale, the per centage cost, and risk must increase inversely with the amount: the expense of a *Pulwar* to Benares, with the wages of the guard and crew, calculated for a voyage of eight or ten weeks, is about six hundred rupees, exclusive of insurance. Losses of magnitude do sometimes occur, from accidents of navigation, as

	By Steamer.	Total from Calcutta.	By Coal Boats.	Difference in starting time required by Coal Boats, compared with the Steamer
Time from Calcutta to Culna, ...	7	7	14	7
Thence to Custee or Commercolly, ...	2	9	20	11
,, Rajmahul, ...	3	12	32	20
,, Monghyr, ...	2	14	42	28
,, Dinapore, ...	2½	16½	50	34
,, Ghazeepore, ...	2½	19	60	41
,, Mirzapore, ...	2½	21½	75	54
,, Allahabad, ...	2	23	0	0

well as by fraud and robbery. A boat carrying a lakh of rupees, despatched by one of the principal Shroffs in Calcutta, was sunk and totally lost, with its freight, about three years ago.

The Hoogly started again on the 17th March, under the sole direction of Mr. Warden, who, it has been stated, lately commanded the Company's yacht Nereid, and had acted under Captain Johnston on the former voyage. The Nuddea rivers being then all impassable to a vessel of her draught, she proceeded by the Doagra in Channel Creek, through the Sunderbuns, and reached Benares with some difficulty, in twenty-one days: thirty-seven miles further on, her progress was stopped at a place called Betoulee, or Kutchwa Ghaut, where there was no channel deep enough for her. Returning to Benares, she remained seventeen days to refit, and descended the river in fourteen days, including the passage by the same track through the Sunderbuns, and from Saugor to Calcutta, where she arrived on the 12th May.

At starting, she drew four feet three inches forward and three feet six inches abaft, with five hundred maunds of coals on board, besides about twenty-two tons weight in provisions, fire-wood, baggage, freight and passengers: the freight consisted only of fifteen packages going up, chiefly on public account, and thirteen for private individuals on her return; she carried nothing for natives. Her lightest draught, during the voyage, was four feet one inch forward and three feet three inches aft, which gave her only two more revolutions, and made little alteration in the steerage. The new poop was not found to cause much impediment to her progress, scarcely more than a common awning would have done, when steaming on the Ganges against a strong westerly wind, which was generally blowing most part of the day. The new sliding rudder fully answered the purpose, though it did not make her steer well: the advantage of the slide was put to the test when the vessel touched on a knowl of sand a little above Buxar: the rudder was instantly forced up by the sand, and quickly fell to its former depth as the water deepened. Mr. Warden thought the stern post should still be added to, and that rudders on the quarters would improve the steerage, but feared they would be in the way, in some cases, and very liable to injury.

In his report upon the voyage, he stated, that the coal stations in the great river had been judiciously chosen; but all the boats, destined for places higher up, were overtaken at Monghyr, which obliged him to load the steamer there to a draught of four feet four-inches by three feet eight inches. The first depôt at Bissuntpore, an extra station adopted in the Sunderbuns, he recommended to be discontinued, as it obliged vessels to leave the lower route and pursue a middle course by Manick Khall, Goodlad's Creek and Chandcolly, which, although the Hoogly passed through with some advantage, having the tide

in her favor, were subject to chances of detention, being only flood passages impracticable at low water: besides, Goodlad's Creek was so narrow, that a steamer of the size of the Hoogly could not escape touching on both sides, which happened to her several times. The Chandcolly Creek, with deep water, was also too narrow and circuitous for such a vessel: the Hoogly lost her jolly boat there, by the branches of a tree tearing it from the stern davits, while she was rounding a sharp point. For these reasons he preferred the lower Sunderbun route, notwithstanding its greater length, and he believed that he should have reached Kulna almost as soon by that passage. Kulna was the second coal station, and a very convenient one, as the steamer could load alongside the bank; an intermediate depôt was unnecessary: there the boilers were cleaned, having been used thus far with water partially salt. The Madomutty was found to be a fine deep river, with no impediment, except in four places, from Momutpore downwards, where strong fishing stakes had been fixed across the stream, leaving only a boat passage of twenty feet; the Hoogly's paddles were injured by them: the depth of the channel was only nine feet below the lower line of stakes, and an immense sand had been accumulated thereby. The vessel arrived at Commercolly on the 23d, having steamed at an average rate of five miles and three quarters per hour, and the same day entered the Ganges at Koosthea.

Mr. Warden considers the Sunderbuns particularly adapted to steam navigation: in passing through them, it was scarcely ever necessary to stop or slow the engine, and after a little practice the charts would suffice without a pilot: but the smaller creeks should not be entered towards night, since there was as much danger at anchor as in steaming, from the large overladen and unmanageable wood boats falling down with the tide, which runs between three and four miles an hour in the springs; an accident of this kind happened to the Hoogly: it was necessary also to look out in the creeks, for stumps and roots of trees projecting from the banks. He suggested a method of fitting an iron guard rail for the protection of the paddle wheels, and recommended that steamers for this navigation, to reduce the length fore and aft, should have their boats on the quarter instead of astern. Many large logs were observed in the great river, a few inches under water, fixed in the centre of the channels.

Above Monghyr, between Dulolpore and Rajowlee, the river had taken a new course since the last trip. Considerable detention occurred at Dinapore, owing to the necessity of communicating with the Authorities at Patna, a distance of seven miles, which might be avoided. On leaving Dinapore, the danger of proceeding was so great, from the ignorance of the pilots, that it was deemed prudent to work with a single boiler, and the progress that day was only eight miles; whereas the next day, with a good pilot, it was fifty-four. The most, and, in Mr. Warden's opinion, the only dangerous part of the Ganges was between Ghazeepore and Benares, on account of the shoals of Kunkur rock, which lie off Kyte, where the soundings are very irregular and the channels very narrow. Quitting Benares on the 9th April, at her lightest draught of four feet one inch forward, and three feet three inches abaft, the Hoogly passed Chunar, and the

same evening arrived off Kutchwa. Here a shoal extended completely across the river; the remainder of the evening and half the next day were employed in examining it, and only two feet six inches of water were found in the deepest part. There were three native boats aground on the shoal, two of which were obliged to unload before they could get over: all the boats, of which a great many were seen, took the same channel; it was thence known to be the right one: none escaped grounding whose draught exceeded two feet. Chunar, consequently, by Mr. Warden's report, is the highest station to which a steamer, of the present construction, could ascend at that season. The river was then at its lowest, with a current of one mile per hour at Kutchwa, about two at Dinapore, as much as five for a short distance between the sands off Surajgurra, and two and a half in the lower parts of the Ganges: it had begun to rise by the time the Hoogly returned to Rajmahul on the 8th May. Her progress from Laulpore to Benares, averaged three miles and a half per hour, and the expenditure of fuel from Calcutta to Benares amounted to one thousand nine hundred and fifty maunds of coals, and two hundred and fifty of wood.

On the return, Mr. Warden adopted Captain Johnston's plan of using the kedge for a stern anchor, and keeping one boiler unemployed; the other he was seldom able to work at full power for any long time. The poop was now a considerable impediment to the steerage, although the wind, which blew a gale in the middle of the day, was favorable; but this disadvantage was more than balanced by the convenience of its accommodation: as, however, the heat was still very oppressive, *being generally one hundred and four* in the cabin during most part of the day, he suggested the addition of a light *half-inch* under-deck, like the double top of a palankeen carriage, with a space of four to six inches for a free passage of air between the two decks, and a shifting partition across the cabin, which was at present undivided. The cabin doors and all the wood casings were split and shrunk by the dry heat. In spite of the precaution of stopping and slowing the engines, and sending out boats when the water shoaled, the vessel grounded several times in descending the stream, which, in many places, was but four to five feet deep in the best channels, but sustained no material injury therefrom. The navigation, even at this season, might be conducted with confidence, if good pilots were procurable: great advantage having been derived from temporary arrangements for pilots during the detention of the boat at Benares, he was induced to submit a scheme of pilot stations,* which,

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* 2 Pilots from Calcutta to Kulna.
2 Ditto ,, Kulna to Laulpore.
N. B. Boats unnecessary for the above.
2 Ditto and Boats from Laulpore to Bogwangola.
2 Ditto.... ditto .... Bogwangola to Mohungunge,
2 Ditto.... ditto .... Mohungunge to Rajmahul.
2 Ditto.... ditto .... Rajmahul to Corn Golah.
2 Ditto.... ditto .... Bagulpore to Monghyr.
2 Ditto.... ditto .... Monghyr to Bar, or Rajwalee Ghaut.
2 Ditto.... ditto .... Bar to Dinapore.
2 Pilots and Boats from Dinapore to Revelgunge.
2 Ditto .... ditto .... Revelgunge to Bhulea.
2 Ditto .... ditto .... Bhulea to Ghazeepore.
2 Ditto .... ditto .... Ghazeepore to Kyte.
2 Ditto .... ditto .... Kyte to Benares.
2 Ditto .... ditto .... Benares to Chunar.
1 Ditto .... ditto .... Chunar to Mirzapore.
1 Ditto .... ditto .... Mirzapore to Poolwarrea.
1 Ditto .... ditto .... Poolwarrea to Sursa.
1 Ditto .... ditto .... Sursa to Allahabad.

under the superintendence of three or more Europeans, provided with fast-pulling covered boats, would, he thought, be a very efficient and useful establishment. He conceived that the class of men, called Jaulpulwarreahs, were the best qualified for the duty, and that they would be satisfied with the pay of Lascars.

The rate of return progress was nearly five miles per hour on the Ganges, with one boiler, and about six and three-quarters with both, through the Sunderbuns; and the expenditure of coals nine hundred maunds, from Benares to Calcutta.*

The Marine Board, in their remarks upon Mr. Warden's report, contrasted the relative progress of the two expeditions from station to station, and drew the attention of Government to the curious and very unexpected fact it seemed to establish, that the shallowness of the river, confining navigation to the main channels, with the necessity of

*Departed from.	Arrived at Coal Depôts.	Hours Steaming.	Distance by Chart.	Fuel received.	
				quantity.	description.
Calcutta, ... 17th March, ..	Bussuntpore, 19th	27 15	190 Miles.	200 Mds.	Coal.
Bussuntpore, 19th ,, ..	Kulna, ... 20th	15 0	75 ,,	150 ,,	,,
Kulna, ... 21st ,, ..	Commercolly, 23d	22 0	106 ,,	250 ,,	,,
Commercolly, 23d ,, ..	Rajmahul, .. 26th	30 50	153 ,,	250 ,,	,,
Rajmahul, .. 27th ,, ..	Monghyr, .. 30th	39 15	123 ,,	420 ,,	,,
Monghyr, .. 31st ,, ..	Dinapore, .. 2d April, ..	30 20	96 ,,	250 Mds.	Wood.
Dinapore, .. 3d April, ..	Ghazeepore, 6th ,, ..	40 0	123 ,,	150 Mds.	Coal.
Ghazeepore, 7th ,, ..	Benares, ... 8th ,, ..	18 25	66 ,,	100 ,,	,,
Benares, ... 9th ,, ..	Bettowlee, .. 9th ,, ..	10 55	37 ,,	0	
Bettowlee, .. 10th ,, ..	Benares, ... 11th ,, ..	9 0		0	
Benares, ... 27th ,, ..	Ghazeepore, 28th ,, ..	12 15		150 ,,	,,
Ghazeepore, 29th ,, ..	Dinapore, .. 1st May, ..	29 15		200 ,,	,,
Dinapore, ... 1st May, ..	Monghyr, .. 3d ,, ..	24 10		200 ,,	,,
Monghyr, ... 3d ,, ..	Rajmahul, .. 5th ,, ..	22 45		150 ,,	,,
Rajmahul, .. 8th ,, ..	Commercolly, 8th ,, ..	25 0		100 ,,	,,
Commercolly, 9th ,, ..	Kulna, ...10th ,, ..	16 0		100 ,,	,,
Kulna, ... 10th ,, ..	Calcutta, ... 12th ,, ..	38 0		0	
		410 25	969 Miles.	2420 Mds.	Coal.
	And returning,		969 ,,	250 Mds.	Wood, as above.
	Total,		1938 Miles.	2670 Mds.	

greater caution, rendered the progress of a steamer slower in the dry season than in the freshes, and stated their apprehension that it would never be otherwise unless steamers should be contrived of extremely small draught of water. The Board did not support the suggestion of a permanent river pilot establishment, conceiving that timely notice to the local authorities would secure the necessary assistance in future.

CHAPTER V.

The notes and observations of Mr. Warden, on the late expedition, afforded useful additions to Captain Prinsep's chart, which was then under preparation, and Government very justly commended the skill and intelligence he had displayed. Some disappointment was experienced on finding so little water in the Ganges in the dry season: it was satisfactory, however, to have ascertained the real state of things, and the minimum depth of the channels. It was now clearly desirable that a less draught of water should be given to steamers, destined for inland navigation in Bengal; and the tug system and the use of high pressure engines, were considered likely to facilitate this object. But before deciding upon a reference to England, for engines of that description, it was thought proper to ascertain how far the object might be attained with those of low pressure, which were then at command. The Marine Board were directed to consult the best informed Officers in their department, and to obtain such other information as might be available. They accordingly addressed the following queries, separately, to Commodore Hayes, Captains Ross, Forbes, Johnston, and Collie, and to Messrs. Kyd, Seppings, Mackenzie, and Jessop.

1st. Will it prove advantageous to have tugs separate from the vessels of accommodation?

2d. What is the best form and construction for a river tug, capable of taking in tow a large accommodation vessel, and having the smallest possible draught of water?

3d. Can the engines of the Ganges and Irrawaddy be made available for interior navigation? And to what purposes may those vessels be applied, when stripped of their engines?

4th. Can the engines of the Hoogly and Burhampootur be more advantageously adapted to Government service, by placing them in other vessels? And to what purposes may those vessels be applied, when stripped of their engines?

5th. Is it desirable to introduce high pressure engines for the purpose of interior navigation? What are their advantages and disadvantages?

All concurred in the advantage of separate tugs, which would protect the passengers from the effects of accidents on board the steamer, and save them from the serious inconvenience of the heat of her fires. The Master Attendant conceived, that the best form of a river tug was that of the country Oolaks, built upon Annesley's plan,* and that in all countries the natives would be found to have shaped their vessels in the forms most suitable to their local navigation. He recommended, that the engines of the Ganges and Irrawaddy should be transferred to new vessels, to be built expressly for ship tugs, and that those vessels should be added to the pilot establishment, which, he complained, was falling into decay. The engines of the Hoogly and Burhampootur would serve for the river tugs, which, he thought, might be constructed to draw less than three feet water: the first would make a good accommodation vessel, drawing only two feet, and might be towed with ease by the Burhampootur. With high pressure engines, which he understood to be one third less in weight, the draught of the river tugs might be reduced to two feet six inches.

Captain Ross believed the Hoogly would draw only eighteen inches when stripped of her machinery, and no more than two feet with one hundred men on board, their arms, &c. and provisions for a short trip. He thought her well adapted for such service; but objected to making pilot vessels of the sea steamers, as their relative breadth was six feet less than that of sailing vessels, which would render them crank under masts and sails of the usual proportions: besides, he imagined, that the necessary alterations would involve a heavy expense.

Captain Collie, the Deputy Master Attendant, answered in accordance with the Commodore; except that he was more apprehensive of danger from the use of high pressure engines, and believed that frequent accidents did occur in America, which caused them to be often replaced with engines of the other principle.

Mr. Kyd agreed, that the two river steamers might be converted into good accommodation boats, at small expense; but suggested, that if the engines of the Hoogly were taken for the new tug, the Burhampootur, by adding three feet to her keel, secured to the bottom with curved chocks, might be rendered an excellent craft for the duty of the port, to communicate with and despatch the Company's ships at Saugor, tug vessels of moderate size, and navigate the Ganges in the freshes. He was of opinion, that vessels might be built to carry the engines of one or both of them, not exceeding a draught of

* Planks crossing each other diagonally, or at right angles, without timbers.

three feet, with speed sufficient for inland river tugs. The best form was that of a canoe, the model on which every boat on the Ganges was constructed, varying only in the proportions of length and breadth. It did not appear that Government had any purpose of building ship tugs, nor did he believe they could be made a source of pecuniary profit against private competition. The Ganges and Irrawaddy, if not wanted as sea-going vessels in time of peace, might be converted into pilot brigs to wear them out, and their engines might be sold or put in store. On the subject of high pressure engines, not having been in England since 1815, he could form no opinion, except by observing, that they were extensively used for carriages in English collieries, and very generally for boats in America, which induced an inference that they would be found advantageous for inland navigation here.

Mr. Mackenzie was equally incompetent to afford information on the subject last mentioned. He approved of the form of the Hoogly and Burhampootur, should their mode of construction be adhered to: by adding a little to the length and breadth, making them respectively one hundred and ten, ~~and one hundred~~ feet and twenty feet, sufficient buoyancy might be given to a tug, carrying the engines of either; but he doubted, whether a tug of adequate power would thus be obtained. Annesley's plan of building might lessen the difficulty, combining, as it did, the desirable qualities of the native craft, with the strength and durability of European workmanship. If correctly followed, there would be no risk of failure; but the wood must be carefully selected and very well seasoned, and good workmen must be employed to lay the coats between the courses of planking with the greatest nicety: this would be the more necessary, in proportion as the size of the vessel were increased. It would be expedient to prepare at once for seasoning, a sufficient quantity of plank for the large vessels, and, in the mean time, to practise the workmen in building small boats for them on the same plan. The steam tugs, and the accommodation boats, he would have of the same size,—one hundred, or one hundred and ten feet by twenty, and fix the machinery as little connected with the hulls as possible, so that it might be removed from one into the other with facility. Either the Hoogly, or Burhampootur might now be converted into a mere accommodation boat, and, he conceived, they would be found very serviceable, and much useful experience would be gained by their being employed in towing each other. The Ganges and Irrawaddy would become respectable ship tugs, if divested of their poops, forecastles and heads, and of all other weighty material capable of being detached: he also thought they would make good pilot vessels. Mr. Mackenzie recommended a reference to Annesley's published Treatise for the best mode of fitting accommodation boats. They might be protected from injury in grounding, and also be much improved in sailing, by giving them bilge keels, fitted parallel to and of the same depth as the central bottom plank. He concluded his paper with a suggestion, that bamboos might be advantageously employed for lightness in the decks of the tugs, with painted sail-cloth underneath.

Captain Johnston thought the Ganges and Irrawaddy capable of being turned into pilot vessels, but their engines could not be adapted to river boats without much alteration. Those of the Hoogly and Burhampootur would answer for the proposed tugs, and the vessels themselves would make tolerable accommodation boats; or they might serve for the conveyance of fuel to the depôts. He preferred another form for the tugs, of which he furnished a plan and model, calculated to combine great buoyancy with sufficient strength, and to secure flotation on an even keel, by means of elliptical and other trussing: he hoped thus to get rid of much weight of material with which Indian steamers hitherto were encumbered. The dimensions of the tugs and accommodation boats should not exceed one hundred feet by twenty-five, with a draught of two feet, allowing the former to carry eighty-five tons in the weight of her machinery and fuel. A very light draught had this important advantage, that it enabled the boat to keep out of the strength of the current, and thereby doubled and trebled her progress in ascending many parts of the river. On the subject of high pressure engines, he could afford no information. Captain Johnston submitted separately, an elaborate report upon the defects and good qualities, and upon the past services* and future employment of the three sea-going steamers, in which, with reference to the declared unfitness of the Enterprise for the purposes of the Bombay Government, he shewed the practicability of making them all cover their expenses in the Bengal service, even in time of peace, provided their establishments were reduced to a scale he now proposed, and that care were taken to keep them constantly in that employment which appeared to be open to them. He further stated, that the boiler of the *Enterprise, being one mass of* enormous weight, (thirty-two tons) could not be removed without pulling her to pieces.

Mr. Seppings, adhering to what he had written in his former reports, deprecated any material alterations in the Ganges and Irrawaddy, by which two useful vessels, fit for general sea service, would, in regard to their utility, be destroyed. He was also of opinion, that the weight and construction of their engines, rendered them perfectly unfit for vessels adapted to river navigation. He conceived, that two vessels might be constructed to steam against the currents of the Ganges, with the engines of the Burhampootur or Hoogly, drawing not more than three feet; to be used either as tugs, or accommodation boats: but, as the present steamers had been proved to be capable of that service, and the accidents of grounding, to which they were exposed, were not likely to injure them more than by rubbing off a few sheets of copper, he recommended, that they should remain as they were. The best form, to secure the smallest draught of water, was clearly a square box, or rectangular section in midships, with an entrance and run to lessen the resistance and improve the steerage. He thought an efficient tug could not be built of less draught than from two feet six inches to two feet nine inches, if condensing engines

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* Appendix I.

were used of equal weight with those of the Hoogly and Burhampootur : of such a vessel he submitted two plans. He feared that a draught of two feet could only be obtained by such a sacrifice of strength, as would render the steamer a disjointed piece of wood-work after a few trips. In support of this opinion, he referred to Captain McKonochie's work on steamers, who had said of tugs, that " they must have substance as well as power, bone as well as blood." Mr. Seppings was strongly in favor of high pressure engines, from their greater compactness and less weight, a property not so essential on the rivers of North America and England as in this country, and attributed to mere prejudice ~~of~~ the common feeling against them. He proposed, however, that the matter should be referred home to a Committee, consisting of Mr. Gurney, Mr. Maudeslay, and SirRobert Seppings ; that drawings of one of the present river steamers should be laid before those gentlemen, with the particulars of the component parts of her hull, &c., that three* feet should be the utmost limit assigned them for the draught of water, with coals for four days of twenty-four hours, and twenty tons of stores, and that their report should precede any further experiments in building. He likewise thought it would be advisable, that the Bengal Government should send some qualified person to the United States, who, after obtaining information regarding the steamers of that country, should proceed to England, and report to the Committee the result of his enquiries. Mr. Seppings gave in a model to shew the principle of ship-building which he had applied to the Hoogly. He would have blended it with Mr. Annesley's plan of alternate layers of board without frame timbers, which he had recommended for an accommodation boat,† if it had not been his object to give her the greatest buoyancy, which object could only be obtained by a rectilinear figure instead of a regular and gradual curve, and this was incompatible with Annesley's method of building.

Mr. Jessop, believing that the Ganges and Irrawaddy were convertible into pilot vessels, thought it would be worth while to devote the engines of one of them to a sea-going vessel, better adapted to general purposes and to tugging. He calculated the expense of shifting them at eight thousand rupees. The two river steamers, without

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* Mr. Seppings has since professed an opinion, that steam tugs for these rivers should not exceed a draught of two feet, and that to give them sufficient power with the requisite buoyancy, they should be furnished with high pressure engines of one hundred horses' aggregate power. Vide Appendix K. J

† Two models, with drawings, had been sent in by Captain Johnston and Mr. Seppings in June 1829, intended for accommodation boats, of capacity for above two hundred men. They were both highly approved; but the preference was given to that of Mr. Seppings, the dimensions of which were one hundred and thirty feet by thirty, with an estimated draught of eighteen inches; and tenders were invited for the construction of a vessel, by contract, after his plan. The lowest tender, however, being little short of half a lakh, Government was unwilling to incur the expense, and no further proceedings were had thereon.

their machinery, were of the proper size to be towed by such vessels of improved form, as their engines were adapted for: boats of the size proposed, would require more powerful engines, and would much exceed the prescribed draught of water; whereas those of the Hoogly or Burhampootur might be fixed in a boat drawing only two feet. The best form for a ship-tug was that of the Margate steam packet, with a long flat-bottom, drawing five feet, and having engines of the same power as those of the Ganges and Irrawaddy. For the smaller engines, a good river tug might be constructed of iron, or it might be made of iron ribs, with planked sides and deck, in both cases more buoyant than a wooden vessel. High pressure engines he believed to have fallen into disuse in England, on account of their insecurity. Their chief, if not their only advantage, consisted in their having but half the weight and bulk of low pressure engines; but they consumed more fuel than the latter. The waters of the Ganges corroded the valves, cocks, &c., with great rapidity, an inconvenience which he attributed to their muddiness, and to some mineral acid, but which may be sufficiently explained by the quantity of sand they hold in suspension, and by the high temperature and humidity of the climate. This inconvenience caused a great loss of steam, and the necessity of frequent repairs. It would be worse in high pressure engines, on account of their metallic packing, and in them the waste of steam would be infinitely greater if the fittings were imperfect. He apprehended too, that the metallic packings could not be replaced in this country when out of order, and that the danger of using such engines would be enhanced by the difficulty of procuring sober and attentive persons to take charge of them.

Captain Forbes doubted not that the Ganges and Irrawaddy might be made pilot vessels, and that as steamers they would be improved by cutting them down, but they would never be powerful tugs. The engines of one of them might be used separately in light draught river tugs, giving them new boilers, which could be made partly with plates of copper rolled at the new Mint, and partly with the material of the old ones. Engines in a steamer, he observed, work more steadily in pairs than single, without a fly-wheel; but a single engine of forty-horse power, would weigh one-third less than a pair of twenty. Those of the two steamers in question, being of the former size, would be large enough for the sort of tugs best adapted for the river. New paddle-wheels and a new shaft, might be made of a lighter construction. The boiler should be flat, or it might have an elevation, exclusive of the steam head, not exceeding four feet and a half. He conceived it possible to contrive such a vessel with capacity for twenty tons of coals, clinker-built, or of metal, so as not to draw more than two feet. The principle he proposed to apply, was a system of trussing, calculated in itself to support the weight of the machinery, and to distribute it uniformly over the bottom of the vessel, which would be also strengthened by the truss: upon this plan, even a country cotton boat would bear the weight of an engine of moderate size. He was preparing a model of a tug so trussed, and would submit

it when finished. Were Government to build two such vessels for the engines of one of the sea steamers, and a third for the two small ones of the Hoogly, they would have three good tugs, embodying all the principles which experiment had shewn to be beneficial, without the necessity of more engines from England. The Hoogly, with the addition of a keel and ports, would be applicable for the conveyance of troops from Saugor, towed by the remaining sea-steamer to Calcutta, and from Calcutta upwards by one of the new river tugs.

Captain Forbes considered the boilers of high pressure engines very liable to burst when new, and certain to explode when old ; and that such engines were objectionable also from their more rapid wear and tear, and from the greater expense, as well as frequency of repairs. Until they should have been improved and become generally used for navigation in Britain, he thought it would be injudicious to attempt their introduction on the Ganges ; especially as the desired lightness of draught, the only object for which they were preferable, could be obtained without them. The most economical boat and marine engines used in America and in England, were those of low pressure. He was satisfied from the late experiments, that steamers, with a low pressure engine power of forty to fifty horses, could be constructed of sufficiently light draught (little exceeding eighteen inches) to navigate safely and beneficially between Calcutta and Allahabad.

The Marine Board, thinking it unnecessary to comment upon the various matter contained in these opinions, confined their remarks to the Ganges and Irrawaddy, which they did not deem it expedient to alter, either for the purpose of obtaining a better ship tug, or with a view to their general usefulness. If one of them were converted into a river tug, her establishment might be reduced ; but much time would be lost in refitting her for sea on an emergency. The Board could not advise the expense of building other vessels for their engines : they believed that, when those engines were ordered, no definite description was given of the service to which the vessels would be applied. Were it a question to build them anew, a more useful form of construction might perhaps be adopted. They certainly were convertible into pilot vessels, but would not ride out a gale at anchor so well as the regular brigs of the establishment.

To promote further the desired object, pending the above reference, the public were invited, by advertisement, to send in plans of vessels capable of being used as river tugs, with engines similar in weight and description to those of the Hoogly and Burhampootur ; and likewise of tugs furnished with high pressure engines. For the best plan of each kind a premium of one thousand rupees was offered, the test of excellence being speed, light draught, and good steerage ; and the tenders were to be submitted to the Marine Board before the 1st August.

Eight plans were received in consequence of this advertisement. They were referred to a Committee, composed of Captain Ross of the Marine, and Captains Hutchinson and Prinsep of the Engineers, who gave their unanimous vote in favor of a plan of Captain Cowles for a steam tug, on the low pressure principle. Calculating her displacement, they found her competent to hold the engines and stores of one of the present river steamers, computed to weigh eighty tons, at a draught of only two feet, although the boat, to increase her strength, should be allowed seventy tons of material instead of forty-nine, assumed in the drawing. The success of Captain Cowles' plan was owing to his having adopted the simple truss principle, which, distributing the weight equally over the whole mass, was considered by the Committee to have, for the purpose in view, a decided advantage over the diagonal construction, which had been adopted in building the Hoogly, as the latter evidently required more timber than the truss. The Committee took occasion to observe, that the diagonal construction of the Hoogly, which had secured her from longitudinal weakness, extended only half-way up the sides, and therefore could not assist in supporting the machinery, except as it strengthened the general frame of the vessel. Although they were far from questioning the well-established merits of the diagonal system of Sir Robert Seppings, they were unanimous in preferring the simple truss principle for vessels of flat straight sides and flat bottoms. This opinion, it will be remembered, is in accordance with one previously given by Captain Forbes.

Mr. Macnaught was considered the only competitor who had in any way complied with the terms of the notice, in his plan No. 2, for a high pressure tug. His method of placing the paddle-shaft immediately over the cylinders, might be a material improvement for boat engines, as it was a saving in simplicity and weight. But as, in describing his engines, he had not given the required information, specifying their power and weight, and his drawing of a boat for them could not be put in competition with some others which had been presented, the Committee did not think him strictly entitled to the premium held out, but recommended his pretensions to the liberal consideration of Government. He had also submitted a plan, No. 1, for a tug, propelled by engines of the other principle : the plan was declared to ~~the~~ be ingenious, but not within the terms of the advertisement, being calculated for engines different from those of the Hoogly and Burhampootur.

In consequence of this recommendation, Mr. Macnaught received a compliment of five hundred rupees for his ingenuity, and Captain Cowles the full premium of one thousand rupees; and it was determined that tenders should be invited for the construction of a vessel upon Captain Cowles' plan, with accommodations, and such other modifications as the Board, on consulting with professional men, should deem advisable. The thanks of Government were also given to Captain Jump, for a model he had presented of

a steam tug designed for sea service, with the remark that there was no present object for vessels of that description, more particularly while ship tugs were maintained by private establishments. The Board were directed to lose no time in the matter, and to bear in mind, that the new vessel must be so constructed, that the engines of the Hoogly or Burhampootur might be transferred to her, in case no others more suitable should be sent out; and they were to procure from Captain Forbes an estimate of the expense of altering them, if necessary, for the purpose. The same Officer was requested to give a memorandum of the engines best adapted to the vessel, with the particulars of her dimensions, in order that an indent might be submitted to the Court of Directors without delay.

Captain Cowles was subsequently requested to furnish a model, according to the drawing which had been approved. Captain Forbes, we have already mentioned, was likewise engaged in preparing one upon a similar principle, designed for a single engine, and consequently for a boat of smaller dimensions. The latter was ultimately preferred, and Messrs. Kyd and Co. undertook to build the vessel in three months, for twenty-five thousand rupees, exclusive of equipment and the fitting of the machinery.* Her length will be one hundred and ten feet, and her breadth eighteen, and it is assumed that she will draw less than two feet, when loaded with fifty tons of machinery, stores and fuel. She is designed for a twenty-five horse engine, but might have buoyancy and capacity for a greater power, by encroachment upon her capacity for fuel. It is not yet settled what engine shall be assigned her, or whether she shall remain without one, the subject of intermediate experiment to ascertain her velocity and draught in different states of lading, until, with that information, a more suitable engine shall be procured from England by specific order.

In the mean time, the capabilities of the Burhampootur, for tugging, were put to the test of experiment, with a view to ascertain to what extent she might be usefully employed in that way, as well as to solve the general question. She was first tried alone by Captain Clapperton, Assistant Master Attendant, on the 12th February, a calm day. Starting from Chandpaul Ghāt, with her coal boxes full, at a draught of four feet and two inches forward, and three feet and one inch aft, she reached Barrackpore, distant eighteen miles, in two hours and thirteen minutes, partly against tide, making twenty-seven and twenty-eight revolutions, and going six knots and a half by Massey's log. In two hours more, she arrived at Chinsurah, ten miles further, ~~with~~ making the same number of revolutions, and at the same speed; from whence she returned to Chandpaul Ghāt in three hours and six minutes, at the rate of six knots and a quarter, making from twenty-six to

* Vide Drawings and Specification of both these plans in Appendix (A)

twenty-eight revolutions per minute. The steam rate, during the whole trip, averaged six nautical miles and four-tenths per hour. Captain Johnston next tried her with the Soonamookhee in tow, on the 20th April, starting with the coal boxes full, provisions for fifteen days, and stores for thirty: her draught was then four feet one inch and a half, by three feet and a half inch, and the engines worked up to thirty-four strokes. She made the distance to Barrackpore, against a tide of two miles and a half per hour, favored with a strong southerly wind, in three hours and fourteen minutes, steaming at the rate of seven knots by common log, but only five and three quarters by the same log, thrown from the extremity of a spar twenty-eight feet from the side, which was considered the true rate. Here the tow was cast off, and the steamer proceeded on alone, passing Chandernagore, distant seven miles, in one hour and thirty-four minutes, and returning from thence to Barrackpore in one hour and six minutes. The number of revolutions, previously reduced to thirty-three, had not varied since the rope of the Soonamookhee was slipped, and the speed had increased only half a mile, being then by log seven and a half near, and six and a quarter at a distance from the side, when going with the wind, and seven and six respectively against it. The two vessels returned to Calcutta in company as before, and reached Chandpaul Ghāt in three hours and twenty-four minutes against a stronger wind, and against a spring tide, the force of which varied from one and a half to three miles per hour. The revolutions of the paddles were thirty-one in a minute, and the speed through the water was six miles and five miles by log, according to the two ways of casting it. Captain Johnston remarked, that the small increase of half a mile raised the water under the bows five inches higher than when tugging, although the tail wave broke higher in the latter case.

A similar trial, made down the river on the 28th April, confirmed the above results. It was then found that, by towing the Soonamookhee alongside instead of astern, a further diminution of speed ensued, amounting to half a mile per hour. Next day the Burhampootur started with three vessels in tow astern, in the following order; the Soonamookhee, a Budgerow of sixteen oars, and a Pinnace of twelve. The vessels were brought as close to each other as their bowsprits would allow, but were still too far apart to be towed to the best advantage. The whole, however, thus linked together, turned round in little more space than the steamer alone would have required. The engines, working at twenty-seven strokes, gave them a speed, by log, of four geographical miles and three quarters in slack water against a fresh southerly wind. When they worked up to thirty strokes, the speed increased to five miles and three quarters by log, thrown alongside in the usual way; but, allowing one-seventh for the wash of the paddles, the true velocity would be five miles. This Captain Johnston considered to be only one mile and a quarter (or one-fifth) less than the rate of the vessel when steaming alone, which would lead to an inference, that the speed reported by Captain Clapperton was nearly half a mile too

great, with reference to the number of revolutions made by her paddles on that occasion. It was observed that, on the previous day, the Burhampootur had towed the Sonamookhee, under the same circumstances, the same distance from the Botanic Garden to Rajgunge, in forty-three minutes, which had occupied fifty-nine when she was tugging the three vessels; whereas the difference in speed, by log, barely exceeded one-fifth. Captain Johnston attempted to account for this apparent want of correspondence, by supposing inequality of tides and some fallacy in the log measurements. The comparison of time and distance must obviously be a difficult problem in a tide way; it is sufficient to notice, that the tide at Rajgunge was found to be running two miles and a half per hour the second day. From Rajgunge, at the bottom of Garden Reach, the four vessels proceeded on against the tide and against a wind much increased, at the rate of twenty-eight to twenty-nine revolutions, with a speed one-eighth to one-fourth of a mile greater than before, as far as the Jar Maker's, in an hour and five minutes, being twenty-seven minutes more than the time occupied by the steamer alone, with less opposing wind, on the 28th. From thence they returned to the starting place off the Esplanade, with wind and tide, in an hour and twenty-two minutes.

These experiments proved that the Burhampootur and Hoogly have sufficient power, in smooth water, to tug boats against a fresh wind and a stream of two miles and a half per hour; but their capabilities in this way are not susceptible of exact computation from the experiments we have described, as no account was taken of the dimensions, draught, and displacement of the boats in tow. Captain Johnston believed, that they would be found more efficient in towing Budgerows than Pinnaces, on account of the form of the Budgerows' bottoms, and their being less encumbered with masts and rigging. The Board were of opinion, that the great difference in the height of the wave under the bows, might be owing to the sinking of the head when the tow rope was cast off, supposing its strain, when fixed astern, to have had a tendency to depress the stern, and thereby bring the steamer upon an even keel. To the same cause they were inclined to attribute the disadvantage at which she tugged a vessel alongside. That disadvantage, however, must, in a certain degree, exist by the angular position of the rudder, and by the effect of the paddles on the water in which she would move tending to retard her progress; whereas the resistance must be partially neutralized in the wake of the steamer.

A further trial took place made on the 12th July. On that occasion the Burhampootur was employed as a tug for the Hoogly, which was made to represent an accommodation boat. The chimney, paddle-arms, and segments of the latter, were unshipped, and she received a provision of coals for her consort, calculated for two days' consumption; her draught of water being three feet eight inches forward and two feet ten inches abaft.

The Burhampootur was drawing four feet two inches by three feet ten inches, with four hundred and fifty maunds of coals, estimated to last fifty hours, besides stores and provisions. The Hoogly was lashed close astern. They started with the first of the ebb and performed a distance of one hundred and seventy-four miles from Bankshall to Berhampoor in fifty-five hours, steaming at an average rate of five miles and three quarters through the water and three miles over the ground. The current, tried three times, was found to be running from two miles and a half to three miles and a half per hour. Several strong eddies were passed without inconvenience, and no difficulty was found in making narrow turnings, the Hoogly acting as a powerful rudder to the other. They reached Barrackpore (one hundred and fifty-six miles) on the return, in seventeen hours and twenty-one minutes, and Chandpaul Ghāt in one hour and twenty-five minutes more, at an average progress of nine miles per hour. Captain Johnston, who likewise conducted this experiment, observed, that it fully proved the power of these steamers to tow an accommodation boat of the dimensions proposed by Government, as the area of her immersed section, according to the design, would, by his calculation, be thirteen square feet less than that of the Hoogly during the trip. The number of revolutions of the paddle-wheels was not stated in his report.

A visit of the Governor General to the Upper Provinces, at the beginning of 1830, gave occasion for a third experimental voyage on the great river, it being His Lordship's wish to make use of the steamer Hoogly for his conveyance back, and to avail himself of the opportunity of drawing conclusions from his own personal observation. The Hoogly was now in charge of Mr. Wall, who had accompanied Mr. Warden, as first Officer, on the two former expeditions. The following particulars of the voyage are extracted from an intelligent report furnished by him through Captain Johnston, who, on losing the command of the Enterprise by her transfer to Bombay, was appointed Superintendent of the Company's Steam Vessels in Bengal.

The Hoogly left Calcutta on the 9th January, with five hundred maunds of coals, besides forty tons of baggage and provisions, and sixty-three native servants of the Governor General: she was consequently more unmanageable and deeper than on any former trip, being at a draught of four feet seven inches by four feet one inch, and made two and a half revolutions of the paddle-wheels less than before, but steered tolerably well in steady currents. Taking the same route as on the second expedition, she reached Bissuntpore on the 11th, and there received sixty maunds of coals, while waiting for the tide to go through Goodlad's Creek. An hour and a half's detention, however, proved insufficient, and she was obliged to anchor at the entrance of the creek two hours more, till half-flood, before there was water enough for her to pass: at low water, the depth was only one foot and a half. Mr. Wall recommended that this passage should not be attempted with a

falling tide; he found it so narrow, circuitous and shallow, that, although he had the crew on shore, guying the vessel with ropes from both head and stern, he could not prevent her touching the bank at every turn, sometimes both with the bow and quarter; and, to add to the difficulty, country boats entered the Creek at each end as soon as the tide began to rise. He found a clear passage through Chandkolly Creek at high water, but nevertheless deemed it prudent to lower the stern boat and tow her through, not being certain how far this extended. On the return, many large country boats were found in the Creek, in avoiding which the steamer touched the bank and rubbed against a tree, which broke one of the poop venetians. Mr. Wall concurred in all that had been said by Mr. Warden, respecting the dangers and delays of this middle route, and in a decided preference for the lower one, although the distance to Kulna that way might be greater by eighty or one hundred miles. The fishermen had begun to lay down their stakes in the Modamutty (or Barassy) river, but a passage was left open in nine fathoms, out of the main channel. These stakes had been disturbed before his return; some of them were then in an inclined position, and there were also a number of bamboos strongly stuck in the channel, which formed serious obstructions to navigation. The stakes were stout enough to break the paddle-wheels, and even to pierce the bottom of the Steamer.

At Commercolly, the flues and boilers were cleaned on the 14th. The Goree river, from Commercolly downwards, had a current of about three miles and a half per hour, which, being little better than an eddy in so circuitous a channel, much affected the steerage. Its banks were observed to be steep and hard, and there were many shoals of stiff clay. The current of the Ganges, at Koostee, was about two miles per hour on the 15th, but from Jemadar Thana to the head of the Rooemarree river, two miles above the Jellinghee, it averaged about four miles with only six to nine feet water, and the banks were falling in. Here the rudder had little command over the vessel. Mr. Wall remarked, that her head always dipped from six to eight inches on approaching a shoal. This might be nothing more than the rising of the bow wave, owing to the more limited room for escapement. The weather was generally calm, which was even a disadvantage, as a light ripple was very convenient for tracing the channels. The current varied from a mile and a half, its general rate, to four miles per hour: the maximum rate prevailed from Chunar to Invalid Thana, (between Derriahpoor and Bar.) The river had abandoned its new channel of last year by Dulolpoor, and returned nearly to its course as observed in 1828. A good pilot was obtained by application to the Magistrate at Chupra, where the navigation was difficult. On the 26th, the Hoogly stuck fast near Berhampoor, and could not be heaved off until she had been lightened with the aid of a

large Dacca Pinnace, which, after this service, was taken in tow for future contingencies and occasionally employed as a pilot. She arrived on the 29th at Ghazeepore, having crossed, just below it, a ridge of sand extending from one bank to the other, with little water to spare in the deepest part. Here she remained until the 2d February, when orders were received for her return to Monghyr, there to wait for the Governor General, who embarked on the 7th March. The stern anchor, according to Captain Johnston's plan, was found very useful in the descent, enabling the steamer to approach a shoal with confidence; and much assistance was derived from the Pinnace on three occasions of taking the ground, as she drew only two feet nine inches and always went off clear when the tow-rope was slipped. The only accident produced by her company was, a little damage to the Hoogly's quarter badge by the bill of her anchor. Mr. Wall was of opinion, that if he had lashed her bowsprit to the stern of the Hoogly, she would have swung alongside, and injured both vessels when the steamer grounded. He conceived towing alongside to be the best plan, although not then adopted, as it was not attended with that risk, and the engines in such case might be backed at any time, and the stern anchor could be used without casting off. But the noise of the paddles was so great an inconvenience, that Lord Combermere had objected to it, when this plan was tried in the Bhaguruttee, with the Lion Pinnace, on his Lordship's return from Dewangunge last October. Both ~~engines~~ *boilers* were sometimes used on the way down, when a deep clear channel was known to extend fifteen or twenty miles.

Considerable detention, as before, arose from the ignorance of pilots, although men were provided on the whole line; and some also from the want of a light fast-pulling boat in place of the steamer's jolly boat. The coal stations were well selected; but in the rains it might be advisable to have a small intermediate supply between Rajmahul and Monghyr, and between Monghyr and Dinapore, and also between Dinapore and Bar, as the coal boxes scarcely contained enough for those distances with a vessel in tow. Besides these suggestions, Mr. Wall recommended, that marks should be fixed where sunken logs endangered the navigation; and that it should be made the duty of the Darogas of Police Thanas to clear the river of them as much as possible, and to cut down and remove such trees as were near falling banks. The Hoogly was once on the point of running upon a sunken tree, and many boats were discovered to have been wrecked by them. The steamer grounded frequently during the trip and twice struck so hard, that she was got off with difficulty.

She, however, reached Calcutta in safety by the same route through the Sunderbuns, on the 15th March.*

With respect to the navigable state of the Ganges in the dry season, Mr. Wall observed, that the shifting nature of the sands made it impossible to name the extent to which it was practicable for a vessel of the Hoogly's draught, as she was liable to meet with barriers of sand in the lower, as well as in the upper part of the river. Two miles below Secrigully, a sand was found to cross completely from one bank to the other, with only five feet in the deepest part. The river was there about a mile wide, and the force of the current one mile and a quarter per hour.

Notwithstanding the many accidents to which the Hoogly had been exposed, it was found, on examining her hull after this voyage, that she had suffered no injury beyond rubbing off a few sheets of copper, which it was necessary to replace. Pending these various experiments, when not actually engaged in them, both the river steamers have been employed on general service in the port of Calcutta, and when other duties have not occurred, one of them has usually been in attendance upon the Governor General, in place of the Feelchupra (or Snake boat) and other small accommodation boats heretofore kept up.

*Departed from.	Arrived at Coal Depôts.	Hours Steaming.	Hours of lighted fires	Coal received before starting.		
Calcutta, ... 9th January,	Bussuntpore, 11th January,	20 30	33 10	500 Mds.		
Bussuntpore, 11th ,, ..	Kulna, ... 12th ,, ..	12 50	17 0	60 ,,		
Kulna, ... 12th ,, ..	Commercolly, 14th ,, ..	22 35	25 45	300 ,,		
Commercolly, 15th ,, ..	Surdah,.... 16th ,, ..	16 0	19 40	180 ,,		
Surdah, ... 16th ,, ...	Rajmahul, .. 18th ,, ..	22 0	26 0	100 ,,		
Rajmahul, .. 18th ,, ..	Monghyr, .. 21st ,, ..	28 0	35 0	200 ,,		
Monghyr, .. 22d ,, ..	Dinagepore, 28th ,, ..	27 15	35 30	250 ,,		
Dinagepore, 25th ,, ..	Ghazeepore, 29th ,, ..	36 0	56 45	200 ,,		
Ghazeepore, 2d Feb. ..	Dinapore, .. 4th Feb. ..	24 10	32 40	300 ,,		
Dinapore, ... 5th ,, ..	Monghyr, .. 6th ,, ..	19 15	23 15	50 ,,		
Monghyr, ... 7th March,	Rajmahul,.. 8th March,	19 10	24 50	100 ,,		
Rajmahul, .. 9th ,, ..	Commercolly, 11th ,, ..	26 30	35 15	130 ,,	Bellona Pinnance in tow.	$5\frac{1}{2}$ hours with both boilers.
Commercolly, 11th ,, ..	Kulna, ... 12th ,, ..	16 15	18 5	130 ,,		$13\frac{1}{2}$ hours with both boilers.
Kulna,..... 13th ,, ..	Bussuntpore, 14th ,, ..	13 30	15 0	300 ,,		
Bussuntpore, 11th ,, ..	Calcutta,.... 15th ,, ..	27 0	29 30	80 ,,		
		331 0	427 25	2880 ,,		
			Remaining,..	200 ,,		
			Consumed, .	2680 Mds.		

In like manner the sea steamers enabled the Bengal Government to dispense with the Nereid yacht, which was transferred to Penang. The Sonamookhee pinnace has been dismantled, and is used as the Governor General's accommodation boat in journeys up the river, under tow of a river steamer.

The Burhampootur once towed a large frigate, the Undaunted, part of the way from Diamond Harbour to Kedgeree, in August 1828; but, as the weather was rough and she was lashed alongside, the strain was found too severe.* In smooth water, it has been proved, that either of the river boats can render assistance to vessels of moderate size, up and down the Hoogly; but they have been more frequently employed for the conveyance of troops and passengers, and to communicate with the Company's ships at Saugor.

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* "On the 14th instant, at 7. 45. A. M., took the Undaunted in tow. At 9. 15. A. M., cast off at Culpee, the vessel making eighteen revolutions per minute when she had the frigate in tow. On the 15th, in attendance on the frigate. On the 16th, at 9 A. M., received orders to go alongside, and assist in towing her in company with the Ganges. At 3 P. M., cast off above Silver Tree. During the time the vessel was alongside, she struck very hard."——*Extract from Mr. Wiseham's report, dated 19th August,* 1828.

CHAPTER VI.

In examining the state of steam navigation in the West, by the details given in Captain Basil Hall's interesting "Travels in North America," we find it peculiarly favoured by a situation of things quite opposite to that which exists in India. The principal rivers, in all the settled districts of the United States, are deep, of an equable and convenient breadth, smooth and of easy ascent, having mostly a current not exceeding two miles per hour. Fuel is every where abundant and cheap. Material of every kind,—iron, timber, artificers, engineers—plentiful in all the great towns of the Union; and there is every where the grand stimulus of extensive employment. The Hudson, the Rariton, the Delaware, the Potamac, the James, the Savannah and Alabama rivers, have their steamers as constant and punctual as English mail coaches: not to speak of the numerous boats which ply upon the Mississippi and its eastern tributaries, and upon the lakes, and in all the sea ports. The chief source of profit in that country appears to arise from passengers, although the charges are extremely moderate. In India, this item of receipt is of little value: the difference of habit, as much perhaps as the heat of the climate, were the white population more considerable than it is, will, for a long time, be a serious bar to the close packed mode of travelling which prevails in other parts of the world. Every thing here is different: the rivers are shallow, or impetuous, according to season; material of every sort is imported; fuel must be carried for many days, and provided at distant stations. In short, the nearer view we take of the subject, the more we discover the impossibility of drawing a comparison otherwise than by contrast.

According to Captain Hall, the common rate of American steamers is more than ten miles per hour. The passage from New York to Albany, a distance of one hundred and forty-five miles, the limit of the tide on the Hudson, was formerly an affair of a week or ten days, and was rarely made in less than three: it is now currently performed

by steam in twelve and thirteen hours, and has been done in little more than ten*. In the course of his travels, Captain Hall mentions some instances of his own rapid progress. From Philadelphia to New Castle, forty miles, he "rattled in a gallant steamer down the Delaware, at the rate of ten miles an hour, including stops, though in the very teeth of the flood tide;" and embarking at Richmond, on the James river, at eight in the morning of the 6th February, 1828, he reached the town of Norfolk the same evening, after a voyage of one hundred and fifty miles. At a similar rate he proceeded down the Alabama, from Montgomery to Mobille, and up the Ohio, from Louisville to Cincinnati.

As the steamers of the Mississippi are of a different class, and, in their loaded state, have not quite the same velocity, we shall here transcribe the account of them given by Captain Hall, on his arrival at New Orleans.

† "At ten o'clock in the morning of the 15th of April, I walked to that part of the "Levée allotted to the steam boats which ply up and down the Mississippi. Thirteen "enormous vessels of this description were lying along the banks of the river. One of "them, called the Amazon, was just setting off for Louisville, in Kentucky, upwards of

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* Captain Hall states the common passage to be thirteen hours, and the shortest above eleven. But Mr. Renwick, who moreover assumes the distance traversed by a steamer to be one hundred and fifty-four miles, says, in a letter to Captain Sabine, R. A., Secretary to the Royal Society,—"the average passages of the North America for the last year, (1827?) including stoppages, were performed in less than twelve hours; on one occasion, in little more than ten hours." This vessel, according to Mr. Renwick, has a speed of fourteen miles per hour: she is built upon a new principle of Mr. Stevens; is furnished with two condensing engines of eighty-five horses' power each, and is said to be the fastest boat in the United States. For a very particular and interesting account of her, see Quarterly Journal of Science, 2d Vol. of 1828. The following statement of her dimensions, &c. is extracted from Tredgold's Treatise on the Steam Engine, last page.

Length of deck,	178	feet.
Depth of hold, (from under side of beam to the keel,)	9	,,
Breadth, (moulded,)	28	,,
Breadth, (extreme above water,)	58	,,
Draught of water,	$4\frac{1}{2}$	,,
Diameter of paddle wheels,	21	,,
Breadth of paddle wheels,	$13\frac{1}{2}$	,,
Depth of paddles,	2	,,
Diameter of cylinders,	45	inches.
Length of stroke,	8	feet.

Number of strokes per minute twenty-two to twenty-six. The usual force of the steam is nine inches of mercury above the atmosphere; the extreme force fourteen, and the two engines consume two cords of wood per hour. The boilers are placed before, and the machinery abaft the paddle-wheels.

† Vol. III. p. 320.

"one thousand four hundred miles distant, which they hoped to reach in ten or eleven "days, though they had to go in the very teeth of the current."

"These boats are employed exclusively upon the river, where the water is always "smooth, and where also they are sheltered by the woods. These circumstances allow of "their accommodations being raised to the height of twenty, and sometimes nearly thirty "feet above the water. They have two complete and distinct tiers of apartments: the "upper one is appropriated entirely to what are called deck passengers, who pay a small "sum of money,* have no very luxurious accommodations, and provide themselves with "*food*: the cabin passengers are those who live in the lower apartments, fare differently, "and are, of course, required to pay a higher sum for their passage."†

"When the Amazon pushed off, there could not have been fewer than one hundred "and fifty men standing on the roof or deck of the upper tier of berths; while in the "lower gangways, passages and balconies, or galleries, groups of ladies and gentle- "men were moving about as if they had been in a fairy castle,—altogether a very lively "and peculiar scene."

The produce of the interior is floated down the river in the same way as it used to be, in large flat-bottomed boats, called arks. "‡ Of course it is utterly impossible to "stem the current with such vessels; and accordingly, when they have reached New "Orleans and discharged their cargoes into the ships, or the warehouses of that great "emporium, they are broken up and the planks sold. In former days, the crews were "much adrift, as they had no other way of returning, except by a long and dangerous "land journey through the swamps and the forests that border the rivers; or they "ascended the Mississippi, slowly and laboriously, impelled by oars, but generally drawn "up by a succession of warps or lines made fast to the trees. Sometimes these boats "were pulled along by means of the branches overhanging the stream. In both ways, "the voyage was an affair of three or four, and sometimes of nine weary months; but "now the same people find an easy and cheap mode of returning in ten days, or a "fortnight, to their homes. They merely take their passage on the deck of one of the "numerous steam boats, which are constantly proceeding to the interior; and are speedily "wafted back again, in company with manufactured goods from foreign countries, "together with fish, salt, sugar, steel, iron and all sorts of things suited to the markets "of those multitudinous inland cities, starting up every day in the heart of the western "country."

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* To Louisville ten dollars, from which two are deducted if they assist in carrying wood.

† Thirty-five dollars each from New Orleans to Louisville.

‡ Vol. III. p. 322.

Except in one instance, Captain Hall has not mentioned the size of the American steamers, nor their draught of water, which, by lists elsewhere given, appears to range between four and five feet in the river steamers of the eastern states: nor has he stated the power of their engines; but he confirms the general report, that these are mostly high pressure, and that, with few exceptions, they burn nothing but wood. In navigating the Mississippi, " *the consumption of this bulky description of fuel is " so considerable, that they are obliged to call at least twice a day at the wooding " stations on the banks of the stream." One remarkable circumstance is, that they move at night as well as by day, whether towing a ship to sea, or steaming up a river to a distant settlement. " At sunset, on the 23d April, 1828," (we quote again from his book†) " we embarked in the Hercules, a high pressure steam tow-boat, and proceeded down " the Mississippi, on a most interesting expedition to the Balize, the principal station " of the pilots at the mouth of the river. On the one side of the steam boat was lashed " a large Hamburgh ship, and on the other an American brig, bound to the Havannah. " The night closed in before we had gone many leagues down the stream; but there was " light enough from the moon to discover, that we were navigating a river of great " magnitude. The width was no where more than half a mile; but every thing we saw " gave indications of depth and uniformity."

The Philadelphia, in which he made the passage from New Orleans to Louisville, distant one thousand four hundred and thirty miles, in eleven days and three hours,‡ including all stops, thus averaging about *five miles and a half* per hour, is described as " one of the largest class of steam boats on the river,"—" a vessel of three hundred and twenty-five tons, drawing seven feet water." Her consumption of fuel and its cost are given as follows.§ " The Philadelphia used about one cord of wood an hour, or one " hundred and twenty-eight cubic feet: a cord consists of a pile eight feet long by four " high, and four in thickness, each billet being four feet in length.‖ Sometimes when " we were pushing hard, we burnt thirty cords in a day. Each cord cost from two and " a half to three dollars, or from eleven to twelve shillings; but the price varied at differ- " ent stations, decreasing as we went up." This is about four times as much as the

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* Vol. III. page 348.

† Vol. III. page 334.

‡ Captain Hall was informed that it had been once accomplished in eight days and two hours.

§ Vol. III. page 348.

‖ " I find by Bull's Essay on Fuel, (Philadelphia,) that a cord of wood weighs about three thousand eight hundred and twenty-six pounds. The rate of coal to wood is 8. 22. to 22. 6."—*Tredgold's Treatise on Steam Engines, page* 360.

The above comparison has reference to " caking coal" and " ordinary oak."

estimated consumption of the Hoogly and Burhampootur, (nine cubes of six feet in soondry wood per hour:) but the two latter only measure one hundred and fifty-six and one hundred and fifty-eight tons, instead of three hundred and twenty-five, and have a speed of only seven and a half statute miles per hour, while the Philadelphi appears to have moved at the rate of about nine.* If the engines of the American vessel had the united power of one hundred and twenty horses, which perhaps would suffice for her speed, her relative consumption of fuel would still seem to be greater than that of the Bengal steamers with a power of fifty horses, allowing a large difference in the combustion of pine and teak or soondry.† This agrees with the opinion of Mr. George Jessop, already quoted, that high pressure engines consume more fuel than those of low pressure.

Captain Hall, starting from New Orleans on the 25th April, ascended the Mississippi in the height of the freshes, which we may infer to have been fully at the average maximum, from the fact of his having seen a formidable crevasse in the Levée, fifty or sixty miles above the town, and from the water being elsewhere within a few inches of the top of the embankment. "‡ In the course of the 27th and 28th of April, (he says) "we made good about one hundred and forty miles, at every part of which the Mississippi "was overflowing its western, or right bank, in a continued stream from six inches to a "foot in depth. Sometimes we passed along distances of twenty or thirty miles, with-"out seeing a single habitation." Again—"We passed several hundreds of miles, where "the river was gushing in this manner over the right or western banks, to the depth, I "*should think, of half a foot, and at some places twice as much.*" But, notwithstanding this fulness of the mighty stream and its extraordinary depth, he states that "§ the

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* Average progress per hour, ... $5\frac{1}{2}$ Miles.
Strength of middle current, say 4
Deduct for passing up as much as possible out of its force, ... 1—— 3 ,,
Stoppages per diem, in all about an hour, for fuel and cleaning boilers, or 1-24th, say $0\frac{1}{3}$,,
Rate through the water, ... $8\frac{5}{6}$,,

to which must be added, the average time lost in slowing the engines occasionally, and in crossing the river to avoid the strength of the stream.

† Pounds of fuel required to convert a cubic foot of water into low pressure steam of 220° from the temperature of 52°.

New Castle Coal, ...	7.25
Oak, dry, ...	12. 9
Pine, ditto, ...	20.02
Peat, ...	30. 5

Tredgold on Steam Engines, page 119.

‡ Vol. III. page 344.

§ Vol. III. page 328.

"velocity of the middle current seldom exceeded four miles an hour any where between "the confluence of the Ohio and the sea." According to Mr. Darby, the whole body of the Mississippi does not flow at a greater rate than one mile an hour.

Not merely does the rapid progress of the American steamers give them the advantage of carrying their fuel, in a few hours, over a great distance in space: such is the abundance of timber on the banks of the Mississippi, and so many settlers have already fixed upon its borders, tempted perhaps by this extra demand for what in other parts is an encumbrance upon the land, and in some cases wholly subsisting upon this resourse;* that numerous piles of fire-wood are found at every league or two, during the greater part of the way, ready at the bank, and easily shipped off in every state of the river. The stoppages on this account seldom exceed a quarter of an hour each time. When the river is full and overflowing, the boat is run alongside the trees, and a hawser made fast to one of them; while two or three broad planks are thrust over the side to form a gangway for the crew and deck passengers, who lose no time in bringing off the wood on their shoulders. In passing up the river, the plan is to edge along the bank where the current is weakest, crossing over for this purpose at every bend, which is done generally with the boat's head at an angle of forty-five degrees with the stream. The pilot of the Philadelphia, although she drew but seven feet, was shy of going into shallower water than three fathoms, but seldom kept so far from the edge of a shoal as to deepen the water to four fathoms: in such situations the lead was constantly going.

The Mississippi was surveyed some years ago from the confluence of the Missouri to the sea, and all its islands were numbered; but these land-marks have not been respected by the stream. "† Sometimes large islands are entirely melted away: at other "places they have attached themselves to the main shore, or, which is the more correct "statement, the interval has been filled up by myriads of logs cemented together by "mud or rubbish. On the other hand the river is perpetually insinuating itself into the "soft alluvial shore, and slicing off portions of land from the points which thenceforward "become islands. The original numbers given to the islands, however, are judiciously "retained as distinguishing names, whether the order be preserved or not, and new "appellations are given to those which start up."

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* "In the course of the second morning we called at a wooding station at a part of the river, where, as there "had been no Levées made, a little village was completely swamped. It consisted of four houses, about a hun-"dred yards apart; behind which, as far as the eye could penetrate into the forest, no land was to be seen. About "an acre of timber had been cut down to make fire-wood for the steam boats, and on the cleared space these little "bits of rude huts had been perched on the tops of piles, so that the flood reached them. All their communication "was by canoes."—Hall's Travels, Vol. III. page 349.

† Idem, Vol. III. page 361.

"Occasionally the current undermines the banks, and plunges thousands of trees at "one dash into the bed of the river. The greater number of these trees are swept down "to the sea; many are stopped in their progress by the islands standing in the way; "while some float into the shallow water between these islands and the main; where "they grow into rafts, often several miles in length, and form, along with the mud "deposited by the river, the substratum of future land."—"Some of the largest get their "roots entangled with the bottom, where they remain anchored as it were, in the mud. "The force of the current gives their tops a tendency downwards and, by its flowing past, "soon strips them of their leaves and branches. These fixtures, called *snags* or *planters*, "are extremely dangerous to the steam vessels proceeding up the stream, in which they "lie like a lance in rest, concealed beneath the water, with their sharp ends pointed "directly against the bow of vessels coming up."

"For the most part these formidable snags remain so still, that they can be detected "only by a slight ripple above them, not perceptible to inexperienced eyes. Sometimes "however, they vibrate up and down, alternately showing their heads above the surface "and bathing them beneath it; which peculiar motion has given them the name of "*sawyers*. If a boat going up happens to have reached a spot where a sawyer is rising, "she stands a good chance of being pierced through and through about the middle; "but if she be coming down the river, she generally slides over these snags and sawyers "without much danger, as their heads are always held down the stream. Besides which, "on the voyage towards the sea, as the boat keeps nearly in the middle of the river, to "be in the strongest current, she is less apt to fall in with these interruptions which "belong chiefly to the sides of the river."

This appears to be the only serious inconvenience, and the only circumstance in which the Mississippi navigation, below the entrance of the Missouri, is more hazardous than that of the Ganges. Until it receives that turbid river, except where it issues from a lake one hundred miles below the falls of Saint Anthony, its clear transparent waters are almost entirely free from drift wood. But the Americans have invented a means of protection, which, although less required, might be worthy of imitation here.

* "So imminent is the danger, that almost all the boats of the Mississippi are now "fitted with what is called a snag-chamber. At the distance of twelve or fourteen "feet from the stem of the vessel, a strong bulk head is carried across the hold from side "to side, as high as the deck and reaching to the kelson. This partition, which is formed "of stout planks, is caulked and made so effectually water tight, that the foremost end of "the vessel is cut off as entirely from the rest of the hold, as if it belonged to another

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* Halls Travels, Vol. III. page 363.

" boat. If the steam vessel happen to run against a snag, and that a hole is made in her " bow under the surface, this chamber merely fills with water; for the communication " being cut off from the rest of the vessel, no further mischief need ensue. Whereas, in " boats which have no snag-chamber, such an accident would probably send the vessel " to the bottom, if the pilot were not expeditious in steering for the bank and lashing " her to a tree."

Another American contrivance seems entitled to the particular attention of Navigators on the Ganges, whether in sailing boats or steamers. Captain Hall describes it in the following terms :

* " I am unwilling to let this opportunity pass, of mentioning, for the information " of nautical men, a very ingenious method devised, as far as I know, by the steam- " boat pilots on the Mississippi and Ohio, for getting their vessels off the bars and " other shoals when they happen to run aground; an accident of frequent occurrence " when the water is low. These boats are furnished with a long and stout spar, ready " to launch over the bows upon these occasions. This they plant in the ground nearly " right a-head, with an inclination of about forty-five degrees; so that the upper end of " it may overhang considerably the forecastle of the vessel. A three-fold block is next " lashed to the head of the spar, and another, with four sheeves, to the bows of the boat. " They then receive a strong hawser through these blocks and bring the fall to the " capstan. By heaving on this purchase, a double object is served; the vessel is not " only lifted up, but she is also shoved or boomed off. Seamen may ask, why the pilots " do not rather lay out an anchor? To which I reply, as they replied to me, that, in " the first place, the current is generally so strong that it is very difficult to send a " small boat into the middle of the stream; and, even were it otherwise, the holding- " ground is so bad, that almost before the cable can be made to bear any strain, the " anchor is sure to come home. Independently of which material considerations, it may " be observed, that the method of booming off by means of a spar need not occupy a " tenth part of the time of laying out an anchor; while it may be carried to any extent " by adding to the number and strength of the purchases, and by the application of " more spars. When the ground on which the vessel has run is soft, it becomes necessary " to nail a broad shoe to the heel of the spar, to prevent its sinking too far in the mud." Captain Hall's opinion of its utility may go far to recommend the contrivance to general adoption. " I cannot help thinking that the principle here described might be introduced, " with advantage, into ordinary navigation. Its simplicity is so obvious, that I can " hardly conceive a case in which, if any of the common methods could be brought to

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* Vol. III. page 371.

" bear, this plan might not be adopted, either alone, or in combination with others already " in use."

We have not been sparing of our quotations from the work of this lively and intelligent writer, because, while more exact information was not within reach, we could not better elucidate the subject of American Steam Navigation, than by giving the details of his personal experience in his own words. Nine years before his visit to the back settlements, one of the ordinary passage steamers, " The Western Engineer," conveyed Major Lang's party to the mouth of the Platte, six hundred miles up to the Missouri. The passage up the Ohio is interrupted at Shipping Port, near Louisville, by a series of falls or rapids, which, however, when the river is swollen, are stemmed by steamers of a smaller class. In one of these, Captain Hall made the passage from Louisville to Cincinnati, a distance of one hundred and fifty miles, in twenty-three hours, against the current at its maximum, and thence he proceeded upwards to Pittsburg, at the fork of the Alleghany and Monongahela rivers, the extreme limit of the Ohio, distant one thousand and thirty-three miles from its confluence with the Mississippi, and nearly as much more from the ocean.

We have said that many of the inferior rivers, on the east side of the Alleghany chain, have their steamers constantly plying for passengers, at distances of one hundred and fifty miles and upwards from the Atlantic. They appear to oppose less difficulties to navigation than the western rivers, being without drift-wood and little subject to freshes. They have also the advantage, that the momentum of their current never reaches so high a maximum. This remark chiefly applies to the streams between the St. Lawrence and the Edisto in South Carolina, Captain Hall having observed the latter to be running with considerable rapidity at the beginning of March. As we advance to the southward, we find them more affected by periodical rains. The Savannah had broken some of its bridges; and the " gigantic" Alatamaha was swollen to its utmost height, in the middle of March:* but this " high fresh" produced so little influence upon its level, that at Darien it still felt a tide which, on that coast, only rises between three and four feet, nearly corresponding with the tide in the Gulph of Mexico, where the highest springs do not reach five feet. Perhaps the San Juan, and other streams in Florida, which have their sources not far from the tropic, may partake of the influence of that region in the period and extent of their freshes; but the streams of the old States, and all those of the great western chain, have their floods at the season when tropical rivers are usually at their lowest ebb.

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* In the same month, the Alabama rose sixty-four feet above low water mark. This river falls into the Gulph of Mexico, " through an alluvial country, in a deep cut or trench with perpendicular sides rising to the height of " sixty or eighty feet."—Vide Hall's Travels, Vol. III. p. 380.

"The Mississippi" (says Captain Hall, speaking of the lower part of the river,) "begins to rise generally in the month of January, and continues swelling till May. It "remains full all June, and a considerable part of July; after which it begins to fall, and "goes on decreasing in volume till September and October, when it is at the lowest. "Sometimes, however, Mr. Pilié informed me, the river begins to rise in December." He states the extreme difference to be thirteen or fourteen feet at New Orleans, one hundred miles from the sea; twenty-three feet near the efflux of the La Fourche, at one hundred and fifty miles; thirty at Baton Range, two hundred miles; and fifty at Natchez, three hundred and eighty miles from the sea. Natchez is a little above the Delta, which commences about eighty miles lower down, with the Achafalaya, its western outlet, the Hoogly of the Mississippi. The greatest rise has been estimated at fifty to sixty feet: the exact locality of this rise has not been mentioned; but, if it be true that the Ohio has an equal rise, we must infer that it is not very far from the confluence of that river.

The Ganges, scarcely a tropical river in locality, yet wholly influenced by tropical rains, begins to rise towards the end of May, and is usually at its maximum in September; subsiding with rapidity from the end of October; after which scarcely a shower falls in the long dry season of India. Its greatest known rise is forty-five feet and a half. This occurs in the neighbourhood of Allahabad,* about the centre of its course; a part of the river in which the freshes commence a month later, and begin to subside a fortnight or three weeks earlier than at Calcutta, thus occupying but three months of the year—half the duration of the same state of *things in the Mississippi.*

This difference in the duration of the freshes, if we may hazard an opinion, appears to be owing to many concurrent causes; the greater length of the Mississippi; its small comparative breadth; a considerable difference in the slope of the two rivers; and the violence and limited period of tropical rains, compared with the spring showers and unequal action of the sun upon the snows, which, during a long winter, overspread the vast regions between the Alleghany chain and the rocky mountains. The whole of

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	Greatest known annual rise.	*Rise in low seasons.*
* At Allahabad,	45 6	29 0
Benares,	45 0	34 0
Colgong,	29 6	28 3
Jellinghee,	26 0	25 6
Do. by observations quoted by Rennell,	32 0	
Commercolly and Custee, not quite certain,	22 6	22 0
Agurdeep,	23 9	23 0
Calcutta, (independently of tide)	7 0	6 7
Dacca, according to Rennell,	14 0	

Notes to accompany the Charts of the Ganges, by Captain Thomas Prinsep.

that wide extended country, from seventy-eight to one hundred and twelve degrees of west longitude, at the broadest part, and from about the thirtieth to beyond the fiftieth degree of north latitude, pours its superfluous waters into the Mississippi. The river which carries that name to its sources in the Red Cedar and Leech Lakes, where ice is seen even in July, is a stream of three thousand and thirty-eight miles in length: but the mighty Missouri, which is in fact the main stream, has travelled an equal distance, before its confluence at twelve hundred and twenty miles from the ocean. Half-way up the course of the latter, the snow lies on the ground from the beginning of November to the middle of March,* when the river begins to swell: soon after the melting of the snows, it would seem that the heat becomes so considerable, as to neutralize, by evaporation,† the effect of the summer showers, and that the whole body of the river would have no existence, but for the absence of that evaporation during a long winter. The space drained by the various feeders of the Mississippi, is about nine hundred thousand square geographical miles, and three hundred and sixty thousand the range of country drained by the Ganges, with its course of fifteen hundred miles. The Delta of the former occupies only fourteen thousand square miles, about a sixty-fourth part of the whole; while the Delta of the Ganges embraces twice that space, or twenty-eight thousand square miles, about a thirteenth part of the area of its range. Allowing to the country drained by the Mississippi, a mean perpendicular fall of rain of nineteen inches, namely, sixty inches within the Delta, and eighteen beyond it,—a large allowance with reference to latitude, distance from the sea, and other peculiarities of situation—and to that which is traversed by the Ganges, eighty-four inches within the Delta,‡ and fifty above it, or a mean fall of fifty-three inches, we find that the Ganges has a more copious source of supply than the father of waters in North America; much of it falling, too, in heavy masses, which are carried off at once into the water courses of the main river. It is not unlikely, therefore, that, in the shorter period of its freshes, the Ganges conveys to the ocean as great a volume as the Mississippi, during

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* Captains Lewis and Clarke wintered on the Missouri in 1804-5, in about latitude 47° N.—Vide the Narrative of that Expedition.

† "We had here occasion to remark the wonderful evaporation from the Missouri, which does not appear to contain more water, nor is its channel wider than at the distance of one thousand miles nearer its source; although within that space it receives above twenty rivers, some of them of considerable width, and a great number of creeks. This evaporation seems in fact to be greater than when we ascended the river; for we are obliged to replenish the ink-stand every day with fresh ink, nine-tenths of which must escape by evaporation."—Travels of Lewis and Clarke, Vol. III. p. 386. This observation was made in returning on the 8th September 1826, a few miles above the entrance of the Platte.

‡ The Sea Coasts of the tropics appear to receive from seven to eight feet of rain on an average, the Coast of Peru excepted, which has absolutely none. At Vera Cruz, in the Gulph of Mexico, on the Malabar Coast, at Colombo, and Trincomalee, the mean annual fall ranges from eighty-five to one hundred inches.

the six or seven months of its corresponding flood, and twice as much, comparing the greatest daily discharge of the two rivers.§

In the freshes of the American stream, below the junction of the Missouri, there is a remarkable steadiness, owing to its immense length, its more extensive ramifications, and the vastness and various latitudes of the spaces from which its supply is obtained. To the same effect, also, contributes the low level of the country on either side, in respect to the river bank, allowing a free escape to the superfluous waters, which are said to inundate an area of five thousand square miles. But the Ganges is always rising or falling, and it is only in the dry season that the changes proceed with regularity. Throughout the rains, there is an undulation in the height of the freshes, exhibiting not only much inequality of daily increase, but frequent depressions too, without apparent cause at the place of observation. Of this fact, established by registers kept at Bogwangola and at many Indigo factories, the cause is to be sought in the partial nature, and the varying slopes of the subsidiary streams. In the higher parts of the river, changes of this kind are both more sudden and more considerable: at Benares and Allahabad, the river has been observed to rise twenty feet in less than a week, and to fall almost as rapidly: the Caramnassa, a torrent which passes into the Ganges on the right bank, a few miles above Buxar, rose upwards of twenty-six feet in one night last June, at a time when little rain was falling in the plains lower down. Another circumstance worthy of notice, is, that the Ganges has two distinct freshes, occasionally even three, every year. The first great rise sometimes reaches its maximum in July, but generally in August, and is equal, or nearly equal to the maximum of September; this is followed by a gradual depression of the surface during three or four weeks, and again the river

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On the Coromandel Coast it is less; but the deficiency is fully made up by the quantity which falls in the long rainy season on the east side of the Bay of Bengal, which, in some places, (Chittagong and Arracan) is said to have as much as one hundred and eighty inches. At Gunga Saugor, the fall is probably somewhat above the average, say ninety-six inches: partial observations of last year indicated much heavier rain there than in Calcutta, which fact is confirmed by a register kept at that place during the present year, the quantity fallen up to the 30th September being ..... Inches, 83. 5

And up to the same date at Calcutta,	52. 0
The annual fall at Calcutta, (mean of fifteen years) is	67.26
Benares, (mean of 7 years)	43.57
Bombay, (mean of 13 years, allowing 2 inches for the dry months omitted)	86. 0
(N. B. The rains are longer and more copious lower down the Malabar Coast.)	
Rees's Cyclopœdia, article Rain, gives for Paris, (mean of five years)	20
London, (mean of seven years)	23
Ditto, (mean of twenty-two years, by the rain gage of the Royal Society, placed on the top of Somerset House,)	17.315

§ Appendix K.

rises in September, attaining sometimes its greatest height in the early part of October. This oscillation is owing to a partial interruption of the rains, and to their usual return with violence about the time of the equinox. Rennell supposes that the strong easterly winds which prevail on the Great Ganges in that season, have a considerable effect in banking up the stream : but it is a common remark (observed Captain Johnston in his report upon the Hoogly's first voyage) that the river falls with easterly and rises with westerly winds. The former must certainly tend to retard the efflux of the stream, although rarely to the extent of raising its surface two feet, which Rennell supposes not unfrequently to happen: a greater influence, however, is produced by the rains, which, it appears by a register kept at Benares, fall more abundantly with the latter ; whereas at Calcutta, and in the neighbourhood of the sea, the east point of the compass is considered the most rainy quarter.

Rennell, quoting measurements taken at Dacca and Jellinghee, in a season of very early rains, attributes half the rise of the Ganges, not indeed to the melting of the snows, but to the showers which fall among the northern mountains. But it rarely occurs that any material increase of volume is perceptible until after the first heavy fall in the plains ; and the river is often much swollen, a little above the Delta, before it has begun to rise at Benares, where, in ordinary seasons, it is at the lowest about the fifteenth of June. The melting of the snows have, no doubt, an influence in maintaining the diminished stream, which flows with little further reduction between March and June ; and the waters of the Gogra, dependent on that source and on mountain rains, at all times bear a large proportion to those of the Ganges above their confluence. The eastern streams tend rather to inundate the country than to swell the body of the main river ; a space, equal perhaps to the submerged borders of the Mississippi, remains flooded many weeks to the depth of several feet, forming an inland sea, more than one hundred miles in breadth, navigable by boats in a direct line between the Ganges, and the Burhampootur and Megna. This vast sheet of water, according to Rennell, flows bodily towards the ocean, at the rate of half a mile per hour, finally discharging itself by the various effluxes of the Delta.

In the opposite season, the Mississippi is still a deep river, containing two-fifths of its greatest volume,* little reduced in breadth, and always affording a navigable channel for large steamers, drawing eight and ten feet. The Ganges, in that season, with respect to the deep parts of its channel, may answer to the description of Rennell, that

* At Natchez, the maximum depth and breadth give a section of 120 feet × 2700, less (say) $\frac{1}{6} = 270{,}000$; and the minimum 70 × 2400, less (say) $\frac{1}{4} = 1{,}26{,}000$. Allowing for ledges, the general depths are probably 100 feet and 50 feet at the two periods, and the mean sections about 2,25,000 and 90,000 respectively.

" at five hundred miles from the sea, the channel is thirty feet deep when the river is at its lowest, and it continues at least this depth to the sea." But the soundings, taken on the late experimental voyages,* have shewn, that its bed consists of a series of pools, separated by shallows or sand-bars at the crossings of every reach, like the Missouri, which, perhaps, would be the state of all large rivers, emptied in an equal degree. These sand-bars, even below Sicrigully, have sometimes less than five feet water in the deepest part, and it has been seen that, a few miles below Allahabad, the passage shallows to two feet; so that it is probable the body of water then contained in the Ganges, within a channel of half the breadth, is scarcely one-seventh part of its maximum in the rains, and only one-twentieth over the shallows.† Higher up, the state of the river is still worse for navigation :—" Above its confluence with the Jumna, (says Captain Smith, speaking of the same season,) the Ganges is a stream of shoals and rapids, which, in a measure, disappear when it has received an additional supply of water from the latter." " Of the difficulty of passing up the Ganges in the first six miles above the Fort, (of Allahabad,) the causes, I fear, are such as will not warrant my holding out strong expectations of their removal. The principal obstruction is felt at the junction of the two rivers, where the large body of sand and earthy matter, brought down by the current, particularly of the Ganges, is deposited near the eddies and slack water,—is again suspended by the stream, as the rivers, rising and falling, as they are constantly doing in different levels, alternately disturb each other, and again deposited in new situations ; thus forming, at the entrance to the Ganges, from the united rivers, a shallow and continually shifting bar. From its confluence upwards, the Ganges runs between banks more widely separated than below (here three miles apart) : through this expanse of sand, the diminished stream of the dry season winds its way with a strong current, but neither deep nor settled channel. A substratum of konkur or clay probably checks the action of the water in deepening its bed ; it is scarcely, however, discernible, the bottom of the channel having usually a layer of rolling sand."

Captain Smith, being instructed to report upon the practicability of conquering this difficulty of the passage to Paphamow, either by a canal, or by an establishment of paddle-boats, to be used as tugs for the river craft, stated his opinion, that " were the plain of the Dooab less elevated than it is, a lateral cut would be very desirable ; but with rivers, rising at the periodical rains upwards of forty feet, taking every advantage of ravines, a depth of cutting of fifty to sixty feet, on a length of about three miles, is unavoidable ; a scale of work involving an expense of from ten to twelve lakhs of rupees, a sum which the trade now on the river would not repay. The total absence of superficial waters in the lower Dooab precludes the adoption of the more economical form of

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* An abstract of the Soundings, taken on the Hoogly's first voyage, is given in the Appendix (L.)

† Appendix K.

a lock canal." Traces were supposed to exist of an unfinished native work intended for a canal ; but Captain Smith, on examination, satisfied himself that it was only an entrenchment to protect the open City and Suburbs of Allahabad from predatory attacks. The employment of paddle or barrel towing boats, he did not consider likely to answer at that particular spot, on account of the shifting nature, as well as the shallowness of the channel, which would often leave them in the middle of a dry sand, at a distance from some new course of the stream, and would render it necessary to change the moorings at least once a year. In the dry season, the river meanders from bank to bank among these extensive sands, cutting itself a channel several feet deep in what was the bottom in its swollen state; so that, in such places, the surface of the stream is actually below the level of the deepest part of its bed in the rains, when the course of the river again becoming parallel to its banks, all such channels are filled up by the sands moving across them. Similar alternating changes are produced elsewhere by the same causes, but in a less degree.* " A question (he added) will naturally arise, how far it is practicable to confine the dry season channel to the same line, year after year ; which effected, the chief objection to the employment of paddle-boats would be obviated." The only chance of partial success, he conceived, would be the discovery, by careful observations of several years, with accurate plans of the state of the river at every period of change, that the stream had an inclination to certain lines : if that were established, it might be possible, by artificial means, to increase its tendency in the same direction, and thereby procure a certain degree of stability : this he considered the highest effort of human power which offered a distant hope of success.

Captain Smith suggested, that other parts of the river would be found more favorable for the trial of such boats. " Between Allahabad and Mirzapore are projecting portions of the main bank, round which, with deep water, the stream rushes with great velocity. The necessity of tracking often brings boats within the confluence of the strongest rush of water, with its attendant inconveniences of the employment of large numbers of men, the breaking of tow-ropes, delay, and, at times, loss of property; whereas the paddle-boats would supply the requisite power of ascending along the less impetuous portion of the stream." These inconveniences are strongly felt in passing Patna, Monghyr, Rajmahul, Sicrigully, and many other narrow bends of the river. Pinnaces are sometimes detained a fortnight in getting round them, waiting for a fair wind, the tow-rope not having force enough to conquer the stream. At Patna, the strength of the current is augmented by

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* " In this state of things (the rising of the river) the channels fill, and the crossing places from one steep bank to another, always more shallow than the channel round the bend itself, become choaked, occasionally, as we found, to the height of a fathom above the level at which they are known to remain in the dry season."—*Captain Prinsep's Report on the first expedition to Allahabad.*

the Ghāts, defence walls, stakes, and other hard materials accumulated on the river bank of a great city, which tend to confine and deepen the channel passing near them; the Ghāts of Benares, and the piles in front of Fort William, have a similar effect.

Something has been done by art under the skilful superintendence of the same Officer, to improve the navigation of the Jumna. That river, although of greater length than the Ganges above their confluence, yet much inferior to it in the average volume of its discharge, is the line of communication with some of the principal commercial marts and military stations in India,—Calpee, Etawah, Muttra, and the Cities of Agra and Delhi, all situated upon its banks; and with the distant post of Kurnaul by the antient canal, branching off at Delhi, which has lately been repaired and re-opened. Its banks are lofty and precipitous, and ridges of rock, in many places, advance into the stream, combining with its general shallowness and strong current, to render navigation extremely difficult and dangerous. The practicability of removing these ledges in the most important part of the navigation, between Agra and Allahabad, being represented to Government by Captain Irvine, of the Engineers, that Officer was appointed to survey the river and improve the channels: but the wounds he received at Bhurtpore obliging him to proceed to England, the execution of his plans was confided to Captain Smith, in December 1826, with a detachment of Sappers and Miners, and a sum of about ten thousand rupees has since been annually devoted to the object. Already the rocky obstructions have been blasted and cleared in more than half the distance upwards, including those of the Pass of Kurreem Khan, where the whole channel was so interspersed with rocks that the extreme difficulty of getting through caused sometimes a detention of weeks. This Pass was opened last year; and, at the same time, a dam was constructed to deepen and give permanency to the channel, by which the passage of boats is reported by Mr. Barlow, the Commissioner of that district, to have been facilitated in a degree quite extraordinary.

The general character of the Ganges is so well described by Rennell, and the works of the great Geographer of India are so familiar to every reader, that it were superfluous to retrace his description, or to attempt a new one: we therefore confine our remarks to a few points of comparison with the American rivers, and to some new facts which have been collected by later observers. All the material changes which time has made in its ever-varying channels, since the surveys of Rennell and Colebrooke, below Buxar where its permanent ranks may be said to cease, are severally marked in the recent chart, and noticed in the explanatory memoir to which we have alluded. In Rennell's days, the course of the river was unknown above Hurdwar, and it is not surprising, with reference to its magnitude below, and the supposed long mountain course of the Burhampootur, under the name of the Sanpo or Tsanpo, that a reported distance of eight hundred miles should have obtained belief, instead of one hundred and fifty or two hundred, which now appears to be the length of the

torrent between that mountain barrier, and its first issue from the snows of Gungotree. This part of the river is quite impracticable to navigation, which absolutely terminates at Hurdwar.

The level of the principal waters in the United States, within the settled districts, and as far as the sources of the Mississippi, appears to have been ascertained with some precision, by surveys connected with canal projects. From the sea to New Orleans, the distance of one hundred miles gives an elevation of thirteen or fourteen feet at full fresh, and only four or five at the opposite state, which being just equal to the rise of tide and beyond the reach of its current, renders the stream almost quiescent in that season. At the fork of the Ohio, in a distance of about one thousand miles, the total elevation is said to be three hundred feet ; and six hundred and eighty feet at Pittsburg, the head of that river, one thousand and thirty-three miles from its mouth. The mean slope would thus be three inches and a half in the Mississippi, below the Ohio, and four and a half in the more confined and shallower channel of the latter river, which however, by an intermediate measurement, appears to have a mean slope of seven inches per mile in three hundred and eighty-eight miles from Pittsburg to the mouth of the Scioto, and consequently only three and a half in the lower part of its course, and less than three when the Mississippi is in high fresh. Hence the relative gentleness of current in the Ohio, which allows a steamer to make a passage of one hundred and fifty miles in twenty-three hours from Louisville to Cincinnati.* The same absolute elevation is ascribed to the Missouri, at the confluence of the Platte, distant little more than one thousand eight hundred miles from the sea, and to the mouth of St. Peter's river on the Mississippi,† said to be two thousand three hundred miles from its efflux. The surface of Lake Erie, according to Dr. Bigsby,‡ is five hundred and sixty-five feet above the ocean, and Major Long thence deduced four hundred and fifty feet for the head of the Illinois, another tranquil river ; which led the Quarterly Reviewers to assign only five hundred feet for the level of the Mississippi at two thousand miles from the sea.§ It has been estimated by Mr. Stickney, that a rise of twelve or fourteen feet in Lake Erie, would send its waters into the Gulph of Mexico, by the Illinois, from the south end of Lake Michigan.

Very different is the slope of the Ganges. At Futtighur, scarcely one thousand one hundred miles from its mouth, barometrical observations have given an elevation

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* Vide Hall's Travels, Vol. III. p. 388.

† Vide Keating's account of an Expedition up the St. Peter's.

‡ Vide Quarterly Journal of 1828, pp. 362 to 365.

§ Vol. XXIX. of 1823—Article, *Valley of the Mississippi.*

of five hundred and fifty feet above Calcutta; which will give about five hundred and thirty for the mean surface of the river, at that distance, compared with the level of the sea. Benares has been found, by similar observations, to be elevated two hundred and eighty feet above Calcutta. But implicit confidence cannot be placed in the barometer for such measurements, and, it must be confessed, we are still much in the dark on this subject. The inference of Rennell, that the general slope is four inches per mile in the lower part of the river, is not made out by the experiment he slightly notices, tried on a section of ground parallel to one of its branches, the level of which, taken by order of Mr. Hastings, gave a descent of nine inches per mile in a right line of sixty miles. From the above data, however, admitting them to be imperfect, and assuming that the slope of a river forms a curve from its source* to its embouchure, decreasing as it approaches the latter, Captain Prinsep supposed an average slope of six inches per mile in twenty-nine miles, from Allahabad (nine hundred from the sea) to Benares; five inches per mile, in three hundred and twenty-six miles from Benares to Colgong; four inches per mile, in one hundred and sixty-seven miles, between the last place, to which he allowed an elevation of one hundred and thirty feet, and Jellinghee; the same between Jellinghee, by the three Nuddya rivers, and Calcutta, in a distance of ninety-seven miles, placing Jellinghee at an elevation of seventy-five feet; and a fall of one or two inches only per mile, according to season, from Calcutta to the sea, which, by Mr. Kyd's tide tables, and his own registers of the tides at Mud Point and in the Salt Water Lake, he deduced to have a mean level about seven feet below that of the Hoogly at Calcutta.†

The surface of thesea, however, at the head of the Bay of Bengal, has not a constant mean level throughout the year. Independently of the daily oscillations of tide, an important influence is produced by the change of monsoon; and it will easily be imagined, that the extent of that influence must be in proportion to the relative duration and force of the opposite winds, and that it must be greater, too, on the leeward than

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* To this very natural inference may be objected, the small slope of the Mississippi in Schoolcraft's first division of that river above the falls of Peckagama, described by him to have a descent of only three inches per mile, with a current of a mile and a half per hour. (Vide Quarterly Review of 1823, vol. 29.) Some other American rivers have also the peculiarity of commencing their course upon an elevated plain, with a sluggish stream, fed by swamps and lagoons, instead of the rushing torrents of mountain ravines.

† "In January, the path of mean level shews a descent of four feet three inches for the whole distance of sixty-two miles, (to Mud Point) which would give eight inches (decimals of an inch) per mile. In August, the descent is eight feet nine inches, giving a slope of one ~~foot~~ seven ~~inches~~ (decimals) per mile, or more than double what it is in January."—*Gleanings of Science* for January, 1830.—Article, *On the Tides of the River Hoogly*. The mean difference of level between Calcutta and Mud Point appears to be under six feet; but it is assumed, that there may be a slope of half an inch per mile from Mud Point to the sea.

on the windward shore. The northerly winds, which commence at the end of October, and terminate in the first or second week of March, are weak and inconstant in the neighbourhood of the Sand-heads: they are sometimes ushered in by a strong gale, which lasts two or three days; but this is commonly the only instance of their blowing with violence in the upper part of the Bay. The southerly winds, which prevail during the rest of the year, are more constant and have much greater average strength, especially from the middle of March to the setting in of the rains in June. No tide registers have been kept any where on the sea coasts of the Bengal Presidency; but at Mud Point, the northern extremity of Saugor Island which is twenty-four miles in length, Captain Prinsep procured daily observations of the rise and fall, from July 1828 to July 1829:* these shew a difference of thirty-two inches between the lowest and highest mean tide levels, the extremes being in January and June. At Calcutta, the highest tides are in September, caused by the simultaneous influence of the freshes and the equinox. The September tides are commonly highest at Saugor also: there, however, the influence of the freshes terminates in a tangent, and a difference of one or two feet is produced by the easterly direction of the wind, if it continue long in that quarter. A severe gale in the same direction will occasion an extraordinary rise of five or six feet, and inundate the whole Island of Saugor:† a gale from the south-west produces similar effects on the eastern side of the Delta. Partial observations of the spring tides have been made at Gunga Saugor, on the southern shore, during the last two years, by which it has been ascertained, that the highest springs of the north-east monsoon are from four feet to four feet and a half lower than the highest springs of the other season, in ordinary years.‡ Mr. Kyd long since supposed the change of the monsoon to produce a difference to that extent at the Sand-heads. Perhaps the difference in the extremes of the mean monthly tides would be found not to exceed three feet and a half, or, at most, four feet, which would correspond with the Mud Point register, allowing for the distance; and the mean level of the sea, in the centre of the Bay of Bengal, must be taken at some point, probably not more than eight or nine inches above the minimum, if we suppose the influence of the southerly winds

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* Vide Gleanings of Science, for November 1829, Article "*On the Tides of the River Hugli.*"

† Saugor Island was entirely submerged by the gale of May, 1823. The experience of that disaster has induced the grantees and tenants of the land, to strengthen their bunds, to a degree that may secure it from such a calamity, which, fortunately, is of rare occurrence.

‡ In the nautical directions for approaching the Coast of Bengal, seamen are recommended to allow a fathom for the difference of soundings in the opposite seasons. Captain Ross has observed ripples in the upper part of the Bay, in the month of March when the monsoon changes, having a velocity of even twenty miles an hour.

At the Chilka Lake, in Cuttack, the season of the salt manufacture commences with the lifting of the tides in March, which push back towards the north end of the Lake, the scarcely brackish water which it then contains, suddenly changing its specific gravity from 1004 to 1025, and, after a few tides, raising it to 1028, the density of the main ocean. This fact is stated from experiment.

to be three or four times as great as that of the opposite monsoon. In both, there is usually a lull at night; the winter nights are often quite calm, with an unclouded sky, and productive of dense fogs upon the river.

More exact data have been obtained concerning the Calcutta tides, through the industry and intelligence of Mr. James Kyd, who, in 1828, presented to the Asiatic Society, the result of a register carefully kept, shewing the daily rise and fall at the Kidderpore dock gates from 1806 to 1827, inclusive.* His tide table was accompanied with a summary of remarks, from which we extract the following.†

"From the point of low water in the dry season, to that of the highest high water in the freshes, is twenty feet ten inches."

"The greatest mean rise, from low to high water mark, takes place in March, April, and May, and is fifteen feet ten inches."

"The greatest mean rise of tide, from low to high water mark, in the freshes, is ten feet."

"The smallest mean rise of tide takes place in the freshes, and is, at neap tides, only three feet six inches."

"The smallest mean rise of tide, in the dry season, neap tides, is four feet."

"From the lowest fall of the river to high water mark, neap tides, in February, is eight feet."

"From the lowest fall in the river to low water mark in the freshes, neap tides, is twelve feet."‡

"The river is at its lowest in the beginning of March."

"At the beginning of November, although the freshes are out of the river, it is upwards of three feet higher at low water than in March."§

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* Vide Transactions of the Asiatic Society, Vol. XVII, part 1.

† The mean influence produced by the freshes is not given in these remarks; but, by a register kept for several years at the late Mr. Richardson's (now the New Howrah Dock Company's) Yard, it appears, that the average water at his Dock-gate was, from three feet three inches to three feet six inches in the dry season, and from eleven feet three inches to eleven feet six inches in the rains, at low water, the difference being eight feet.

‡ Mr. Kyd states, that, during the inundation in September, 1823, the low water level stood at eighteen feet six inches, the tide having ebbed only fifteen inches on that day.

§ At Mud Point, the mean tides of March and November have the same level, those of January being considerably lower than both.

"The river is in the most quiescent state during the months of November, December, January and February; during these months, the night tides are higher and more rapid than the day tides,* and there are, on some occasions, bores at night."

"The strongest flood tides, and the greatest mean rise of the tides are in March, April, May and June; the day tides, in these months, are higher than the night tides."†

In March, April and May, the water of the Hoogly is slightly brackish off Calcutta in the springs, and the tides are felt fifty miles higher up: but in September, when "the freshes are at their height, there is no visible tide off Calcutta, and the ships do not swing up,"—except when the springs are very strong.

The great rise and fall of tide at the embouchures of the Ganges are not unproductive of benefit, both to agriculture and commerce. As the land has, in consequence, obtained a higher level, the inundation is carried off from the upper part of the Delta soon after the cessation of the rains, and an easy drainage is afforded to the newly cleared estates in the Sunderbuns. To the Pilot, indeed, these tides may be a cause of anxiety, often requiring the greatest exertion of his vigilance and skill; but, in compensation for the dangers of the stream, and of the spits of sand, called Sand-heads, which they accumulate at its mouth (instead of a continued bar never having more than fifteen feet water, as at the embouchures of the Nile and the Mississippi,) we have the important advantage of a deep channel affording anchorage for the largest ship of war: "so that, *if* the Americans of the Mississippi boast a longer, more constant, and better course of up-land navigation, the inhabitants of Calcutta may set off against them the superior advantages of the egress for their commerce."‡

Enough, however, has been said to shew the immense superiority of the North American rivers for inland, especially for Steam Navigation. Although the Ganges and the Burhampootur, (for, in that respect, they are about equal,) must be regarded as rivers of twice the magnitude of the great Mississippi, measured by their maximum

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* "As much as two feet."

† "Seldom more than one foot."

‡ Vide Notes to accompany the Charts of the Ganges, page 40. Captain Ross has kindly furnished the following Memorandum—"A ship will not find less than five fathoms in the eastern channel, at low tide, as high up as the spit buoy. Above the spit buoy, and through the old channel, the depth at low water is three or three and a quarter fathoms, and in Thornhill's Channel, two and three quarters or three fathoms, in the north-east monsoon."

expenditure and by their relative breadth,* the rapidity of their discharge renders them, in the dry season, comparable only (if at all) with the ramifications of the latter above the forks of the Ohio and Missouri. Like the Ganges, the Missouri is shallow and full of sand-bars, with a slope more considerable, and a current more rapid, than those of the Upper Mississippi and its eastern tributaries. Two thousand miles up, at the fork of the Yellow-stone, the Missouri preserves its general breadth of five to eight hundred yards from bank to bank, shrinking about one-third as the freshes retire. In 1819, an attempt was made to reach the Yellow-stone with steam boats, and perhaps might have been successful had their draught of water not exceeded that of the Hoogly and Burhampootur.† From the published accounts of the expeditions of Lewis and Clarke, and of Major Long's and Governor Cass' parties, and others, it does not appear a more difficult achievement to carry up a steamer to the first falls of the Missouri, about two thousand five hundred miles from its mouth, and three thousand seven hundred from the sea, or to the falls of St. Anthony on the Mississippi, eight hundred and forty-three miles above the confluence of the former,—or to the rapids and falls of most of the other feeders of the great river, than to accomplish a steam voyage to Allahabad, in the dry weather. Much more than this will be feasible, when steamers shall have been reduced to a draught of two feet: the navigation of the Ganges will be open to them, as far, at least, as Cawnpore, and that of the Jumna, perhaps, to Delhi. The numerous difficulties which exist to the attainment of the object, in a country where timber is not procurable of equal lightness with fir or cedar, have been sufficiently noticed in detail: but that, in the end, they will be successfully overcome, we confidently rely on the progress already made, and on the ingenuity of those whose skill and science are now engaged in the pursuit, aided, as no doubt they will be, by the intelligence of England. The perfect establishment of steam navigation on the Indian rivers will not be a rivalry, but

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* The breadth of the Mississippi, from the Sea to the Missouri, is half a mile, scarcely varying more than between eight hundred and nine hundred yards: that of the Ganges is very unequal, but it may be reckoned to average a mile in the dry season, on its whole course through the plains, and two miles in the freshes.

† "I regret to state that the expedition, up the Missouri to the Yellow-stone, has, in part, failed. The steam boats destined for the Upper Missouri, after laboring against the current for a number of weeks, were obliged to give up the enterprise. Every exertion has been made to overcome the difficulty of navigating the Missouri, with the power of steam; but all will not do. The current of that river, from the immense quantity of sand moving down with the water, is too powerful for any boat yet constructed. The loss, either to the Government or the contractor, will be very great. Small steam boats of fifty tons burthen, with proper engines, would, I think, have done much better. Boats like those employed, of twenty to thirty feet beam, and six to eight feet draught of water, must have uncommon power to be propelled up a river, every pint of whose water is equal, in weight, to a quart of Ohio water, and moves with a velocity hardly credible. The barges fixed to move with wheels, worked by men, have answered every expectation: but they will only do when troops are on board, and the men can be changed every hour."—*Letter from Mr. Austin to Mr. Schoolcraft, dated Herculaneum, 17th September*, 1819. *Vide Schoolcraft's Travels in the central portions of the Mississippi Valley, p.* 248.

a step in advance of what has been accomplished elsewhere. The experiments on the Ganges will open to the power of steam, those rivers which are now considered impracticable in America, and almost every stream of sufficient magnitude and importance, to convey merchandize on a loaded barge.

The American rivers, which fall into the Mississippi on its right bank, have the same disadvantage as the Ganges, in the absence of forest for the supply of fire-wood; and only one coal district has yet been noticed in the plain of the Missouri. In Bengal, where the dense population renders the lands on the river bank of high value, it is doubtful if this deficiency could be supplied by cultivation cheaper than by the present system of coal depôts. The superiority of coal, too, in the compactness of its conveyance, must induce a preference for that description of fuel, even at some additional cost, in every place where it can be procured. Fortunately, there have been discovered coal beds in various parts of India, besides the district of Burdwan. The coal of the Kasiya hills, in Sylhet, was brought to notice some time since by the late Mr. Jones, who described it to be of a nature similar to the Cannel coal of England: its general quality, however, in our present imperfect knowledge of the matter, is supposed to be inferior, and its locality is not favorable for working the mines. But the coal of Assam, to which we have already adverted, a coal perfectly suitable for welding iron and steel, promises to be a cheap and abundant resource for the steamers, which may hereafter be established upon the Burhampootur, and upon the Soorma and Megna. On the right bank of the Ganges, Captain Tanner lately discovered a patch of inferior coal in the district of Bhagulpoor: but a more important discovery has been made, which will greatly facilitate steam navigation in the higher parts of that river; a valuable vein of coal, to which the attention of Government was first invited by the Acting Magistrate of Sheerghatty, in 1828, has recently been opened by Lieutenant Sage, in the Palâmoo district, upon the Koel river, a small stream which flows into the Soane, whose embouchure is a little above Patna. The quality is found to be fully equal to the best Burdwan, and it is hoped, from its centrical position, and the existence of a water communication in the rains, almost to the foot of the mine, that the fuel stations on the upper part of the Ganges will, hereafter, be supplied very much more cheaply than they were on the late experimental voyages. Already a depôt of this coal has been formed at Patna. Captain Franklin traced the same deposit to the district of Sohagpoor; and again it shews itself under latitude twenty degrees N. in a south-easterly direction, near the fork of the Wurda and Payn Gunga rivers, which flow into the Godavery, affording the opportunity of forming coal depôts at Masulipatam. Thus, within a few years after the first discovery of the mineral in India, it has been traced through fifteen degrees of longitude, almost in a direct line from the eastern side of the valley of Assam, through Sylhet and Bengal, to the confines of the Hyderabad territory: we may now consider the supply to

be inexhaustible, and look to it as a resource for firing, and for many branches of manufacturing industry, as well as for steam navigation,—a resource, the nature and value of which were entirely unknown before the establishment of our dominion in the country. On the other side of India, indications of coal had long since been reported in Cutch: some specimens have, at length, been conveyed to Bombay from that district: their quality is said to be bad; but the researches now making, under the auspices of the Bombay Government, may lead to more successful results, and if they should disappoint expectation, in regard to the resources of our own territories, the mineral is known to exist in an island of the Persian Gulph, which the authorities at that presidency have judiciously sent to explore. The discovery of a serviceable coal of easy access, in the Bombay provinces, or within reach of a cheap water conveyance, would be a very valuable acquisition to a place which has, hitherto, been dependent upon supplies from England or Bengal, enhanced in price by a freight three or four times the prime cost of the article: it would remove the most serious objection to the employment of steam on that side of the peninsula.

Note.—Since these pages were in the press, the boat built by Messrs. Kyd and Co. for a river steam-tug, on Captain Forbes's plan, has been launched, at a draught of only ten inches. Loaded with thirty tons of kentledge, the weight calculated by Captain Forbes for a twenty-five horse engine, and five days' coal, she was found to draw eighteen inches; and the draught was increased to two feet, (exactly corresponding with his estimate) when loaded with fifty tons of kentledge, which would allow her to carry an engine of thirty-five or forty horse power. With this quantity of ballast, placed on the intended site of the machinery, and at an even draught of two feet, she was towed by the Burhampootur for an hour off Calcutta, to ascertain the degree of resistance she would occasion, and did not reduce the speed of that veseel more than one eighth, the rate with the tug being five nautical miles and three quarters, and without it, six and a half. The trial was made by Captain Johnston in slack water, on the 9th October: he reported the boat to be "perfectly under command of the helm; stiff, and exhibiting not the slightest appearance of strain in any part of the trussing."

POSTSCRIPT.

The work was already in course of delivery, when a report was made of the fourth voyage of the Hoogly to Benares, which it has been deemed worth while to annex to the Appendix. The peculiarity of this voyage is, that the steamer was employed the whole way as a tug; notwithstanding which, she performed the distance from Calcutta in twenty-four days, including several very short stages, having been only two hundred and two hours under steam; a result more successful than was anticipated, and superior to all her previous performances. She was accompanied by the Burhampootur, also used as a tug, and both vessels arrived at the same time. It is now therefore no longer a matter of doubt, that the current of the Ganges may be stemmed at any season by a steam tug of ordinary power, and that Troops and Military Stores and Treasure may, in this way, be transported with facility and despatch to the up-country stations on the river bank, or in its vicinity.

APPENDIX A.

GENERAL DESCRIPTION OF STEAMERS IN BRITISH INDIA.

	NAMES.	Length between Perpendiculars.	Breadth extreme.	Tonnage. By Act of Parliament as a sailing Vessel.	Tonnage. By Act of Parliament as a Steamer.	Total Horses Power.	Number of Engines.	Builder.	Engineer.	Cost ready for Steaming.	REMARKS.
		Feet.	Feet.	Tons.	Tons.	No.	No.			Sa. Rs.	
Private Steamers.	COMET AND FIREFLY, ... *Note.*—Number of revolutions per minute, when light, 36—when loaded, 30.	89 „ 4	13 „ 3½	76 42/94	54 88/94	20	2	J. Anderson, Kidderpore near Calcutta, in 1826.	Henry Maudeslay.	92,013 2 cost of the two.	These two vessels, the property of Messrs. Alexander and Co., were constructed for smooth water, and are used as accommodation boats. Diameter of paddle-wheels, .. Feet 9 0 Length of paddle-boards, ... 4 0 Breadth of ditto, ... 1 0 Number of ditto, (to each wheel,) . 8
	EMULOUS, ... *Note.*—Number of revolutions per minute, when light, 28—when loaded, 24—length of stroke 3 ft. 4 ins.	126 „ 9	19 „ 2	226 64/94	127 74/94	100	2	Evans, River Thames, in October, 1825.	Horsley Company.	about 170,000	Sailed out to the Hoogly, and was purchased by the Merchants of Calcutta, as a river tug, for which she is now used. Diameter of paddle-wheels, .. Feet 12 6 Length of paddle-boards, ... 8 0 Breadth of ditto, ... 1 8 Number of ditto, (to each wheel,) 12
	FORBES, ... *Note.*—Number of revolutions per minute, when light, 25—when loaded, 23—length of stroke 4 ft.	126 „ 10	22 „ 6	302 17/94	161 83/94	120	2	Howrah Dock Company, opposite Calcutta, in January, 1829.	Bolton and Watt.	310,000	Built for towing vessels—has made a voyage to China—the property of Messrs. Mackintosh and Co. of Calcutta. Diameter of paddle-wheels, .. Feet 15 0 Length of paddle-boards, ... 8 0 Breadth of ditto, ... 2 0 Number of ditto, (to each wheel,) . 14
Government Steamers.	DIANA, ...	100 „ 0	16 „ 8	132 82/94	89 52/94	32	2	Kyds and Co. Kidderpore, launched in July, 1823.	Henry Maudeslay.	70,000	The Machinery was first sent to China with the frame timbers, &c. but the proprietor changing his plan, forwarded the whole to Calcutta, where a new vessel was completed by the aid of a private subscription. On the Burmah War breaking out, she was purchased by Government, and proved highly useful in the Irrawaddy; she is now at Moulmein, still the property of Government. Diameter of paddle-wheels,.. Feet 12 0 Length of paddle-boards, ... 5 0 Breadth of ditto, ... 1 4 Number of ditto, (to each wheel,) . 6
	ENTERPRISE, ... *Note.*—Number of revolutions per minute, when light, 24 to 25—when loaded, 18 to 20—length of stroke 4 feet.	141 „ 6	27 „ 8	464 2/94	275 41/94	120	2	Gordon, at Deptford, in February, 1825.	Ditto.	400,000	Intended to carry passengers between India and England—purchased by Government for General Service—lately received heavy repairs at Bombay. Diameter of padd e-wheels, .. Feet 15 0 Length of paddle-boards, ... 7 0 Breadth of ditto, ... 1 5 Number of ditto, (to each wheel,) 14
	IRRAWADDY AND GANGES, ... *Note.*—Number of revolutions per minute, when light, 30—when loaded, 18 to 20—length of stroke 3 ft. 8 ins.	110 „ 5	24 „ 6	305 57/94	170 48/94	80	2	Kyds and Co. Kidderpore, in 1826-7.	Ditto.	200,000 each	Built for Government and employed for transporting troops, towing ships, &c. Diameter of paddle-wheels, .. Feet 12 0 Length of paddle-boards, ... 7 0 Breadth of ditto, ... 1 8 Number of ditto, (to each wheel,) . 12
	TELICA, ... *Note.*—Number of revolutions per minute, when light, 30—when loaded, 24 to 26.	92 „ 10	17 „ 6	134 0	81 33/94	50	2	Humble and Hurry, Liverpool, in 1824.	Fawcett & Co. Liverpool.	65,000	First sent to South America—afterwards came to Calcutta—sold to the Bombay Government.
Vide Note.	BURHAMPOOTUR, ...	99 „ 0	18 „ 0	152 3/94	86 19/94	50	2	Kyds and Co. Kidderpore, in January, 1828.	Henry Maudeslay.	144,000	Built for Government, for river navigation. Diameter of paddle-wheels, .. Feet 13 0 Length of paddle-boards, ... 5 0 Breadth of ditto, ... 1 4 Number of ditto, (to each wheel,) 12
	HOOGLY, ... *Note.*—Number of revolutions per minute, when light, 30—when loaded, 26—length of stroke 2 ft. 8 ins.	102 „ 8	18 „ 0	158 30/94	89 40/94	50	2	Howrah Dock Company, opposite Calcutta, in March, 1828.	Ditto.	124,600	Ditto.
	HUGH LINDSAY, ...	140 „ 4	24 „ 10	411 0	0 0	160	2	Bombay, at the Honorable Company's Dock-yard, in 1829.	Ditto.		

The above Statement has been compiled by Mr. Seppings, Surveyor of Shipping to the East India Company, at Calcutta; the measurements, except the Hugh Lindsay's, which is copied from a Bombay paper, are taken according to Act of Parliament (as regards length and breadth); the length, from fore part of stern under the bowsprit, to aft part of stern post along the rabbit of keel; the breadth, at the broadest part above or below the main wales.

APPENDIX A.

GENERAL DESCRIPTION OF STEAMERS.

NOTE.

In copying the Drawings prepared by Mr. Seppings for this work, the Artist, being hurried in the execution, has committed some unimportant inaccuracies in tracing the lines, and has made a few trifling omissions.

Since the Drawing of Captain Forbes's Boat was prepared, it has been found necessary to fit her with a Dead Wood and Rudder, on the plan of the Thames Barges, and Iron plates have been substituted for Copper.

In Captain Cowles's Plan, the Iron braces or ties (the end ones) are intended to fasten upon Chocks over the Keel, placed between the floor timbers.

The following is a list of the Drawings : the absence of the Telica, and want of opportunity, in the case of the Comet, Firefly and Emulous, have caused these to be omitted.

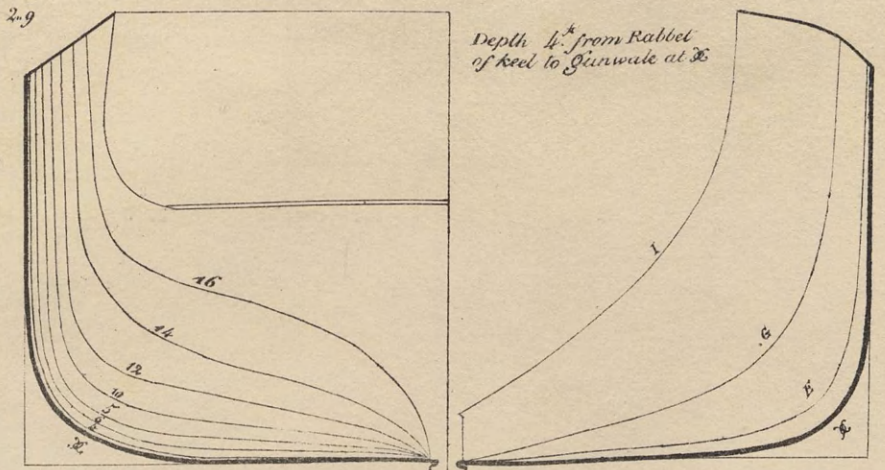
1. King of Oude's Steamer.
2. Forbes.
3. Diana.
4. Enterprise.
5. Irrawaddy and Ganges.
6. Burhampootur.
7. Hoogly.
8. Ditto, (shewing the fastenings).
9. Captain Cowles's River Tug.
10. Captain Forbes's Ditto.

King of Oude's STEAMER
Built at Lucknow.

Number of Stations or spaces between 16 station and ℄ are as follows

16 to 14 distance between 2..9
14
12 } at equal distances
10 } of 2..9 from
8 } each other or
6 } 10 divisions.
4
2
0
4
2

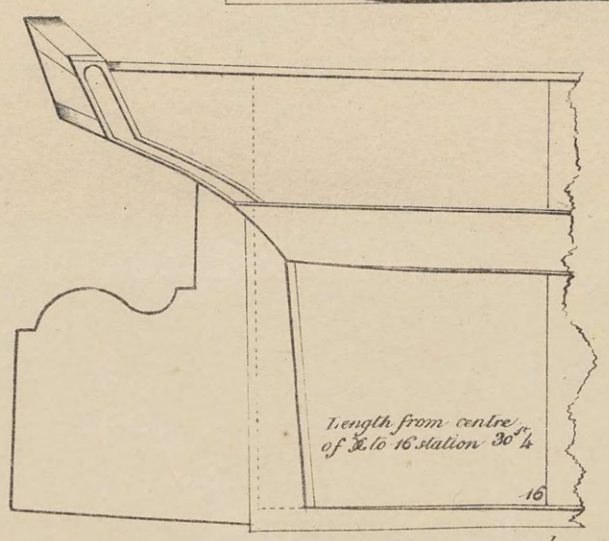
2 to ℄ (centre) = 2..10.

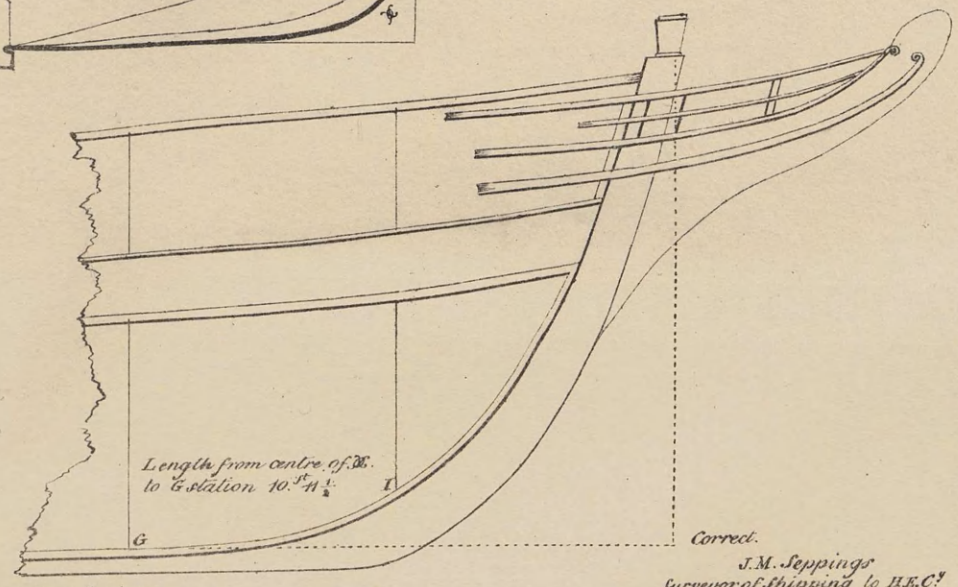


Depth 4.ft from Rabbet of keel to Gunwale at ℄

Number of Stations or spaces between G station and ℄ are as follows.

G to F distance between 2..9
F to C " " " "
C to B " " " "
B to ℄ " 2..8
(or 4 divisions.)





Scale. 1/4 Inch to a foot
1 2 3 4 5 6 7 8 9 10

Correct.
J.M. Seppings
Surveyor of Shipping to H.E.C.I
in Marine dep.t Calcutta 1830

Drawn on Stone by J.B.A. Tassin

Printed at the Gov.t Lith.c Press.

FORBES. Steamer built (opposite Calcutta) by the new Howrah Dock Comp.y (Owners Messrs. M.cIntosh & C.o

BODY PLAN

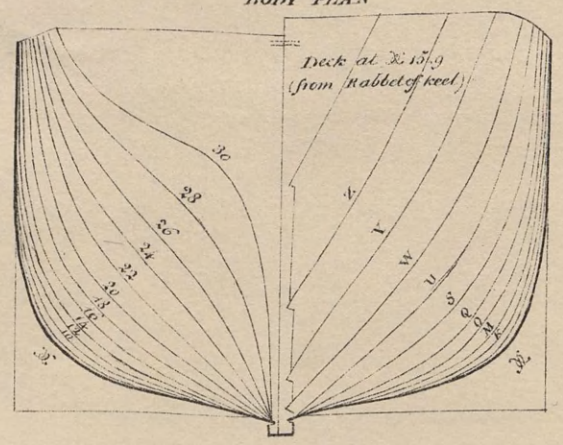
N.o of Stations between 26 Station and X. are as follows

26 to 24 distance between 4 f.t 3.

24
22
20
18
16
14
12
10
8
6
4
2

at equal distances of 4-3 from each other or 12 divisions

2 to centre of X. 2 f.t 8 1/2



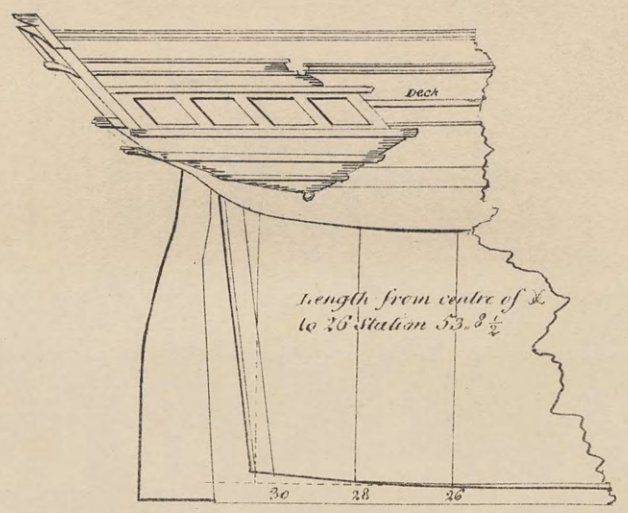
N.o of Stations between U Station and X. are as follows

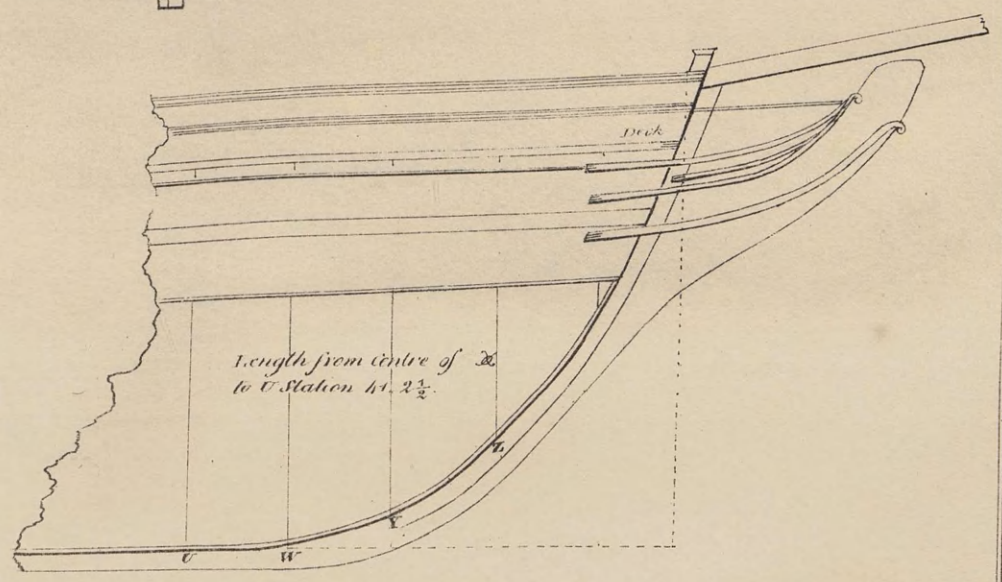
U to S distance between 4.3.

S
Q
O
M
K
H
F
D
B

at equal distances of 4 f.t 3. from each other or 9 devisions

B to centre of X. 2 f.t 11 1/2





Scale. 1/8 Inch to a Foot

1 2 3 4 5 6 7 8 9 10

(Correct) J M Sippings
Surveyor of Shipping to H.E.C.
in Marine Dep.t Calcutta 1834.

Drawn on Stone by J.B.A. Tassin

Printed at the Gov.t Lith. Press

The Honble Companys Steamer DIANA built at Messrs Kyds & Co Dock yard Kidderpore near Calcutta

Number of Stations between
20 station and K are as follows
20 to 18 distance between 4.0
18
16
14
12
10
8
6
4
2
(1)
(4)
(2)
(2) at equal distances of 4.0 from each other or 12 divisions
to centre of K 3.10

Dock at K

Number of Stations between
G station and K are as follows
G to K Distance between 4.0
K
C
A
F
(D)
(B) at equal distances of 1.f from each other or C divisions
B to centre of K 3.9

Length from centre of K to (20) Station 51.10

Length from centre of K to 2 station 27.9

Scale 1/4 inch to a foot.
0 1 2 3 4 5 6 7 8 9 10

Certified J.M. Sopping
Surveyor of Shipping to H.E.I.Co
in marine dept Calcutta 1830.

Drawn on Stone by J.B.A. Tassin

Printed at the Govt Lith Press.

The Honble East India Company's Steamer ENTERPRIZE built by Mess.rs Gordon & Co upon the Thames.

Nos of Stations between 23 station and K are as follows

23 to 22 distance between 3 ft 0

22, 18, 16, 14, 12, 10, 8, 6, 4, 2 — at equal distances of 6 feet from each other or 10 divisions

2 to centre of K 6 ft

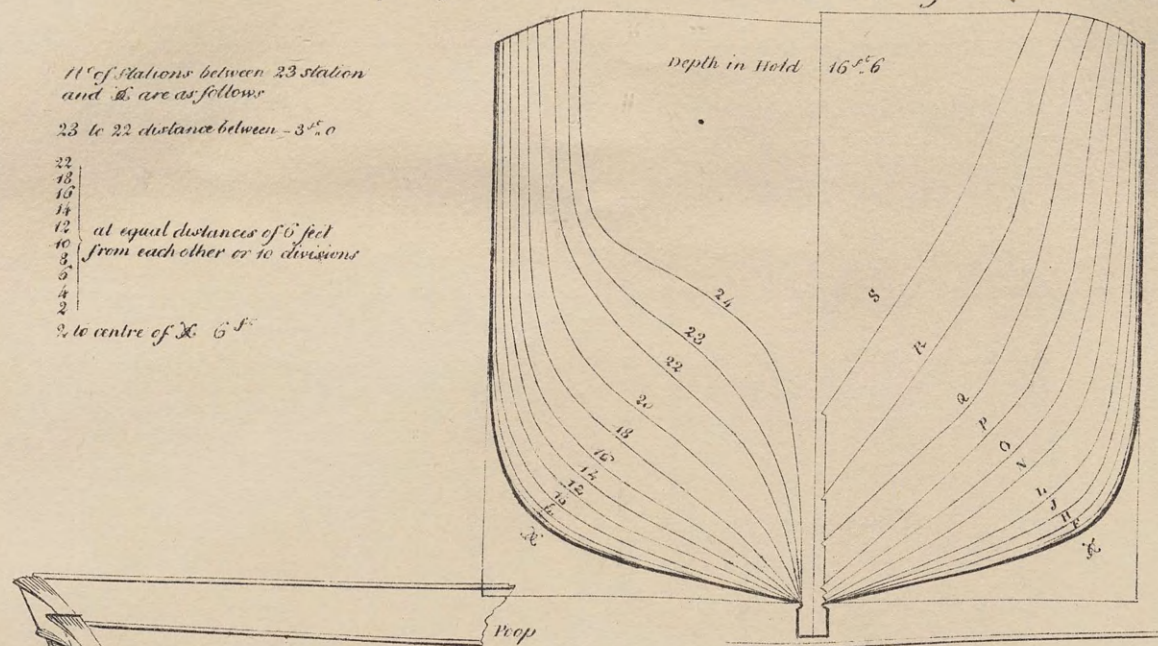
Depth in Hold 16 ft 6

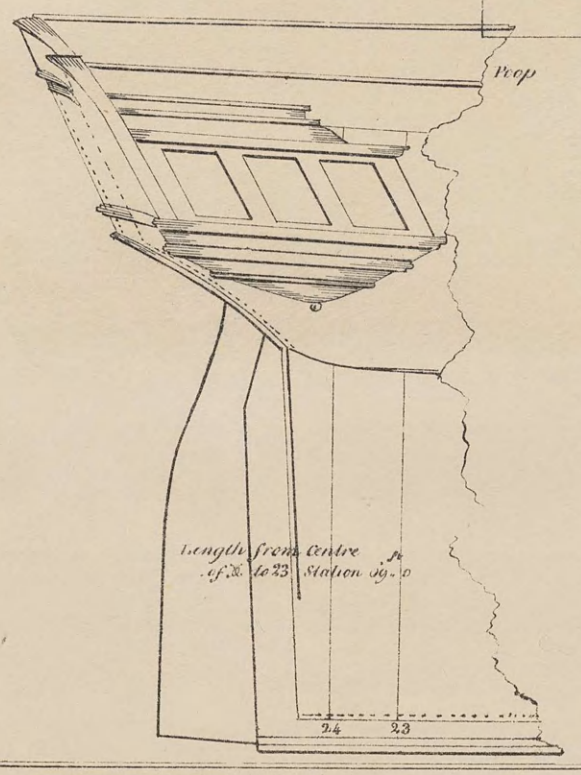
Nos of Stations between N station and K are as follows.

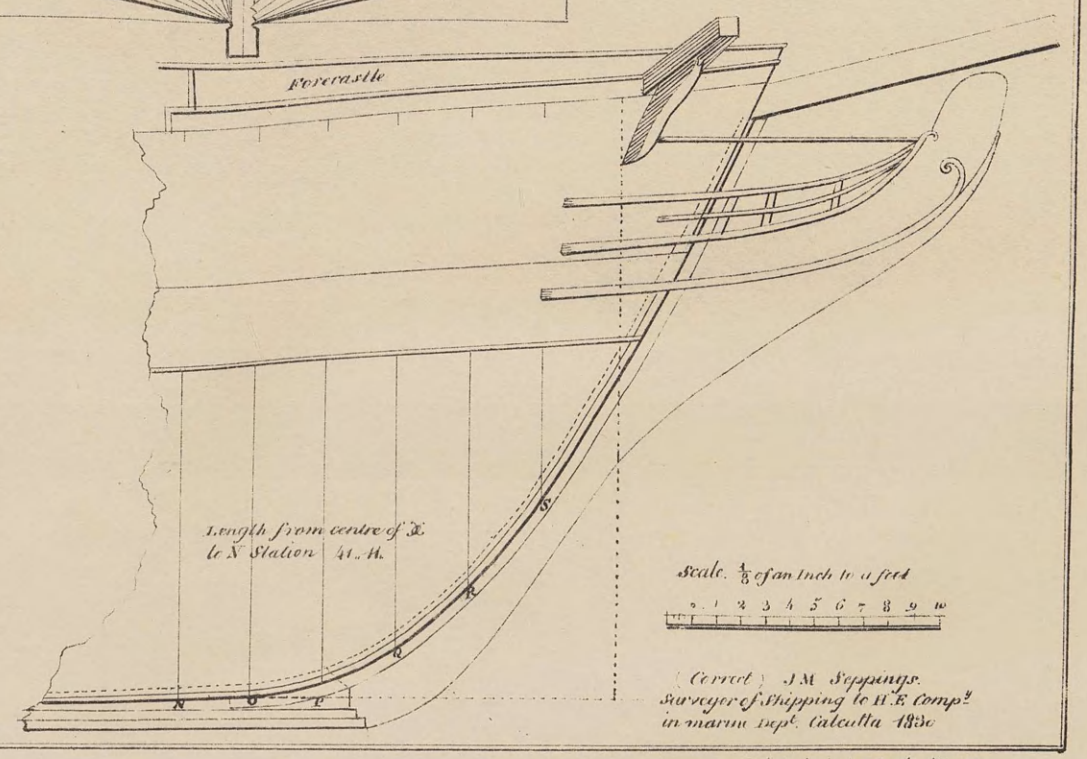
N to L distance between 6 ft 0

L, J, H, F, D, B — at equal distances of 6 feet from each other or 6 divisions

B to K centre 4 ft 11







Scale. 1/8 of an Inch to a foot

0 1 2 3 4 5 6 7 8 9 10

(Correct) J M Seppings
Surveyor of Shipping to H.E. Comp.y
in marine Dep.t Calcutta 1830

Drawn on Stone by J.P.A Passin.

Printed at the Gov.t Lith Press

The Honble East India Compy's Steamers IRRAWADDY and GANGES built at Messrs Kyds & Co Dock-yard (Kidderpore near Calcutta.)

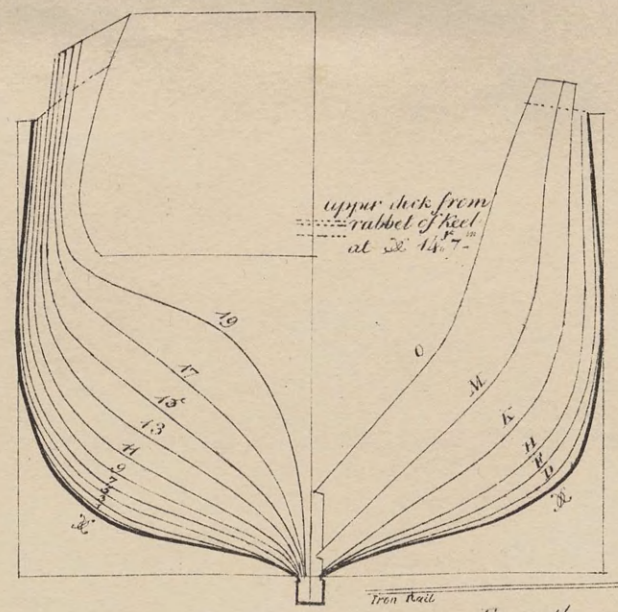
Nos of Stations between 19 Station and X are as follows

19 to 17 distance between 4 ft 9.

1
15
13
11
9
7
5
3
(4)
(2)
(2)

at equal distances of 4 ft 9 from each other or 11 divisions

to centre of X 5 ft 2



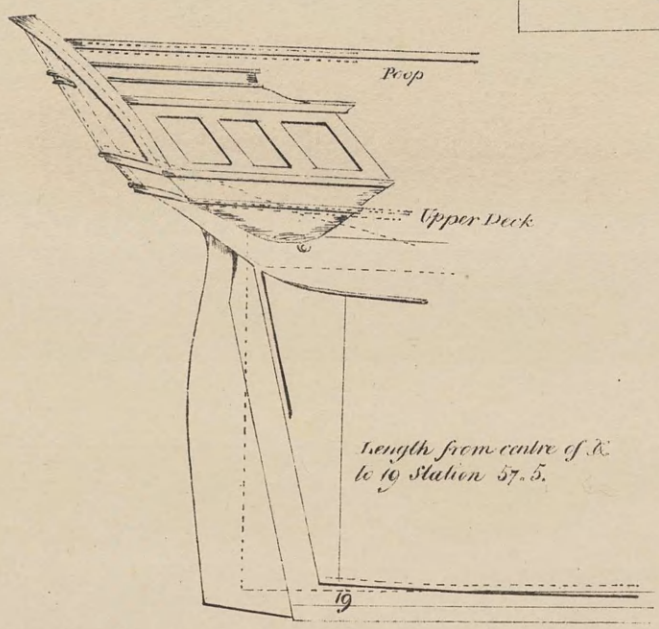
Nos of Stations between K Station and X are as follows

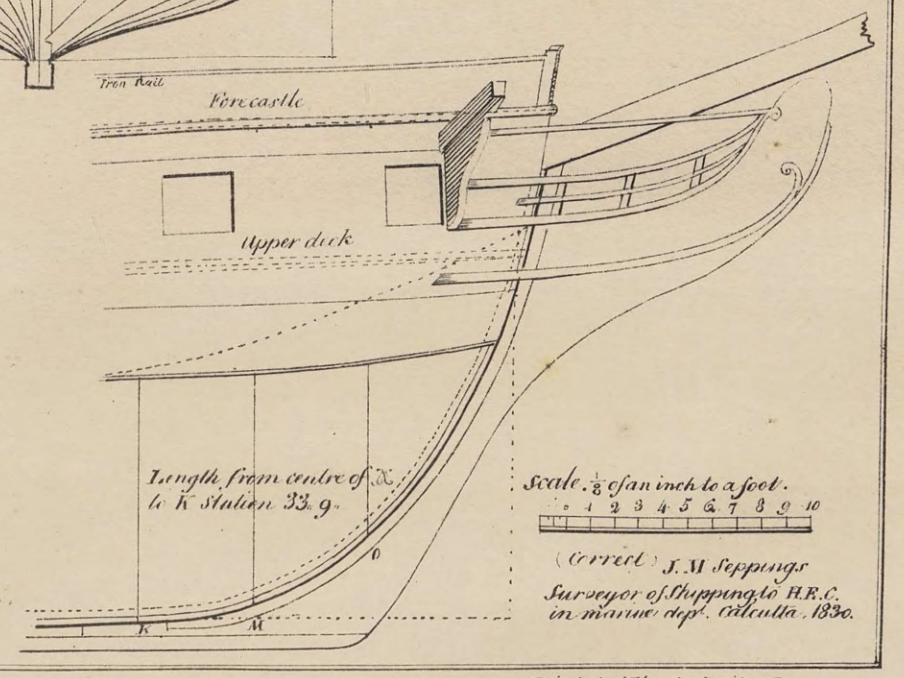
K to H distance between 4 ft 9 in

H
F
D
(B)
(D)
(B)

at equal distances of 4 ft 9 from each other or 5 divisions

(B) to centre of X 5 ft 3 in





Scale. 1/8 of an inch to a foot.

0 1 2 3 4 5 6 7 8 9 10

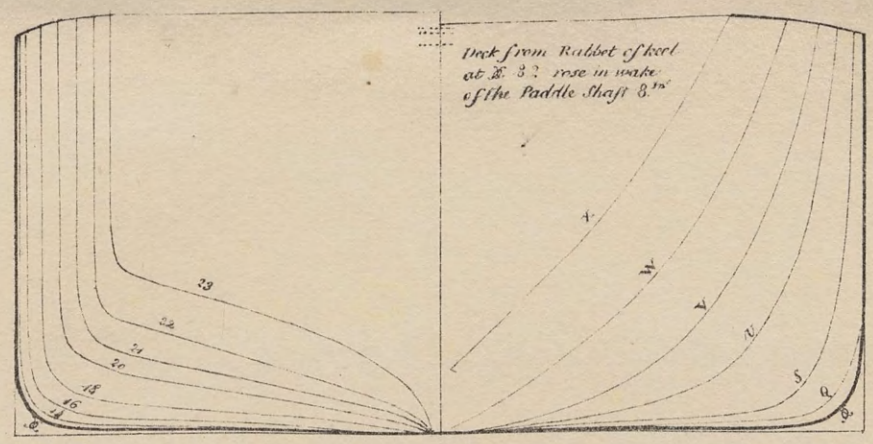
(Correct) J. M Seppings
Surveyor of Shipping to H.E.C. in marine dept. Calcutta. 1830.

Drawn on Stone by J.B.A. Tassin.

Printed at the Govt Lith. Press.

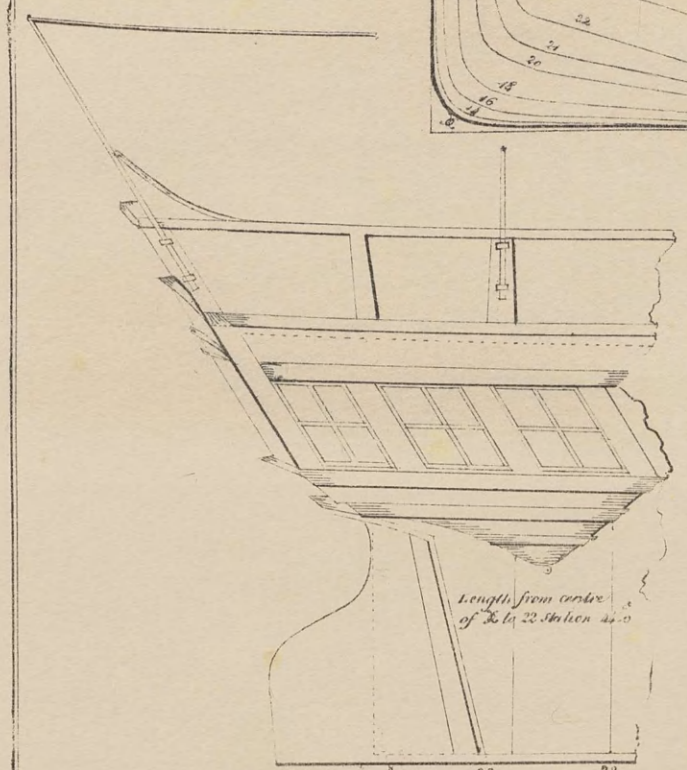
The Honble East-India Company's Steamer BURRAMPOOTER built at Messrs. Kyds & Co's Dock-yard (Kiddeerpore near Calcutta)

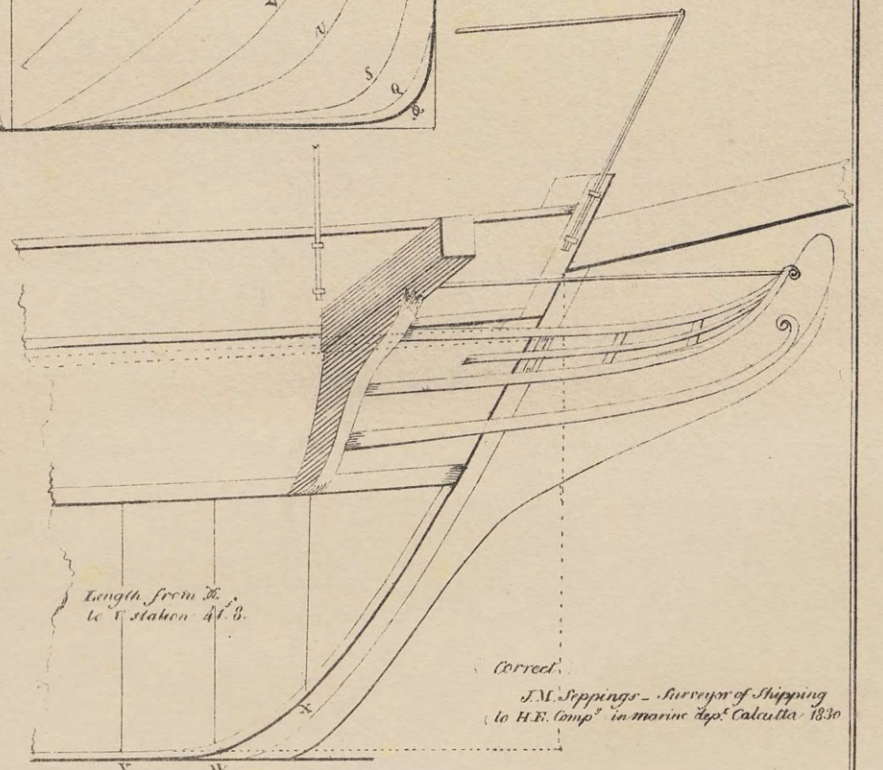
Number of Stations or double Room and spaces between 22 Station and X. are as follows
Station 22 distance from 22 Station 4 ft
13
12
11
10
9
8
7
6
5
4
3
2
1
at equal distances of 4 from each other or 10 Divisions



Deck from Rabbet of keel at X. 3? rose in wake of the Paddle Shaft 8 Inc

Number of Stations or double Room and spaces between IV Station and S. are as follows
Station IV to S 4 ft 5
S
R
Q
M
K
H
F
D
B
A
at equal distances of 4 ft from each other or 10 divisions





Scale ¼ of an Inch to a foot
1 2 3 4 5 6 7 8 9 10

Correct
J.M. Seppings - Surveyor of Shipping to H.E. Comp.a in marine Dep.t Calcutta 1830

Drawn on Stone by J.A. Tassin.

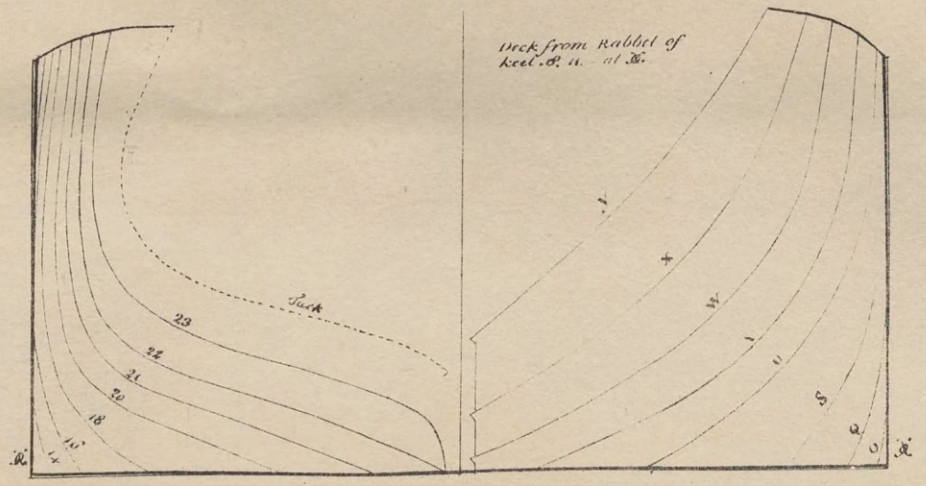
Printed at the Gov.t Lith.c Press

The Honble East India Company's Steamer HOOGLY built (opposite Calcutta) by the New Howrah Dock Company.

Nos of Stations between 22 Station and ℄ are as follows
22 to 20 distance between 4 - 11

20
18
16
14
12
10
8
6
4
2
℄

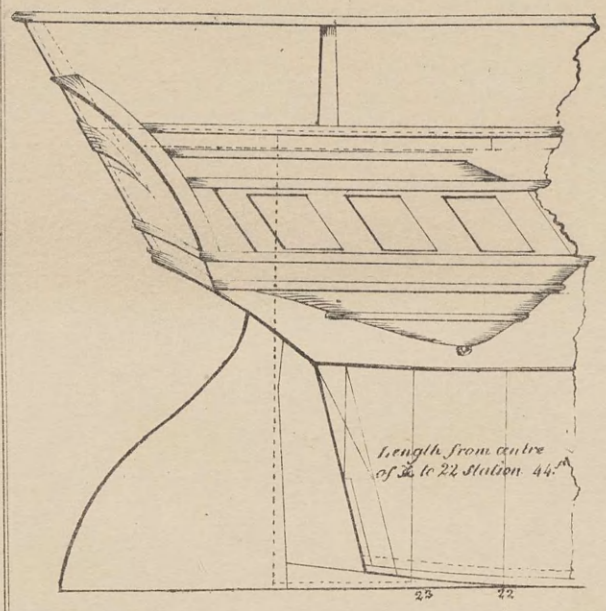
at equal distances of 4 f.t from each other or 11 divisions

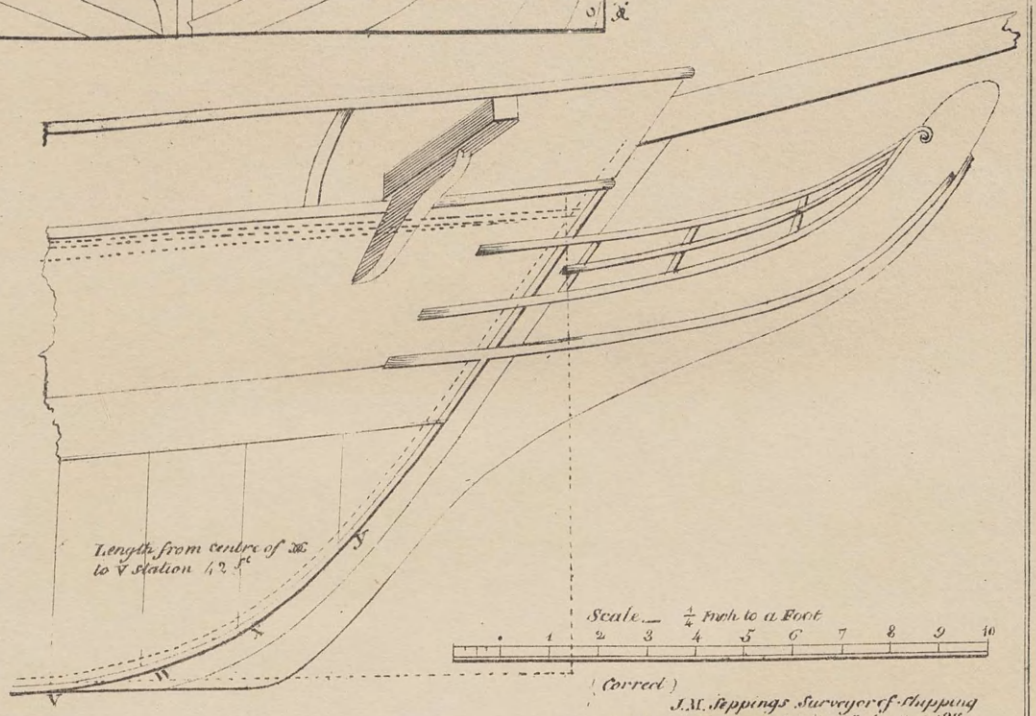


Nos of Stations between V station and ℄ are as follows
V to U distance between 2.6

U
S
Q
O
M
K
H
F
D
B
℄

at equal distances of 4 f.t from each other or 10 divisions



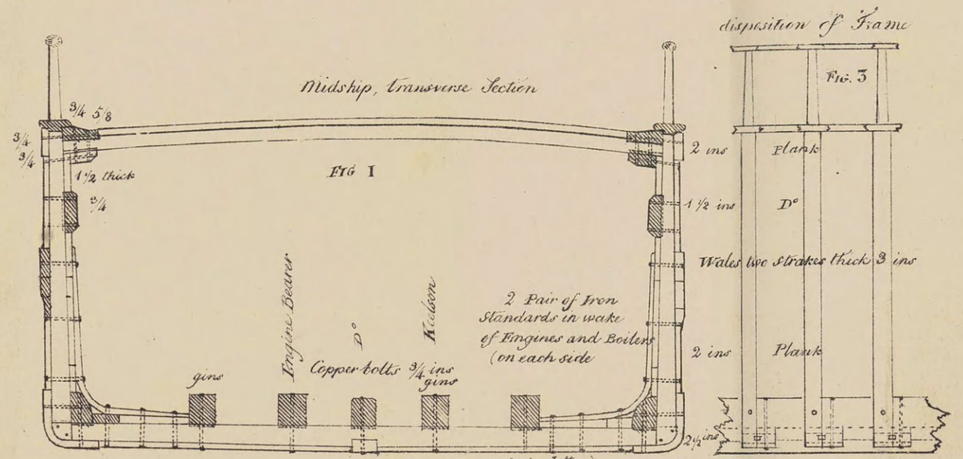


(Correct)
J.M. Seppings Surveyor of Shipping to H.E.I.C. in Marine Dept — Calcutta 1830.

Drawn on Stone by J.B.A Tassin.

Printed at the Govt Lith Press

Plan pursued by Mr. Seppings in fastening the Honble Comps. Steamer HOOGHLY.



Floors scored only 1/2 inch. — (2 ins bottom) Heads of floors and Heels of Fullocks rounded off as here shewn

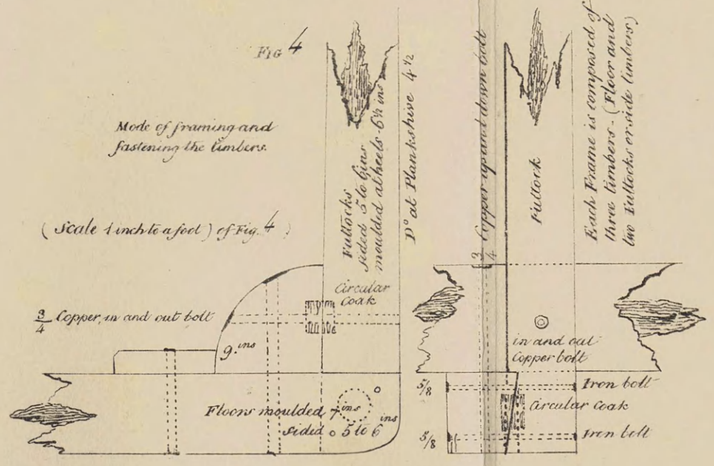
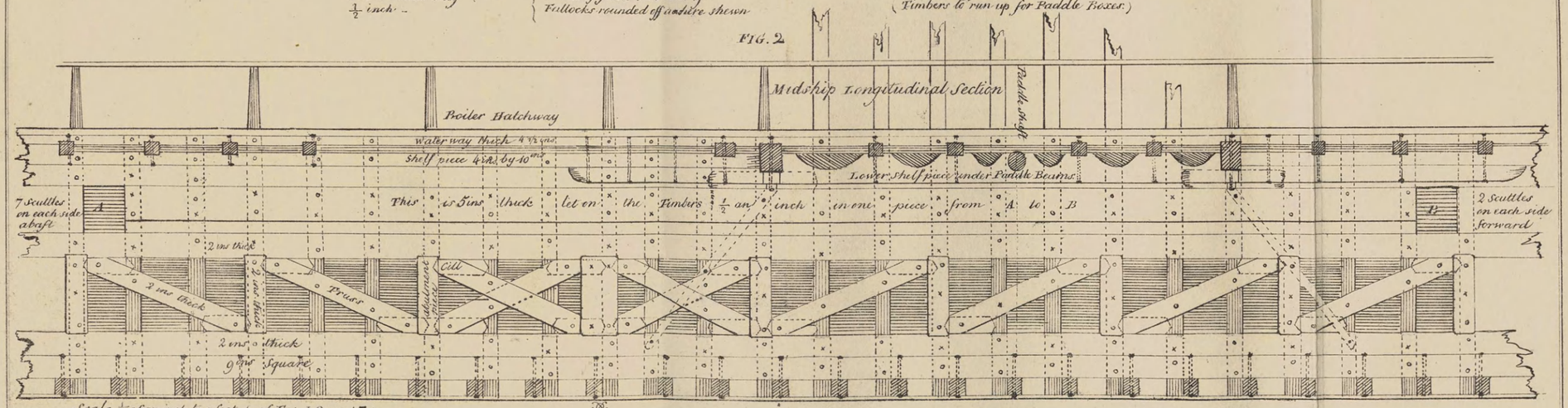


FIG. 2



NOTE. The Hooghly is built entirely of Teak wood. Copper fastened up to the Wales above them with Iron, all the Bolts marked in Fig. 2 are throughs ones, all the planks on the sides (inside and outside) are scarphed, upon the Flat of the bottom they are butted (as is usual) The waterways, Shelf pieces, Engine Bearers, Keelson, thick Pieces (at Head of Floors to connect the frame timbers together) Planks outside and inside are in 40 Feet to 60 Feet lengths. J.M.S.

J.M. Seppings — Surveyor of Shipping to the Honble East India comp.s marine Dep.t Calcutta 1830.

Drawn on Stone by J.B.A Tassin.

Printed at the Gov.t Lith.c Press.

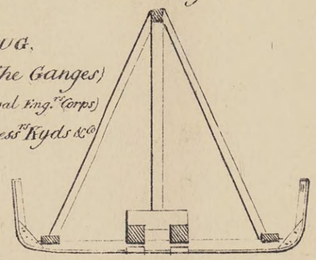
a Drawing of a STEAM-TUG,
for shallow water (to navigate the Ganges)

Proposed by Captain Forbes (Bengal Engr. Corps)

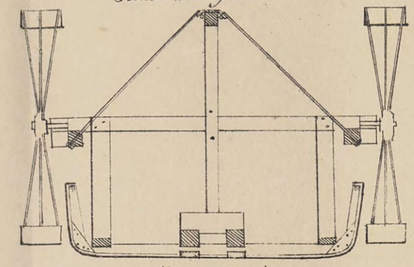
Building by Contract, at the Dock-yard of Messrs. Kyds & Co

Kidderpore near Calcutta

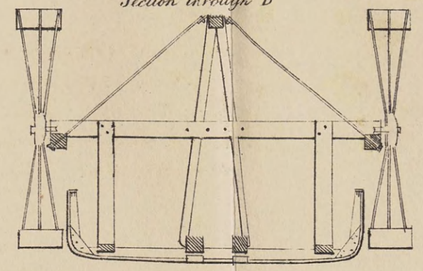
Section through B



Section through C



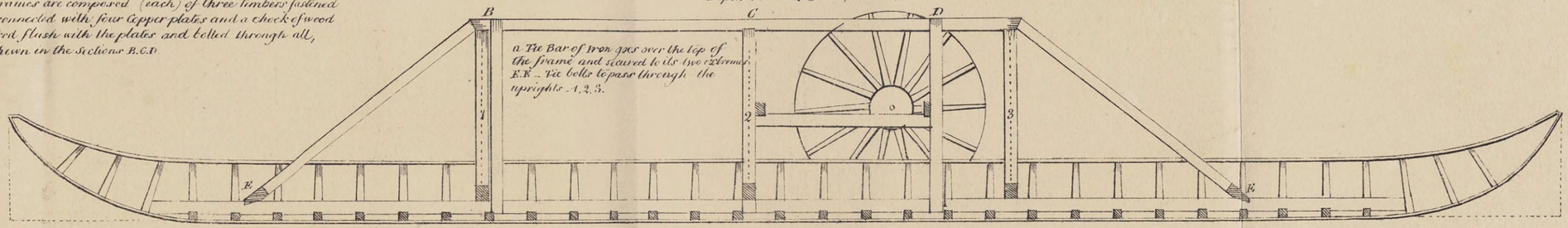
Section through D

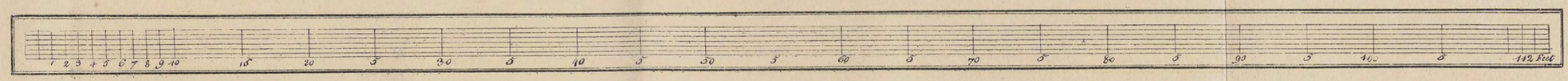


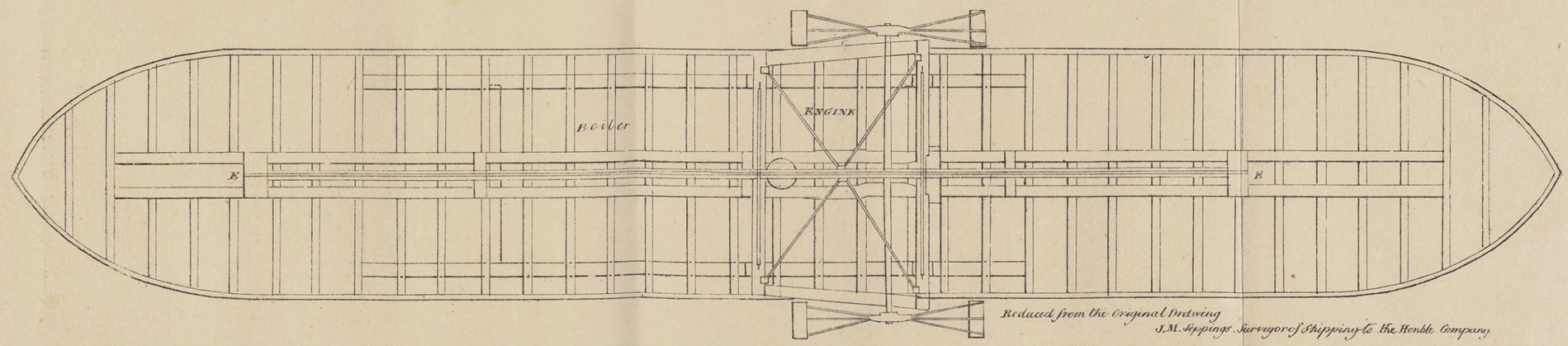
Length ..... 112.0 feet
Breadth 18.0
Depth 4.3

Draft of water with a 25 horse condensing Engine complete, Coals Stores &c aboard not to exceed 2 Ft

(NOTE.) This Boat is built without any beams or Deck the Frames are composed (each) of three timbers fastened and connected with four Copper plates and a chock of wood Worked flush with the plates and bolted through all, as shewn in the Sections B.C.D







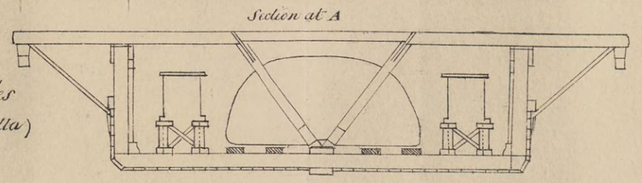
Reduced from the original Drawing
J.M. Sippings Surveyor of Shipping to the Honble Company

Drawn on stone by J.B.A. Tassin

Printed at the Govt. Lith. Press.

a Drawing of a
STEAM-TUG
for Shallow Rivers Proposed by Capt.n C Cowles
(1st Assistant to the Master attendant of the Port of Calcutta)

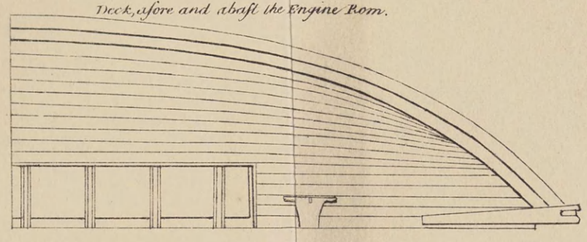
Section at A



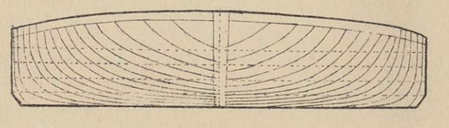
	feet	ins
Length extreme	130	0
Breadth D°	30	4
Weigth of Timber	Tons 42	0
D° of metal	7	0
D° of Engines	50	0
Tons	99	0

Displacement at 2 feet draft 123 Tons − 99 Tons = 24 Tons for Coals stores &c.

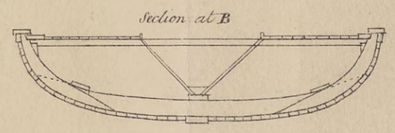
Deck, afore and abaft the Engine Room.



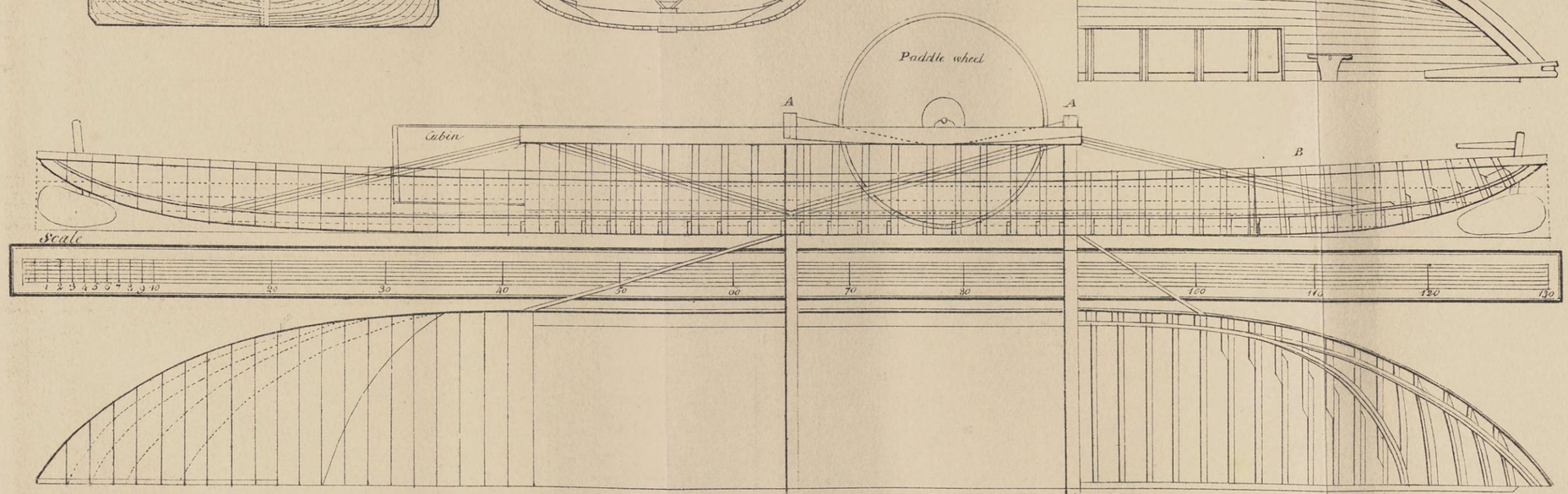
Body



Section at B



Paddle wheel



Reduced from the Original (J.M. Sippings Surveyer of Shipping to Honble E. Comp.y) Calcutta 1830

Drawn on Stone by J.B.A Tassin.

Printed at the Govt Instn.s Press.

APPENDIX A 2.

Specification of Captain Cowles's Boat, proposed as a Steam Tug for shallow rivers.

THE Steam Tug which I have delineated in the accompanying drawing, may be described in general terms, as a square engine-room, constructed of frame work, with the fore and after body of a boat attached; in the disposition of the several parts of which I have endeavoured to obtain the greatest strength of fabric, with the least possible quantity of materials.

This vessel is designed for a pair of low pressure engines, similar to those on board the Hoogly steamer, (two twenty-five horse engines,) but with an increased diameter of the paddle-wheels.

The engine-room, or body of the boat, is formed by floors of three inches by twelve, to the heads of which timbers of five by eight are attached at right angles, and secured by means of dowels and through bolts, as shewn in the drawing. Immediately under the bearing of each of the paddle beams, and at the after-part of the engine-room, these timbers are twelve inches square; and under the bearing of the paddle-shaft there are two of eight inches square. To each of the beams, which rest on their timbers of twelve inches square, are fixed two diagonal stanchions, which, from being secured to the beams and bottom of the boat by means of iron strops, act both as trusses and ties, and which will give great additional strength to the bottom of the boat, as well as prevent any lateral working of the timbers and beams.

Inside of the timbers of the engine-room, there are two trusses, the heels of which butt down on the thick stuff at the floor heads, in the wake of the center large timber which supports the after paddle-beam, the heads running up in opposite directions to the two extremes of the engine-room, where they are scarphed, partly into the thick stringer which runs along the tops of the timbers, and partly into the heads of other trusses which run down to the two extremes of the boat. Outside of the timbers, and immediately opposite these trusses, are two flat iron braces, firmly secured to the heel of the center large timber of the engine-room, and continued from that point, in opposite directions, to the heads of the timbers forming the boundaries of the engine-room, and from thence down again to the two extremes of the boat in the same direction as the trusses. Each timber is bolted to the truss and tie by a bolt passing through all: this iron tie must be let in flush with the siding of the timbers, so as not to interfere with the planking.

The planking is two inches thick, and carried up to the sheer strake, leaving the timbers of the engine-room above that open: the engine-room is covered with a light *fir* deck, arched and covered with painted canvass like that of a Bauleah: before and abaft the engine-room, instead of a regular deck, there is a light platform laid, leaving spacious hatchway for the reception of coals, with substantial painted canvass covering over head, which will afford accommodation for the crew at one end, and for the engines and Master at the other.

The engine-frames are rose upon sleepers, constructed as shewn in the drawing, with cross pieces over every floor, and are secured to the floors by means of flat iron staples, embracing the lower part of the floor, and let in flush with the under side, each leg of which is finished with an eye bent at right angles with the leg, of sufficient size to receive the holding-down bolts: this will prevent wounding the timber by bolt holes.

Aware that, in calculating the weight of a boat, there are many little items which are liable to be omitted, I have, in order to meet such contingencies, given a scantling, which, in practice, will bear reduction. With this increased scantling, and including in the calculation every piece of timber necessary to the formation of the whole, I make the total weight of timber in the boat forty-two tons, two quarters and eight pounds; and the displacement, at two feet draft, I make one hundred and twenty-three tons, sixteen hundred weight, two quarters and eight pounds; and allowing seven tons for copper and iron, we have left for coals, stores, &c. twenty-four tons sixteen hundred weight.

The length of the boat is one hundred and thirty feet; breadth, extreme, thirty feet four inches:* with less dimensions than the above, the same draft of water might be obtained by carrying the square shape well forward and aft, so as to give the extremes greater bearings: but to do this, that part of the boat's side which is perpendicular and occupies about sixty feet of the whole length of the boat, must be extended to at least ninety or one hundred feet. Upon such an extended surface, the various eddies in the river would act so powerfully, that it would be next to impossible for any ordinary rudder to counteract the effect; particularly when we take into consideration the very little depth to which the rudder will be immersed.

In the plan now under notice, I have endeavoured to remedy this evil (which forms the principal objection to a long boat in a river) by giving the fore and after body of the boat a shape that will be but little affected by such eddies, having but little lateral resistance; besides which, a rudder being fixed at the bow and moving in an undisturbed medium, will act so powerfully and instantaneously, that the accident so commonly met with by boats, that of being thrown off from a point by the eddy tide, could scarcely ever happen; for, should the eddy from a point impinge obliquely on the bow, (which it will often do) that part of the vessel presents such an easy rounded body, that its effect would scarcely be perceptible, and still less can it oppose the foremost rudder. The rudder abaft, although of no utility in steering, will nevertheless be found useful, when the boat is steering through a narrow channel, with a strong wind on the beam; for in such a situation the boat, having such little hold of the water, would be liable to be driven on the lee shore, which these two rudders put both a-starboard or port, as the case may be, would prevent by drawing the vessel bodily off the shore: in fact, the rudders, when in a line with the keel of the boat, would act as lee-boards, and of course with increased effect, when placed at an angle with the keel.

(Signed) C. COWLES.

Calcutta; July 30th, 1829.

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* F.	I.		BURHAMPOOTUR.
30	4		18 feet beam.
	2 feet draft.		4 feet draft.
60	8	area of immersed portion of transverse section.	72 feet, area of immersed portion of transverse section.

APPENDIX A 3.

Specification of Captain Forbes's Plan for building a Steam Tug for shallow water, as transmitted by Mr. Secretary Prinsep to the Marine Board, dated 30th March, 1830.

THIS Drawing has been constructed in illustration of a *Principle*, by the adoption of which (modified according to the depth of water in a river) steam engines, of considerable power, may be employed in light therefore small *draughted* tug boats.

The shell, or hull, of such vessel (of metal or of wood) would, without the longitudinal trusses, be bent downwards in the centre. By these, (giving more than the strength of high and heavy sides) and by the light floor timbers, secured upwards to the long engine sleepers forming the tie beams of the trusses, the weight of the engines and boilers will be uniformly distributed over the whole length and breadth of the floor of the vessel.

Two transverse trusses, strengthening those longitudinally situated, carry (totally apart from the sides of the vessel) the bearings of the paddle-wheels and shafts.

From the manner in which the longitudinal and transverse trusses are arranged, they conjointly receive, as they are calculated firmly to resist, and bear, as they are adapted uniformly to distribute, all the strains and the entire weight of the machinery.

Proposed as a Tug, such a boat will neither require a *deck*, on account of its strength, nor from its effect in diminishing stability, admit of it.

The great breadth, and the weight of coals, stores, men, &c. placed on planks, crossing the floor timbers, and consequently keeping the centre of gravity low, will insure requisite stability.

The reduction of the weight of material may not improbably compensate for the loss of velocity, which, if her hull were of the same weight with a narrower-beamed, sharper-headed, deeper-draughted vessel, would unquestionably be experienced. The attainment of a small draught of water being an object, independent of which no other good quality of the vessel could be of avail, its accomplishment (in providing flotation for the total weight of the *machinery*, stores, men, and *hull)* necessarily led to an increased length of floor and beam; further, as the weight of the *machinery*, *stores*, and *men*, for any given power of engines *assumed*, could not be diminished, it solely remained practicable to attempt the reduction of total weight by reducing the quantity, therefore weight of material in the hull.

Aware that in roofs of large span the greatest strength, with least weight of material, is obtained by means of frames or trusses involving the principle of an arch, its abutments near the walls prevented from spreading, by iron or wooden tie-beams, the idea early suggested itself of getting rid of a part of the weight

of the sides of the vessel, and of decks, side-rails, &c. by making trusses constructed on this principle do the work hitherto imperfectly performed by those heavy generally air or wind-opposing parts. At this point, the next question obviously regarded the best position on the vessel's floor for the trusses. Placing them on the sides (an idea I for some time circulated and sketched) was mainly rejected for three reasons:

1st.—Because no truss limited to a height less than that to which the paddle-wheel shaft is elevated, can, without a greater weight than common sides, have equal strength.

2dly.—Because, when the truss is raised so as to obviate this objection, the pair of trusses, now of useless weight, stand apart at the very opposite sides of a vessel, necessarily (for light draught) of great breadth, situations in which they can in no way assist in giving such strength to the bottom as will, without immense scantling and weight in the floor timbers, (*adverse* to light draught) enable it to carry the load of the engines, boilers, and paddle-wheels.

3dly.—Because, with the trusses in the sides, and their carrying the inner bearings of the paddle-wheel shafts, nearly all the strains of the engines and machinery would still, through the sides, be communicated to the weak bottom of the vessel.

The rejection of the idea of placing the trusses in the sides, finally led to arching them over the engines and boilers, making (by extension) the long sleepers, on which the machinery stands, also answer to be beams.

Saving, in this respect, considerable weight, it only additionally remained to introduce transverse trusses, so situated as, whilst strengthening and supporting those longitudinally dispersed, to afford the bearings requisite for the paddle-wheel shafts.

Simple as the accomplishment of such objects may be deemed, it will be remembered that, where complicated machinery is concerned, simplicity is the last thing arrived at.

Neither will it be overlooked that, let what may be the exigency, the processes of invention cannot be artificially accelerated.

Apart from practice, the branches of science that lead to them, lead a thousand times astray.

Until, *with a small engine fitted up in a light Country boat*, I have made further experiments, I could wish the models submitted to be regarded but as proofs of an earnest desire to promote an important (already partly effected) National object.

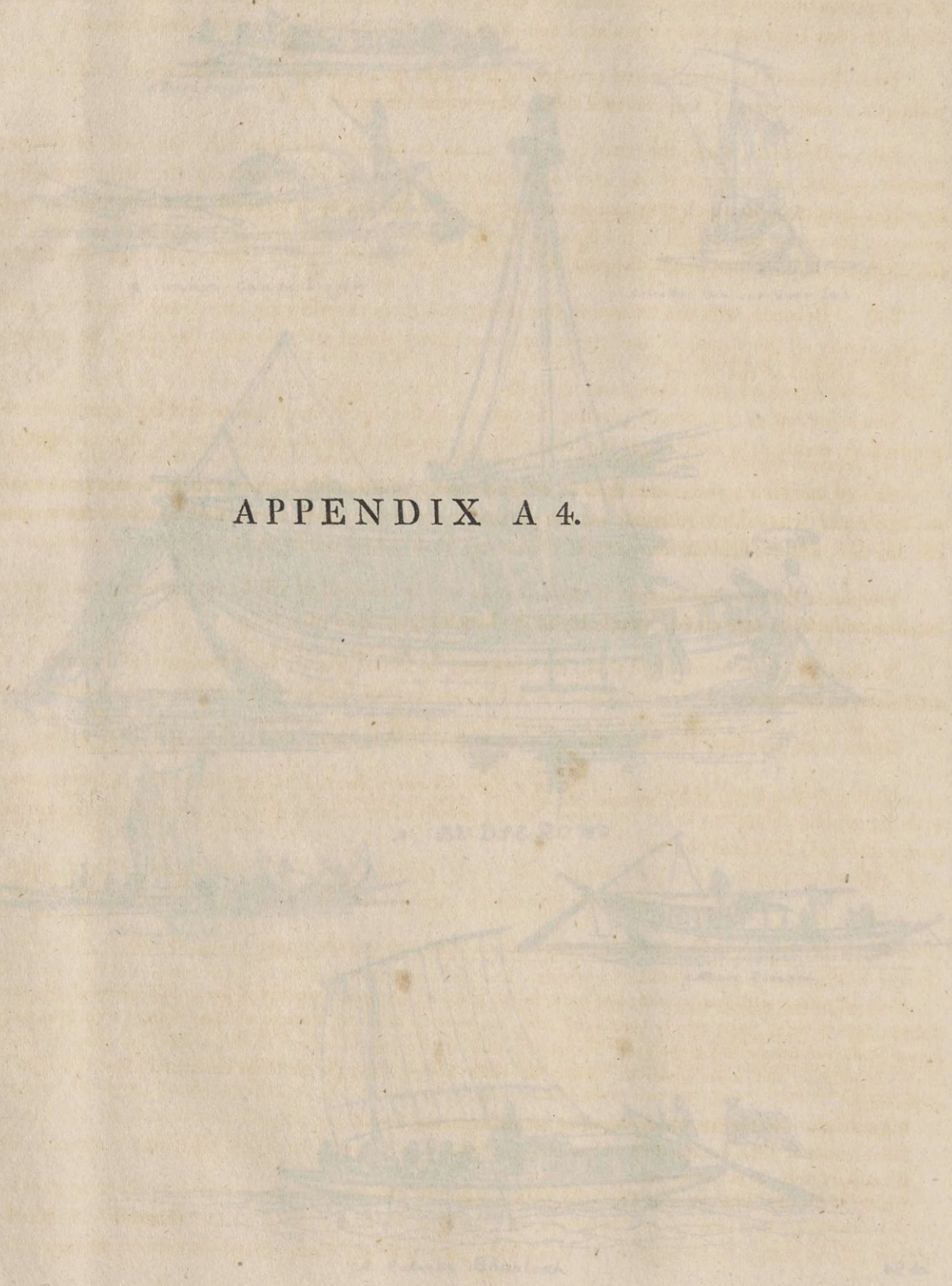
(Signed) W. N. FORBES,
Captain, Engineers.

Note.—Trusses, with their rectangular parts in the plane of the outer bearings of the paddle-wheel shafts, and with the end uprights of these parts merely connected with the vessel's sides by timbers oblique both to a vertical and to a horizontal plane, are trusses but to the eye. So positive they in principle become "skeived arches," or what (to bear weight or strain) is weaker, and *worse arches* in which the lines keying hang *far out* of the horizontal plane included betwixt the abutments.

Engines of a vessel of the full size—two of twenty-five horse power
Total length of ditto, one hundred and twenty-five feet.
Breadth of ditto, twenty-five feet.
Draught of water, with stores on board, under two feet.

(Signed) W. N. F.

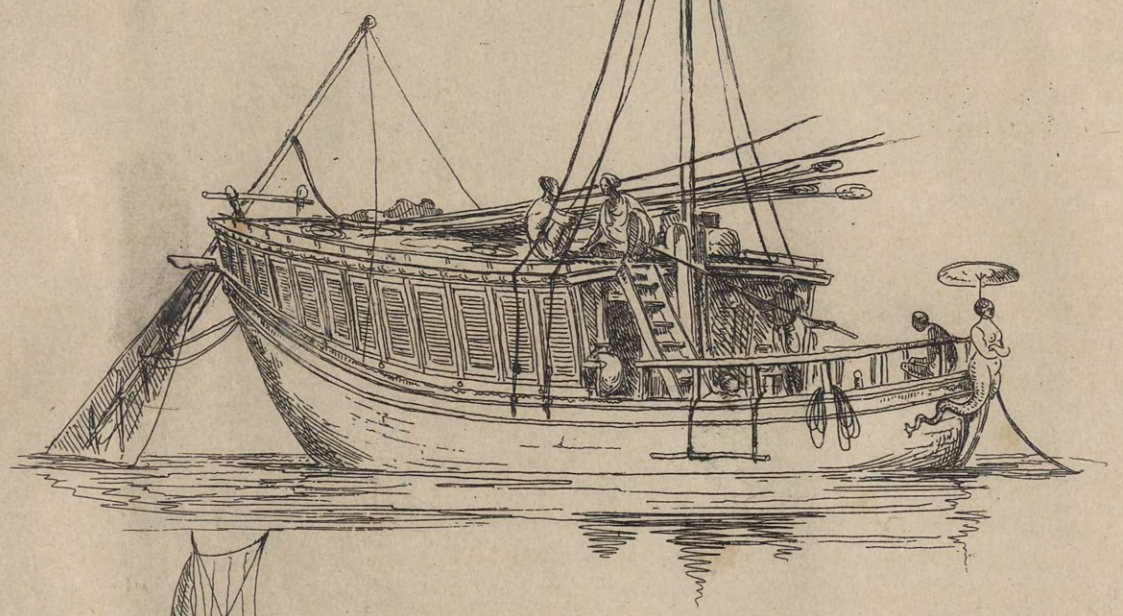
APPENDIX A 4.



A Ferry Dinghee

A common Calcutta Dinghee

Calcutta Panswai - under Sail



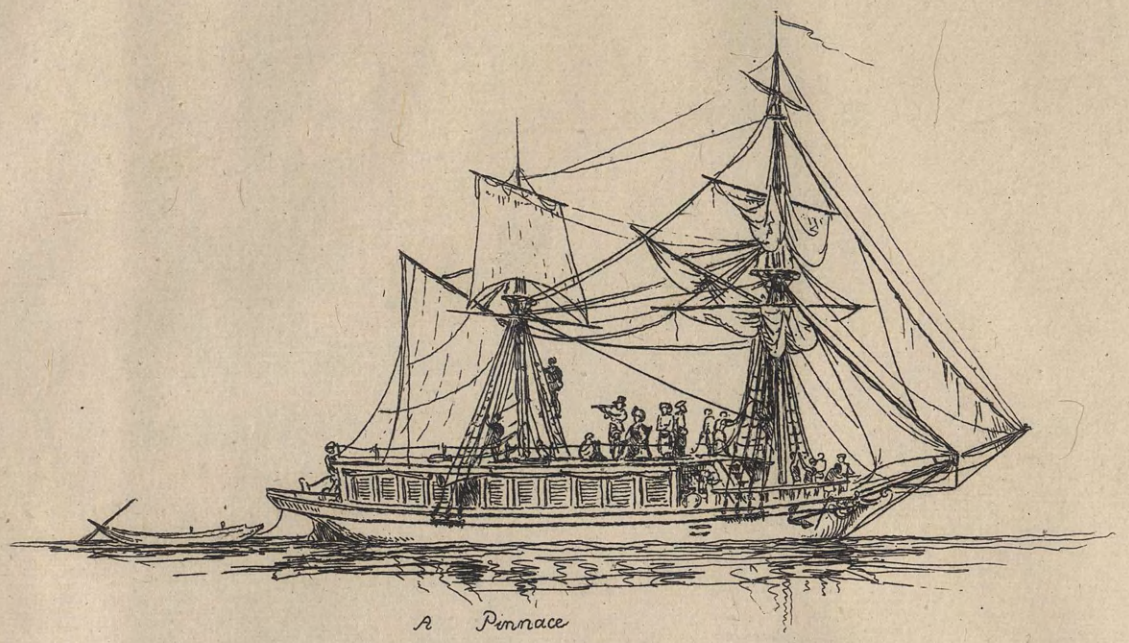
A BUDGEROW

A Fishing Dinghee

A Native Bhauleah

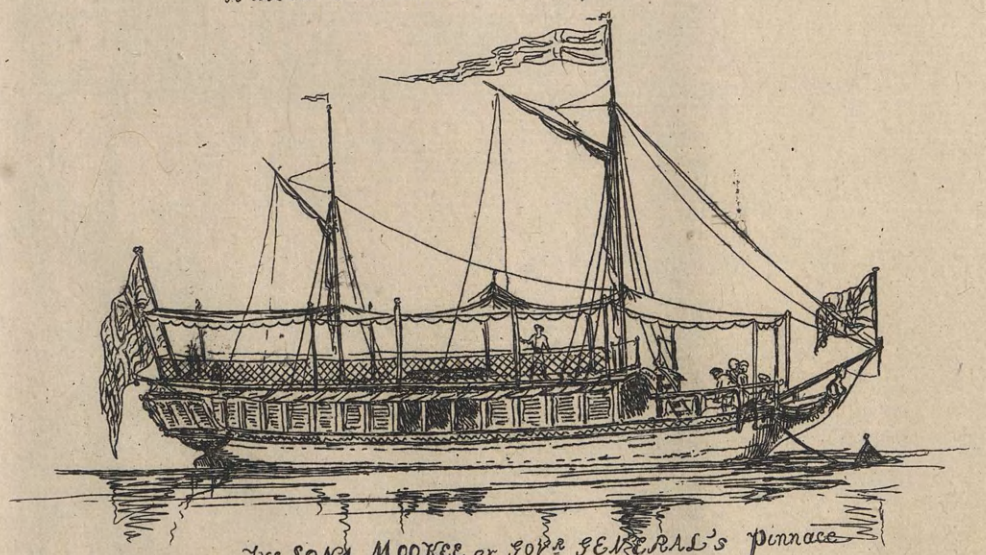
A Calcutta Bhauleah

WP del



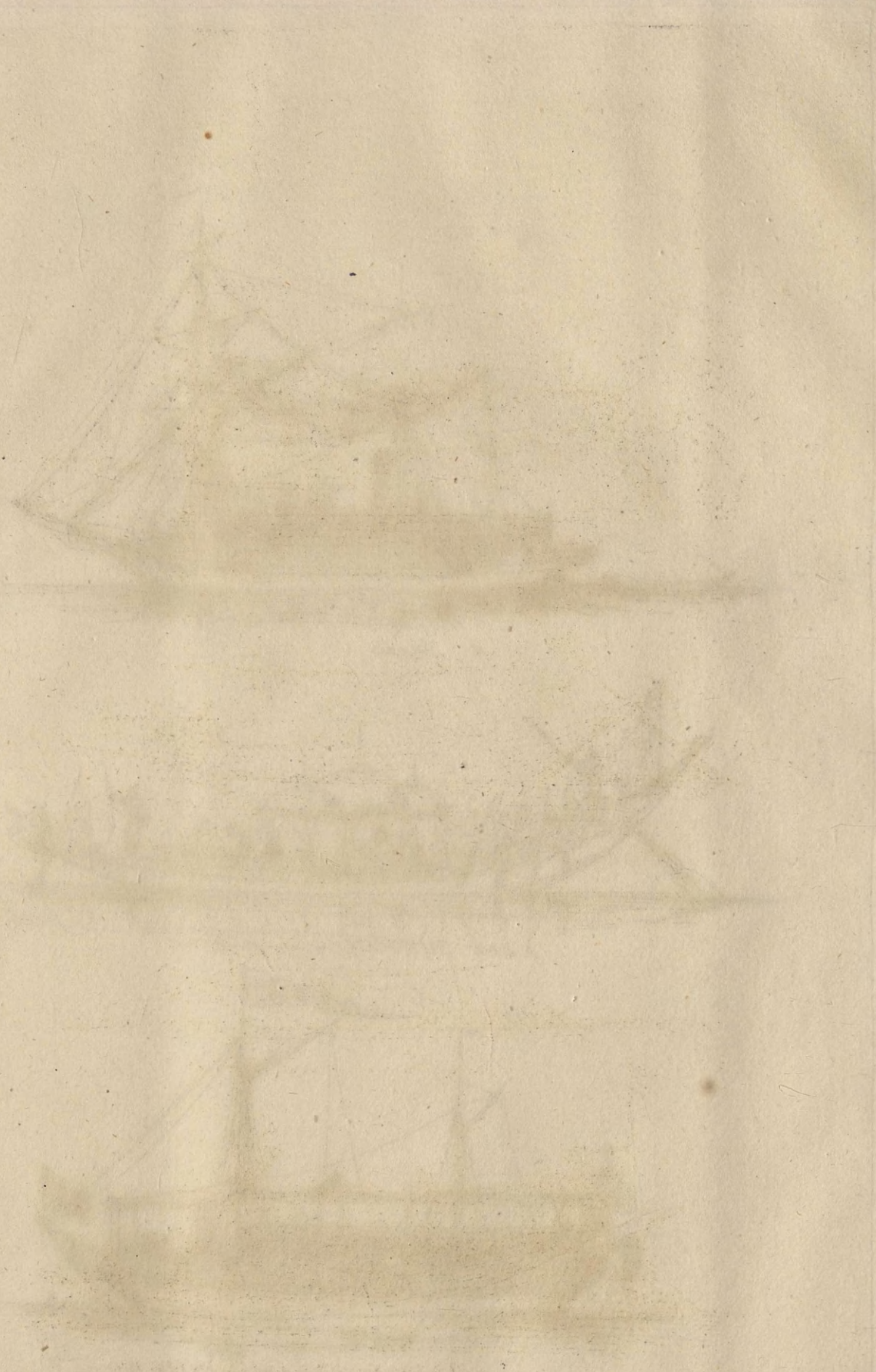
A Pinnace

A MOR PUNKHEE or Native pleasure boat

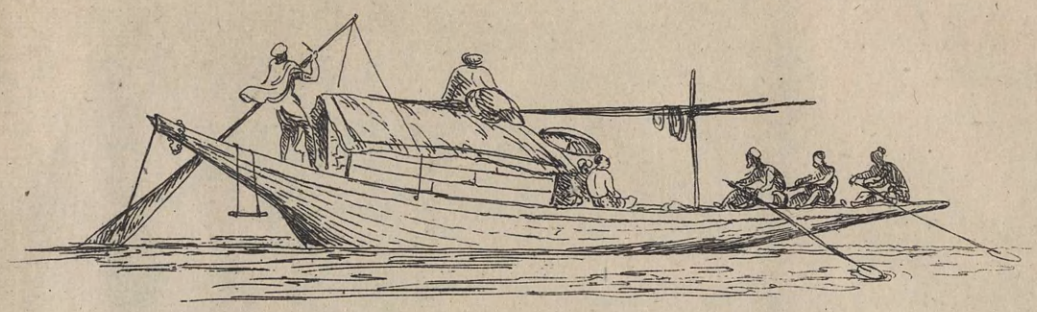


THE SONA MOOKEE or GOVR GENERAL'S pinnace

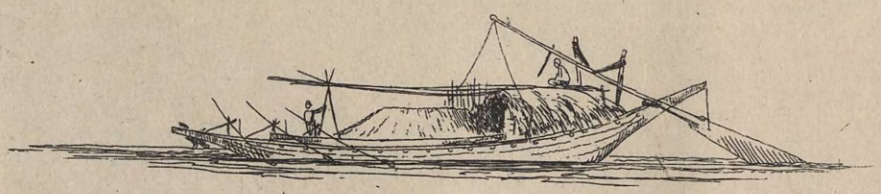
WS 1830



A KUTTA Panswai of 900 Mds



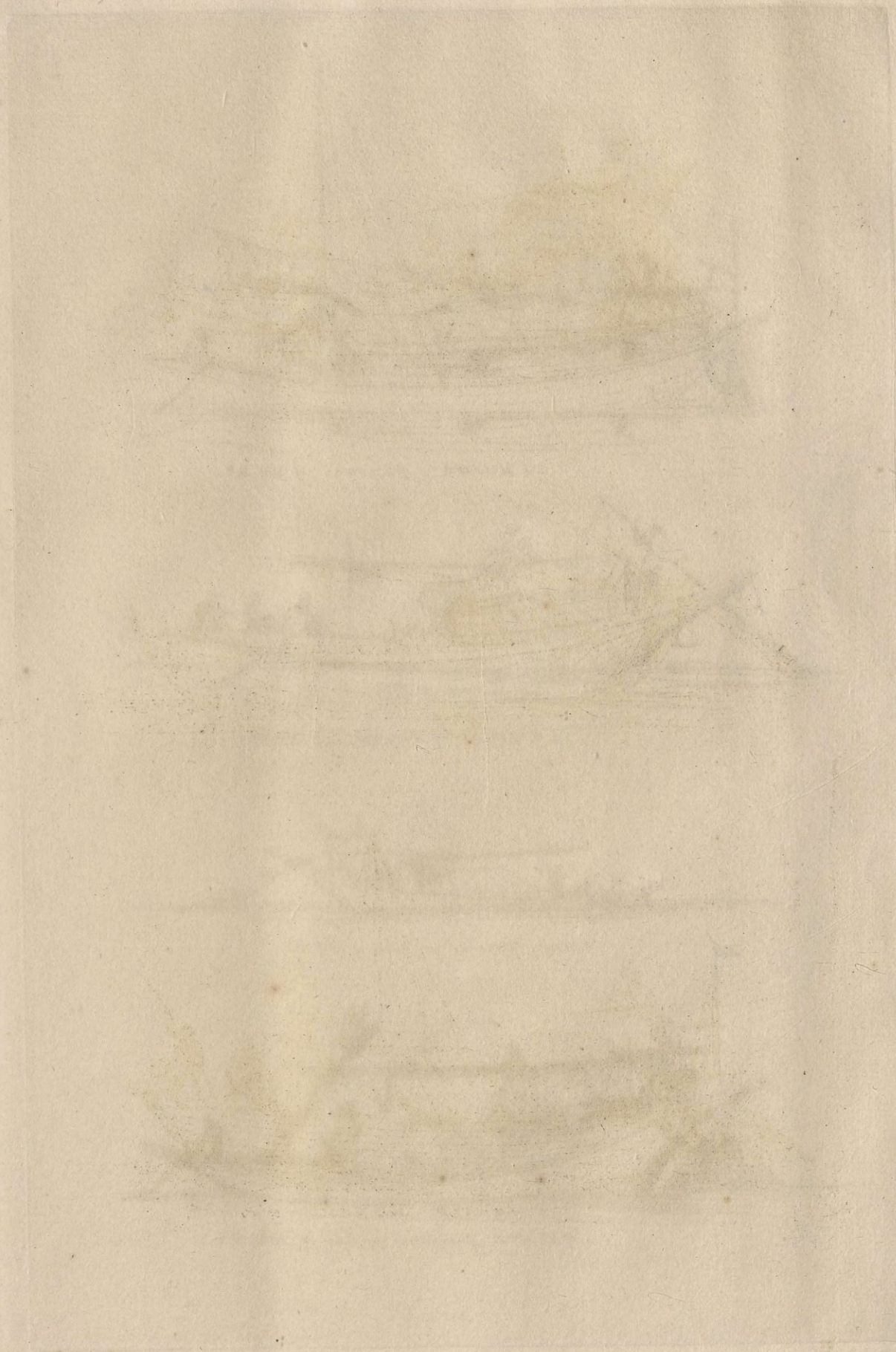
A CALCUTTA Panswai of 200 Mds

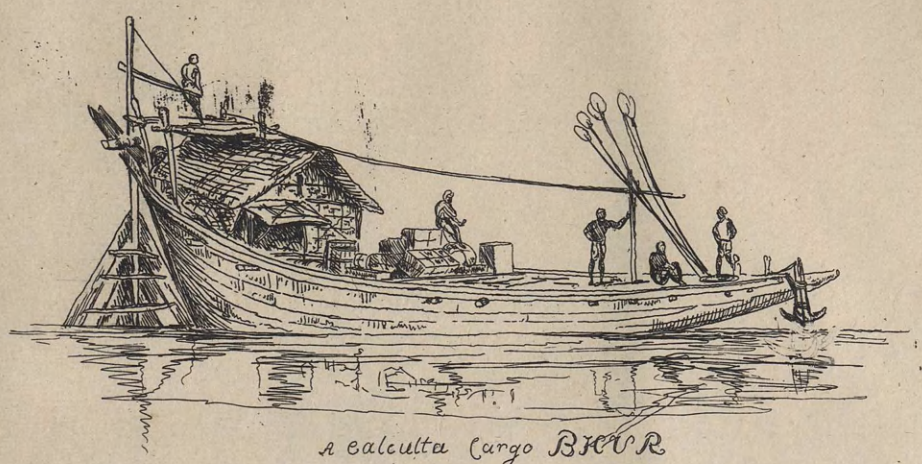


A Hooghly Panswai for Sand of 800 Mds

A MUDDER Panswai for Grain of 1000 Mds

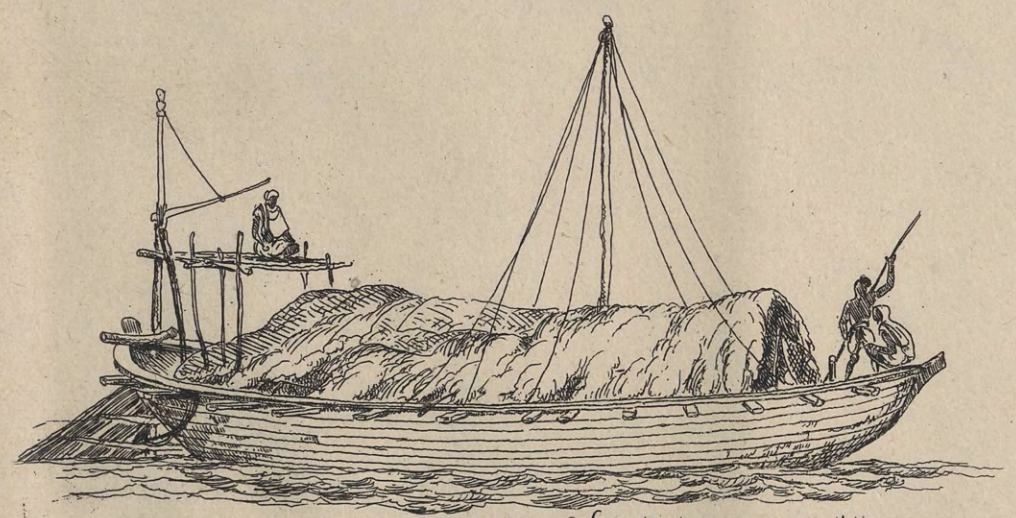
- WP del





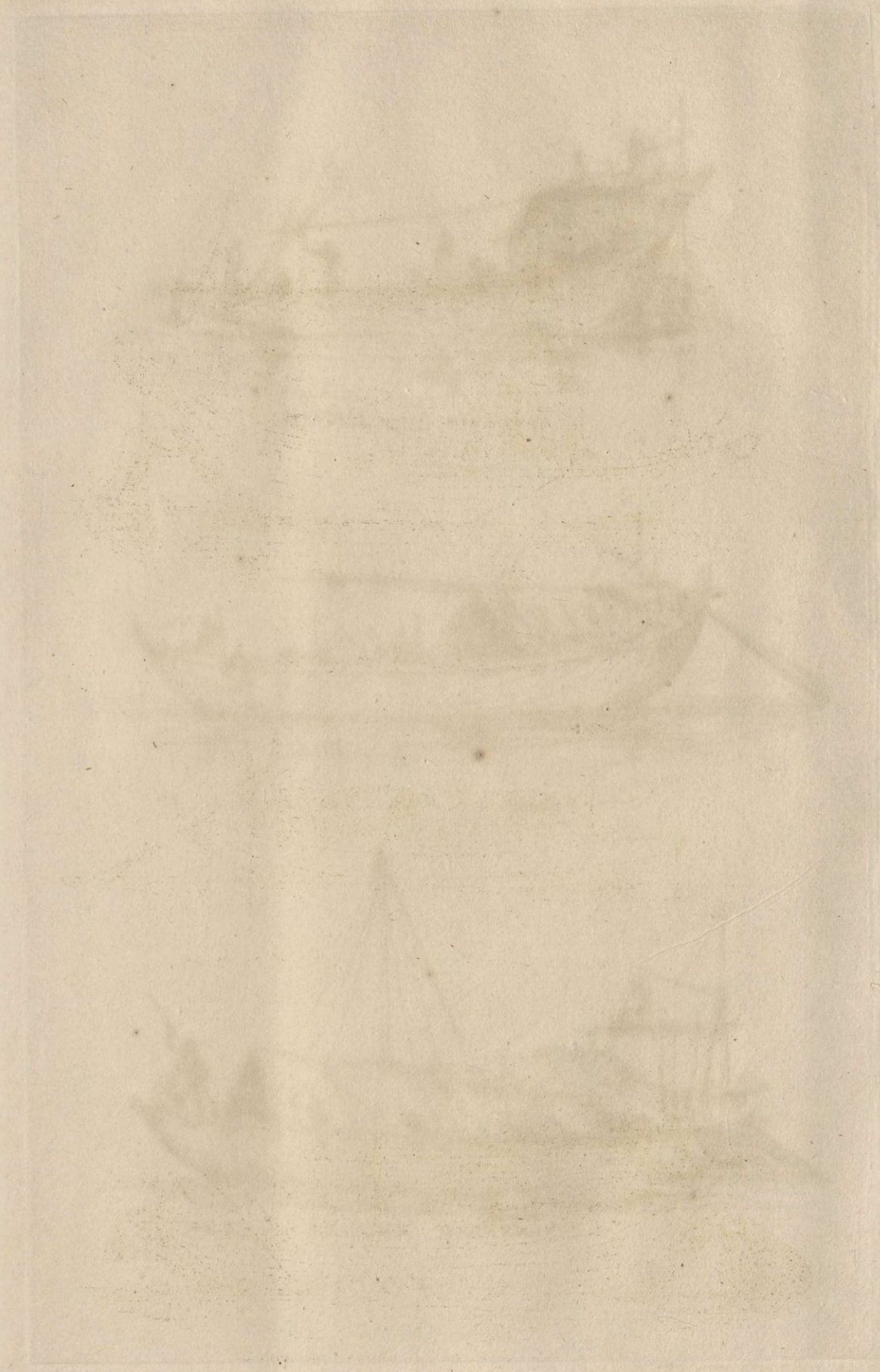
A Calcutta Cargo BUJR

A Saltee or Hola - for Coals - of 600 Mds

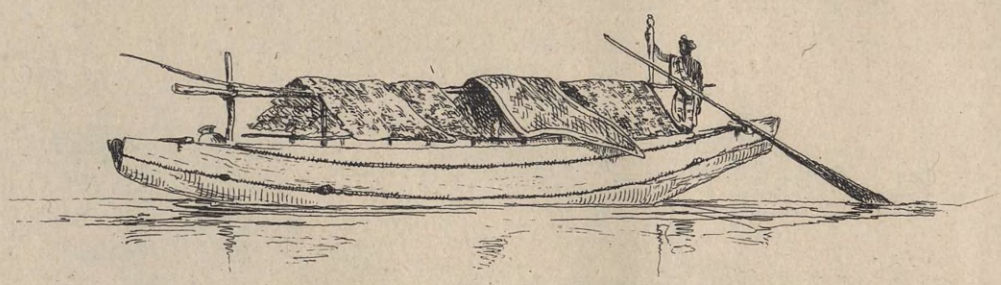


A FURUKHABAD KUTORA of 800 Mds

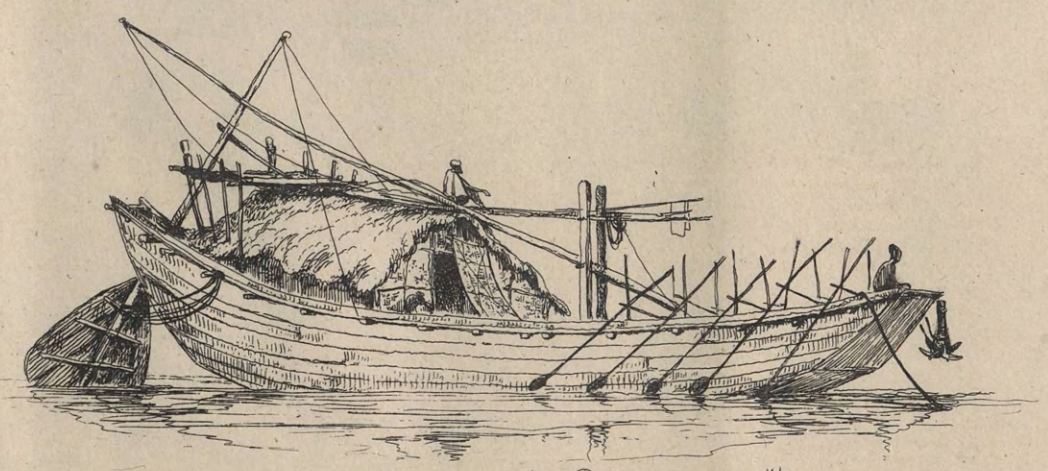
WP del 1830



A Dacca Pulwar of 500 maunds

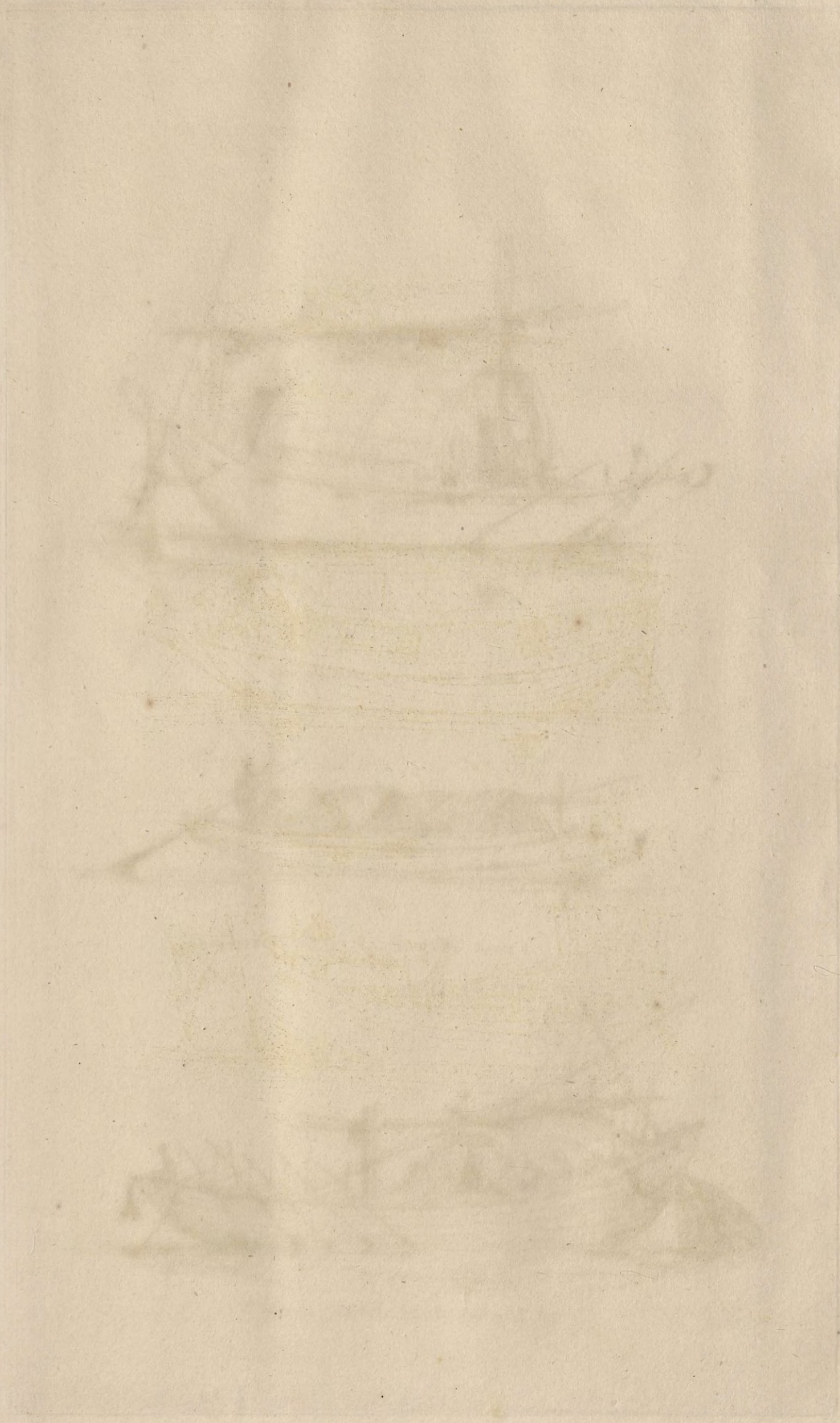


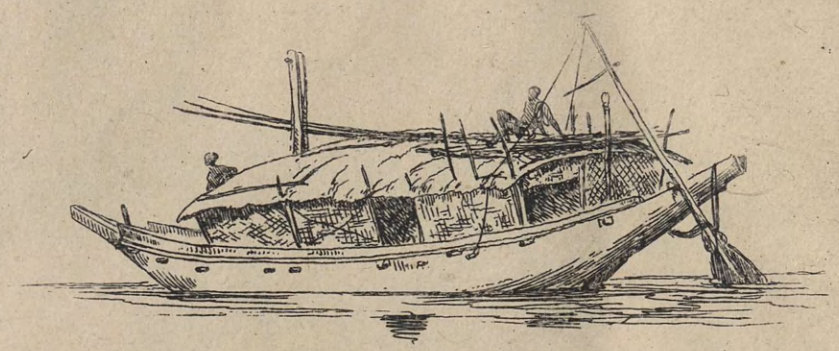
A small Mug Boat of the Sounderbunds



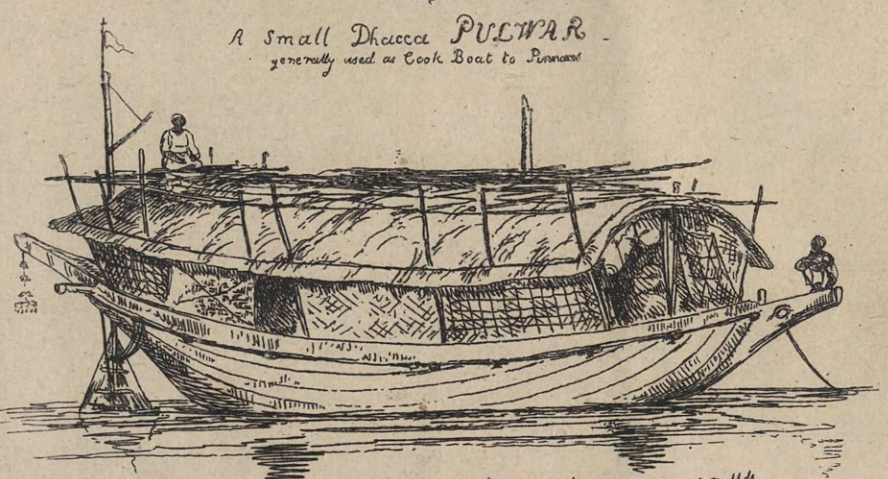
W.P del

A Tumlook Salt Boat of 800 Mds



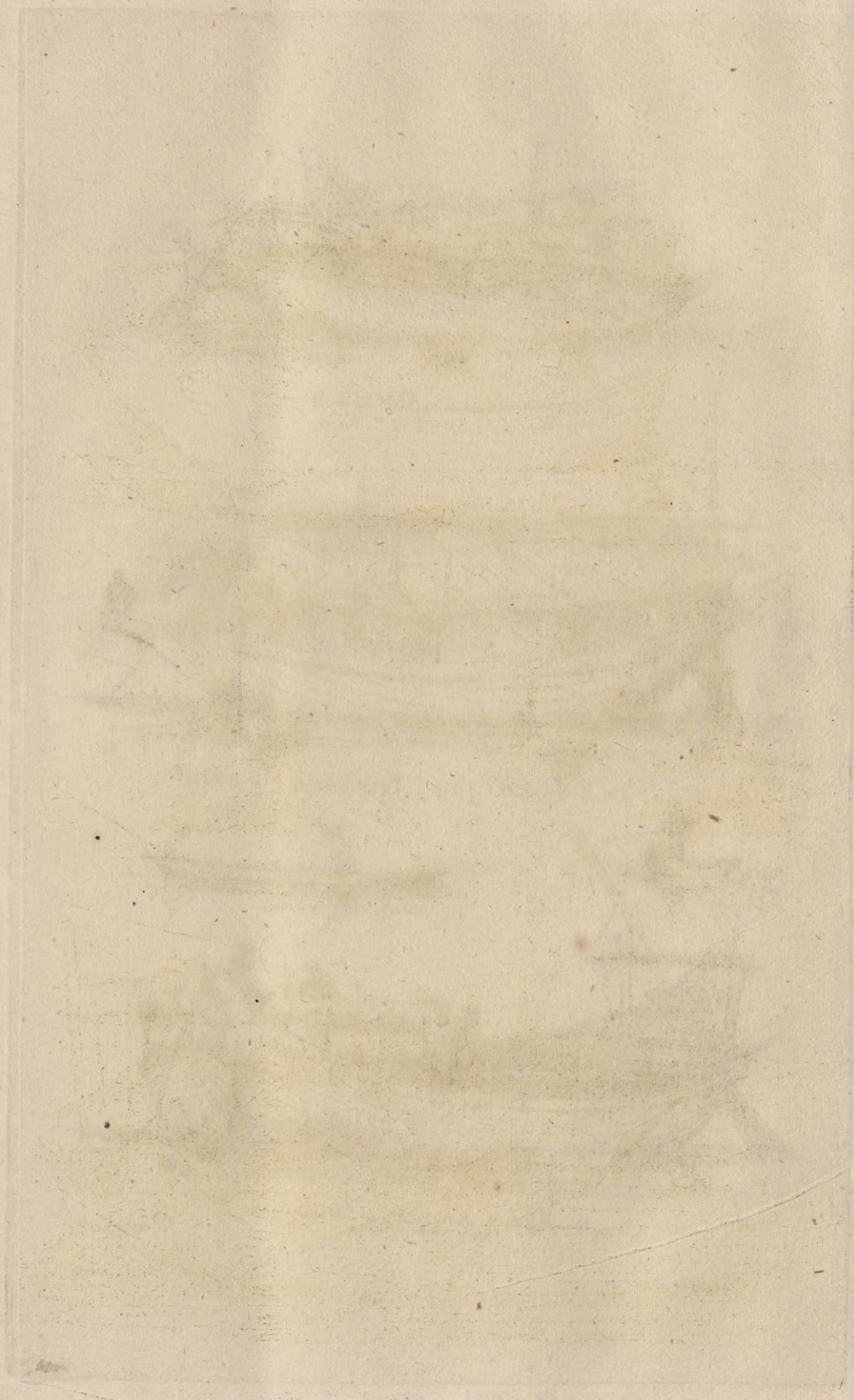


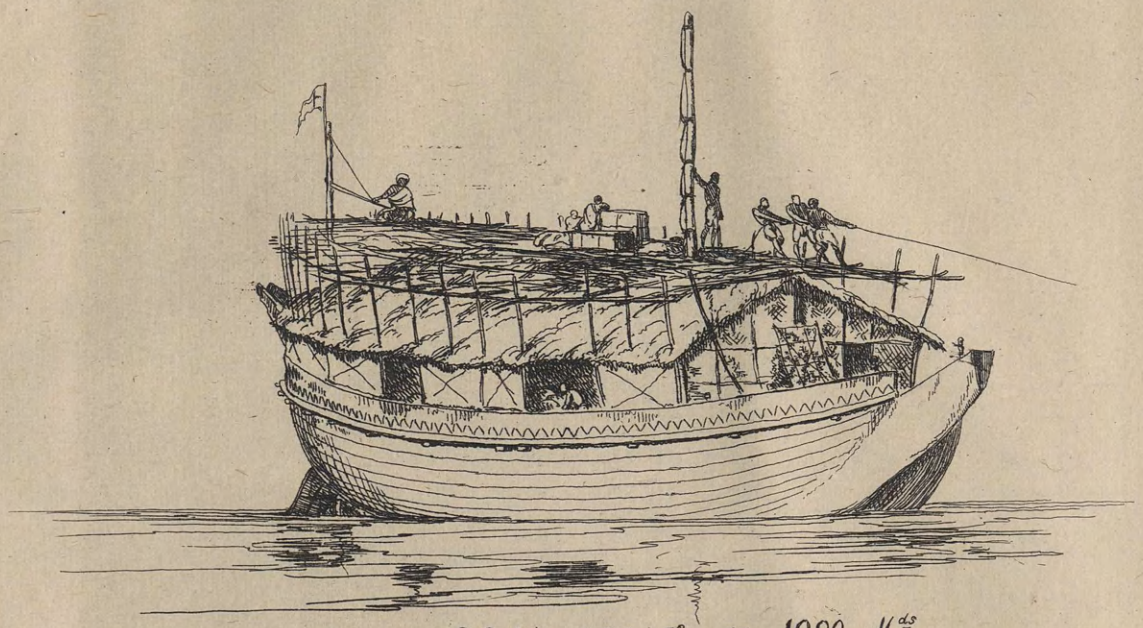
A small Dhacca PULWAR
generally used as Cook Boat to Pinnaces



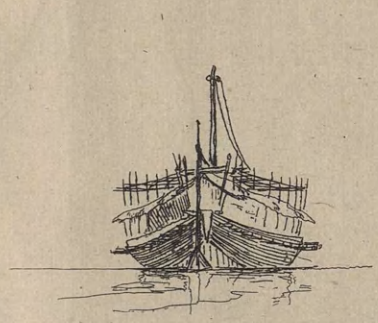
An OOLAK from Azimabad of 400 Mds

A Budra Khoolea or Wood boat
of the Soonderbunds

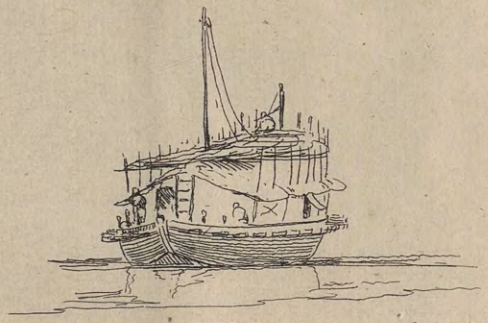




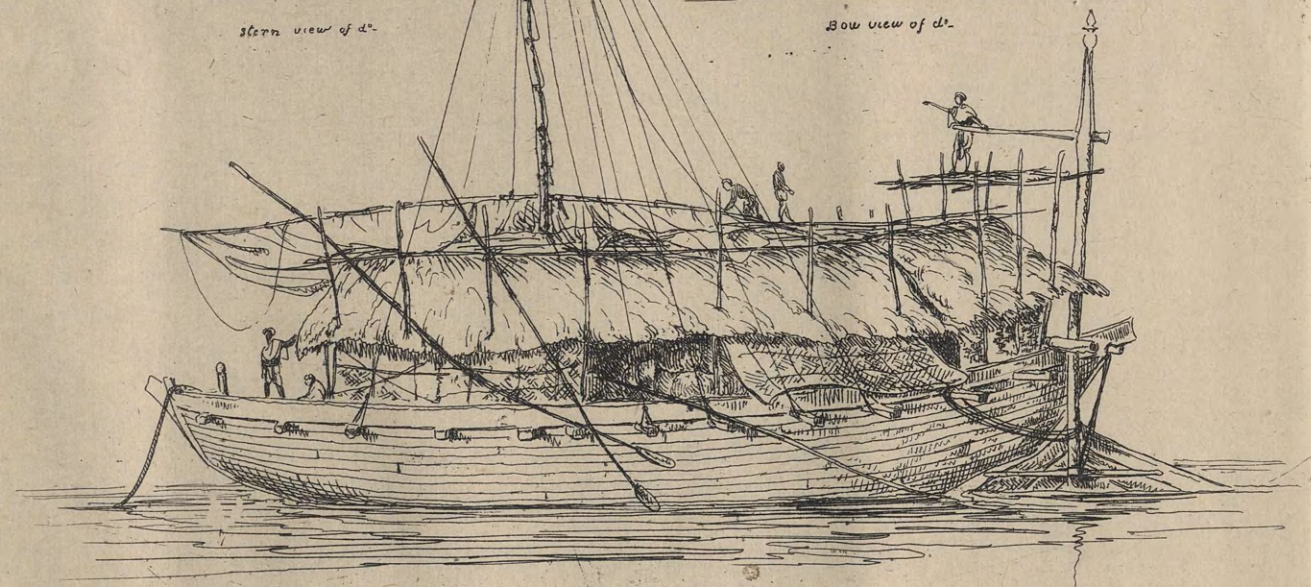
A CHUPRAH OOLAK of 1000 Mds



Stern view of d°



Bow view of d°



A MIRZAPORE Cotton PATELA of 1000 Mds

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APPENDIX A

NOTE.

The preceding Etchings are given in illustration of the Remarks concerning Country Boats, at page 84.

APPENDIX B.

* *Proceedings of a General Meeting of Subscribers to the Fund for encouraging a Permanent Communication by Steam Vessels between Great Britain and Bengal, held at the Town Hall, Calcutta, on Wednesday, the 17th December,* 1823.

Mr. Harington, Chairman of the Committee, elected at the Public Meeting of the 5th ultimo, having been requested to take the Chair, after briefly stating the object of the present Meeting, as held in pursuance of the adjournment, agreed to at the Public Meeting abovementioned, proceeded to read the following Report on the part of the Committee then appointed:

"The Committee appointed at the Public Meeting, held on the 5th November, 1823, for carrying into "effect the Resolutions passed on that date, with a view to encourage the establishment of a communication "between Great Britain and India, by Steam Navigation, have now the pleasure of reporting their proceed-"ings, for the information of the Subscribers, to the proposed bonus or premium, and at the same time, "submit a copy of their correspondence with the Right Honorable the Governor General in Council."

"It will appear from this correspondence, that the apprehensions of hazard, attending an attempt to "navigate Steam vessels between Great Britain and India, which, from the want of sufficient explanation "on the part of the Committee, were entertained by Government in the first instance, have been entirely "removed by the Committee's letter of the 26th ultimo, and that Mr. Secretary Lushington's letter in reply, "dated the 4th instant, expresses "the cordial disposition of his Lordship in Council, to promote an "enterprise promising so much benefit to the State and to the community," with his Lordship's consequent "resolution to place at the disposal of the Committee, the sum of twenty thousand rupees, as a contribution "towards the attainment."

"The conditions attached to this liberal grant, and specified in the letter abovementioned, met the ready "concurrence of the Committee, as stated in their Chairman's answer of the 10th instant: and the modifi-"cations therein proposed, of the Rules contained in the Committee's proceedings of the 10th November, "for regulating the grant of a premium to those who may first establish, on a permanent footing, a commu-"nication between Great Britain and India by Steam Navigation, having been considered by the Governor "General in Council, (as intimated in the concluding letter from Mr. Secretary Lushington,) "perfectly "satisfactory," the Rules so modified are now submitted for the final consideration and adoption, if approved, "of a General Meeting of Subscribers."

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* Extracted from the Bengal Hurkaru of 19th December, 1823.

The correspondence referred to in the above Report, was then read, as well as the proceedings of the Committee: after which the several Rules proposed by the Committee for regulating the grant of a premium or bonus to those who may first establish a permanent communication between Great Britain and Bengal by steam navigation, were unanimously adopted, with a few verbal amendments in the following terms:

First.—That the proposed bonus or premium be offered for the establishment of a permanent communication between Great Britain and Bengal, by Steam Packets, navigating by either of the routes of the Red Sea, or the Cape of Good Hope.

Second.—That the amount received under the Subscription opened for the purpose, (deducting therefrom any disbursements authorized by a General Meeting or Committee of the Subscribers, or, if the net receipts from the subscriptions shall exceed the sum of one lac of sicca rupees, so much thereof as shall amount to that sum,) be assigned as a premium to any individuals, or company, being British subjects, who may first establish a communication by Steam Vessels between Great Britain and Bengal, by either of the routes abovementioned, before the expiration of the year 1826.

Third.—That the communication required for the premium above stated, shall be considered to have been established on the completion of two voyages or passages from Great Britain to Bengal, and two voyages from Bengal to Great Britain, by the vessel or vessels of any individuals or company, being British subjects, within a period not exceeding an average of seventy days, for each of the four voyages; provided further, that such vessel or vessels be not of a less burthen than three hundred tons, or three hundred and fifty tons, whilst the Act of Parliament which requires that burthen for British ships proceeding to India, shall remain in force.

Fourth.—That if the full premium be not earned by any individuals or company, under the foregoing Rules, by the completion of two voyages or passages out, and two home, as required within the limited period; but one voyage from Great Britain to Bengal, and one from Bengal to Great Britain, shall have been performed, in conformity with the preceding Rules, before the expiration of the year 1826, a moiety of the stated premium shall be assigned to the individuals or company, being British subjects, by whose vessel or vessels such two voyages out and home, shall have been performed.

Fifth.—That the amount subscribed for the purposes above stated, (with an exception to authorized disbursements as provided for in the second Rule) be lodged as received, or as soon afterwards as may be convenient, with the Government Agents, to be invested in Public Securities of the Remittable Loan, the accruing interest upon which, until the principal shall be called for, to be invested in the same manner and the aggregate, provided it shall not exceed the sum of one lac of sicca rupees, the stated limitation of the premium, to be assignable as above, in whole or in part, to the persons who may be entitled to the full premium or a moiety of it.

Sixth.—That all claims to the premium receivable under the foregoing Rules, or to any part thereof, be finally determined by the Committee of Managers, to be elected at the present General Meeting of Subscribers; and in the event of any part of the amount subscribed remaining unappropriated in the hands of the Government Agents, at the expiration of the year 1826, and of no persons being entitled to receive the same, that the balance so remaining be at the disposal of a General Meeting of the Subscribers for any purpose connected with the object of promoting a permanent communication by steam vessels between Great Britain and

Bengal, either by a partial re-imbursement of expense incurred in a meritorious, though unsuccessful attempt to establish steam packets as proposed, or by any other application of the unappropriated fund in hand to the purpose above stated, which may appear just and proper. If any balance remain which may not be so applied, it shall be returned to the subscribers or their representatives, in proportion to their respective subscriptions.*

The Meeting next proceeded to the election of a Committee of Managers, in pursuance of the last rule above stated, and it being understood that the Chairman of the late Committee, as well as several Members of it, on account of their public or other engagements, wished to decline being re-elected to the permanent Committee of Management, it was resolved, that this Committee consist of thirteen Members, five of whom to form a quorum, with a discretion to fill up vacancies in the event of any of the Members quitting the Presidency, and to call a General Meeting when required.

It was further resolved, that the Committee of Management, to be now elected, shall possess full powers to carry into effect the whole of the Rules and Resolutions passed at this Meeting, as well as to complete the subscription for the proposed bonus or premium which has been opened by the Committee appointed on the 5th ultimo, and to adopt such measures as may appear proper for extending the same to the Presidencies of Fort St. George and Bombay, and to the Island of Ceylon.

The following Gentlemen were then elected, to constitute a Committee of Managers for the purposes above stated:—

J. P. Larkins, Esq.; Holt Mackenzie, Esq.; Jas. Pattle, Esq.; Chas. Lushington, Esq.; Commodore Hayes; Captain Bruce, of the Bombay Marine; Captain Forbes, of the Engineers; J. Palmer, Esq.; G. Mackillop, Esq.; David Clark, Esq.; G. J. Gordon, Esq.; Alex. Colvin, Esq.; and C. Sutherland, Esq.

The Chairman laid before the Meeting a book of subscriptions to the Steam Navigation Fund, by which it appeared that, including the donation of twenty thousand rupees from the Right Honorable the Governor in Council, the amount ascertained to have been subscribed, exceeds the sum of sixty-two thousand rupees.

The Chairman, at the same time, informed the Meeting, that in compliance with the Resolutions of the late Committee, he had transmitted copies of their proceedings, with an Address from himself, to the principal Civil and Military Officers at the several stations in the interior of the country subject to this Presidency, and that he had yet received returns from Moorshedabad and Lucknow only. The subscriptions at the latter

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* As this resolution has been variously interpreted, it may be proper to mention, that it originally stood as follows:—vide Government Gazette of 13th November, 1823, which contains an account of the proceedings of a Meeting held on the 10th of that month—

Sixth.—That all claims to the premium receivable under the foregoing rules, or to any part thereof, be finally determined by a Committee of Managers, to be elected at the General Meeting of the Subscribers, to be held on the 17th December next; and in the event of any part of the amount subscribed remaining unappropriated in the hands of the Government Agents at the expiration of the year 1826, and of no persons being entitled to receive the same, that the balance so remaining be returned to the subscribers, or their representatives, in proportion to their respective subscriptions, unless otherwise disposed of by the unanimous vote of a General Meeting of Subscribers.

place, amounted to Lucknow sicca rupees three thousand four hundred and fifty, of which two thousand had been contributed by His Majesty the King of Oude, and five hundred by his Prime Minister, the Nuwaub Moatummud-oo-Dowlah.

On the motion of Mr. McClintock, seconded by Captain Hodgson, it was resolved, that the thanks of the Meeting be given to the Chairman and Members of the Committee appointed on the 5th ultimo, for their able and satisfactory discharge of the trust committed to them.

Also, that the best acknowledgments of the Meeting, and of all persons interested in the establishment of a communication by steam vessels between Great Britain and India, are due to Lieutenant James Henry Johnston, of the Royal Navy, for his active and zealous exertions in promoting that object.

Lieutenant Johnston, in a short address to the Meeting, expressed his sense of the honor conferred upon him by this public acknowledgment, with his cordial wishes for the successful accomplishment of an object which had engaged his attention in England, and which he had the satisfaction of having forwarded in India.

The proceedings of the Meeting were then closed with the usual vote of thanks to the Chairman.

(Signed) J. H. HARINGTON, *Chairman.*

APPENDIX C 1.

Memorandum of Twenty-six Passages, made by the Enterprise, between Calcutta and different Ports in the Bay of Bengal,

Left.	On the	Arrived at	On the	Time employed. Hours.	Time employed. Minutes.	Distance in Miles.
Sand Heads,.....	7th January, 1826,	Rangoon, ...	12th January, 1826,	120	—	620
Rangoon,.....	14th „ „	Floating Light,.....	18th „ „	96	30	620
Sand Heads,.....	22d „ „	Rangoon, ...	27th „ „	110	—	620
Rangoon,.....	30th „ „	Floating Light,.....	4th February, „	123	—	620
Sand Heads,.....	13th February, „	Rangoon, ...	17th „ „	93	30	620
Rangoon,.....	27th „ „	Floating Light,.....	3d March, „	106	—	620
Sand Heads,.....	20th March, „	Rangoon, ...	25th „ „	122	—	620
Rangoon,.....	28th „ „	Floating Light,.....	3d April, „	146	45	620
Sand Heads,.....	30th April, „	Rangoon, ...	6th May, „	137	30	620
Rangoon,.....	15th May, „	Floating Light,.....	21st „ „	143	—	620
Akyab,.....	22d June, „	Ditto, ...	24th June, „	84	—	240
Sand Heads,.....	5th August, „	Rangoon, ...	10th August, „	132	55	620
Rangoon,.....	3d September,„	Floating Light,.....	8th September,„	121	30	620
* Sand Heads,.....	24th March, 1827,	Masulipatam, ...	29th March, 1827,	124	—	490
Masulipatam,.....	30th „ „	Madras, ...	1st April, „	54	30	180
Madras,.....	11th April, „	Amherst Harbour, ...	19th „ „	200	15	1000
Amherst Island,.....	13th June, „	Floating Light,.....	16th June, „	66	30	340
Sand Heads,.....	8th September,„	Akyab,.....	12th September,„	60	—	240 } †
Akyab,.....	15th „ „	Floating Light,.....	17th „ „	54	—	240 } †
Sand Heads,.....	5th October, „	Rangoon, ...	10th October, „	122	50	650
Amherst Harbour,.....	22d „ „	Floating Light,.....	28th „ „	136	30	650
Sand Heads,.....	3d December,„	Amherst Harbour, ...	9th December, „	140	—	650
Amherst Harbour,.....	16th „ „	Floating Light,.....	21st „ „	111	—	650
Sand Heads,.....	5th January, 1828,	Amherst Harbour, ...	10th January, 1828,	113	36	650
Amherst Harbour,.....	27th „ „	Floating Light,.....	3d February, „	147	40	650

Average rate $5\frac{3}{4}$ miles per hour.

* The Vessel was under repair from September 1826 to March 1827.

† Thirty hours lost in screwing up the paddle-wheels.

Note.—The subsequent employment of the Enterprise was as follows:—

March, 1828—Proceeded to the Line, towing the Herald Yacht, and returned in April.

Made two trips with stores to Arracan.

July—Despatched to the Undaunted frigate to convey Lord William Bentinck to Calcutta, after which, she was laid up under repair until December, when she was sent with Mr. Bayley to the Arracan and Tenasserim Provinces, and in January she returned.

25th February, 1829—Started with Lord William Bentinck, for Singapore and the intermediate settlements,—returned 6th April, and was then made over to the Bombay Government.

APPENDIX C 2.

Statement of Services performed by the Honorable Company's Steam Vessel Ganges, during the year 1828.

Date.	Description of Service employed on.		Freight.		Number of days employed.
	Government.	Private.	Passengers.	Treasure.	
1828. January, 4th & 5th.	Conveying to and from H. M. S. Java, at Kedgeree,	.. .. ..	Captain & Officers, ...	.. ..	2
10th.	Conveyed to Kedgeree,	....	Admiral Gage, Captain Carrol, and Officers, ..	....	2
11th.	Returned to Calcutta,	....	....		
14th & 15th.	Receiving and conveying to the H. C. S. Minerva, at Saugor,	....	.. .. ..	71 Boxes, wt. 21¼ Tons,	2
16th & 17th. 18th & 19th.	Towing Minerva to Sea, Returning to Calcutta,	....	....	....	4
20th.	Conveying to the H. C. S. Thomas Grenville, at Diamond Harbour, ..	....	Captain Shea, 8 Seamen, (prisoners for the Princess Charlotte,)	.. ..	4
21st & 22d.	Towing the Grenville to Saugor,	....	....		
23d.	Returned to Town with Capt. Shea and Officers,	....	.. .. ..		
26th.	Received on board 140 Invalids for the H. C. Ships Princess Charlotte and Wellington, baggage, &c.	.. .. ..	Three Officers on duty with Invalids, (140 men)	.. ..	4
27th & 28th.	Conveying ditto to Saugor,				
29th.	Returned to Calcutta.				
February, 7th & 8th.	Conveying to Hedgelee,	.. .. ..	.. .. ..	20 Boxes	5
10th & 11th.	Returning to Calcutta,	.. .. ..	.. .. ..	(2 Lacs)	
12th to 14th.	Towing H. C. C. S. Neptune to Sea,	.. .. ..	.. .. ..	.... ..	16
15th.	Left her, and ran for Balasore,	... ...	... ...	.... Rs.	
16th.	Arrived at ditto,	... ...	... .	 8,61,296	
19th.	Received on board,	.. .. .	.. .. ..	79 Boxes,	
21st.	Arrived at Chittagong,	... ...	... ...		
24th.	Received on board,	.. .. ..	.. .. ..	94 Boxes,	
	Left Chittagong,	... ...	... ...	... ...	
27th.	Arrived in Calcutta,	.. .. ..	.. ..	... ...	
March, 12th.	Received on board for the H. C. S. Thomas Grenville, at Saugor,	....	Captain Shea, and 24 Invalids,	101 Boxes (13 Lacs).	4
13th.	Delivered Treasure, &c.	....	....	....	
14th.	Towed the Thomas Grenville to Sea,	....	....	....	
15th.	Returned to Calcutta,	....	....	....	

Date.	Description of Service employed on.		Freight.		Number of days employed.
	Government.	Private.	Passengers.	Treasure.	
1828. April, 1st to 4th.	Towing and attending the H. C. S. Investigator to Sea,	... ...	... ...	... .	5
5th.	Returned to Town,				
May, 4th to 11th.	Attending and Towing H. M. Ship Satellite to Sea,	... ...	... ...	... ...	8
12th.	Returned to Town,	... ...	... ...	.. ..	1
23d to 27th.	Conveying Troops from H. C. S. Berwickshire at Saugor, to Calcutta,	... ...	88 Men, 1 Officer, 1 Writer, 1 Cadet,	... ...	2
28th to 30th.	Running to Saugor and conveying Troops from the H. C. S. Sir David Scott,	... ...	266 Men, 1 Officer, 1 Assist. Surgeon, 1 Cadet, ..	... ...	3
31st to 3d June.	Ran to Saugor and conveyed Troops from the H. C. S. Reliance, to Chinsura,	... ...	8 Officers, 1 Cadet, 1 Assist. Surgeon, 146 Men,	... ...	4
4th.	Returned to Calcutta,	... ...	... ...	... ...	1
5th to 7th.		Towing Ship Norfolk to Sea, ..	... ...	....	4
8th.	Returned to Saugor,	....			
9th & 10th.	Receiving from H. C. Ships Balcarras and George 4th, and conveyed to Chinsura,	... ...	7 Officers, 190 Men, ...	... ...	3
	Landed at Calcutta, ...	... ...	9 Cadets, 2 Writers, 1 Assistant Surgeon, ...		
11th.	Returned to Calcutta.				
12th to 1st July.	Waiting the arrival of the new Governor General,				
2d & 3d.	Conveyed to H. M. S. Undaunted at Kedgeree, on Deputation, ...	... ...	Col. Vaughan, .. Comdr. Hayes, .	... ...	3
3d & 4th.	Conveyed Troops from the H. C. S. Thomas Coutts to Calcutta, ...	... ...	13 Officers, 3 Cadets, 240 Men,		
5th to 8th.	Running to Saugor and conveying to Calcutta, from Thomas Coutts, ..	... ...	80 Men, ...	.. .. ..	4
	And from the General Harris, ...	... ...	.. .. ..	19 Boxes, ...	
11th to 13th.	Conveying to the H. C. S. Berwickshire and attending her to Sea, ..	... .	Captain Maden, 40 Convicts	... ...	4
14th.	Returned to Town,	... ...	... ...		
22d to 25th.	Attending H. C. S. Sir David Scott to Sea, ...	... ...	... ...	... ...	5
26th.	Returned to Calcutta,				
29th.	Conveyed Troops to Chinsura, ...	... ...	9 Officers, 200 Men, ...	... ...	2
30th.	Returned to Calcutta, ...	... ...	... ...		
August, 7th to 13th.	Conveying to Marquis of Huntly and towing her to Sea,	... ...	Lord Bishop and Suite, and Captain Fraser,	... ...	9
14th & 15th.	Returning to Diamond Harbour, filled up Coals,				
16th to 20th.	Towing H. M. S. Undaunted to Sea,	... ...	... ...	... ...	6
21st.	Returned to Calcutta,				
23d & 24th.	Run to Saugor for H. C. S. Geo. 4th. Ship got to Sea before we reached,	... .	... .	... ...	3
25th.	Returned to Town,				
26th to 29th.	Attending and towing H. C. S. Balcarras to Sea,	... ...	... ...	... ...	5
30th.	Returned,				

Date.	Description of Service employed on.		Freight.		Number of days employed.
	Government.	Private.	Passengers.	Treasure.	
1828. September,					
6th & 7th.	Conveyed to H. C. S. General Harris and towed her to Sea, ...	... .	Capt. Stanton, of the Ship.	30 Boxes, ...	4
8th & 9th.	Returning, ...				
18th to 21st.	Attending and towing H. C. S. Thos. Coutts to Sea,.....				
22d.	Returned and towed H. C. S. Asia from Kedgeree to Diamond Harbour, ...	... .	... .	... .	6
23d.	Returned to Town, ...				
30th to 2d Oct.	Running to Balasore, ...				
4th.	Received on board, ...	.. ..	... ...	30 Boxes, (1,21,000 Rs.)	8
7th.	Arrived off Town, ...				
20th to 22d.	.. ..	Towing Ship Carnbrea Castle from Hoogly Point to Calcutta,	... ...	... ...	3
24th to 27th.	.. ..	Towing the Turkish Admiral's Ship from Cookry Hatty Reach to Town, ...	... .	... ...	4
November, 6th to 8th.	Towing H. C. S. Rose from Diamond Harbour to Town, ...	... ...	... ...	... ...	3
9th.	....	Towing Ship Lord Amherst to Town from Runpore Reach, ...	... ...	... ...	1
10th to 3d Dec.	Under repair.				
4th.	Left Calcutta for Sandoway with Troops,.....	... ...	1 Officer, 94 Seapoys.		27
8th.	Arrived at Sandoway.				
10th.	Left ditto with	... ...	2 Officers, 141 Seapoys.		
14th.	Arrived in Calcutta.				
16th.	Left for Sandoway with	... ...	2 Officers, 100 Seapoys.		
20th.	Arrived at Sandoway.				
22d.	Left Sandoway with	... ...	1 Officer, 126 Seapoys.		
25th.	Arrived off Town.				
26th & 27th.	Taking in Coals, &c.				
28th.	Left Calcutta for Sandoway, with....	... ...	1 Officer, 114 Seapoys.		
January 1st.	Arrived at Sandoway.				
				Total days employed, ...	171

Number of hours under Steam, ... 2,061.

FUEL EXPENDED.

Burdwan Coal	795 Tons.
Tallow, ...	30 Cwt.
Cocoanut Oil, ...	18 Maunds.

Garcowa	Dec. 30, 1858	Calcutta	Jan. 4, 1859	21	42	14	None	1
Calcutta	Dec. 28, 1858	Canboma	Dec. 31, 1858	40	None	33	None	1
Kyouk Tyloo	Dec. 17, 1858	Calcutta	Dec. 21, 1858	80	None	33	None	1
Canboma	Dec. 10, 1858	Kyouk Tyloo	Dec. 16, 1858	14	None	17	None	1
Calcutta	Dec. 8, 1858	Canboma	Dec. 14, 1858	118	None	84	None	1
Akyab	Dec. 5, 1858	Calcutta	Dec. 6, 1858	25	None	17	None	1
Calcutta	Nov. 28, 1858	Akyab	Dec. 1, 1858	63	None	33	None	1
Akyab	Nov. 23, 1858	Calcutta	Nov. 28, 1858	40	None	8	None	1
Calcutta	Nov. 18, 1858	Akyab	Nov. 23, 1858	62	None	10	None	1
Intercepted	Nov. 17, 1858	Calcutta	Nov. 17, 1858	8	None	30	None	1
Calcutta	Nov. 10, 1858	Intercepted	Nov. 10, 1858	8	None	24	None	None

Nov. 10, 1858.—Sold and left Moulmein, 1858. The Steam up for the purpose of accepting the Company on duty.

Intercepted.

From 4th to 8th October 1858, employed steaming H. C. Ship

Floating Light	Aug. 14, 1858	Calcutta	Aug. 16, 1858	30	8	38	None	8
Sandoa	Aug. 13, 1858	Floating Light	Aug. 14, 1858	7	8	10	None	None
Calcutta	Aug. 5, 1858	Sandoa	Aug. 10, 1858	10	None	90	None	30
Madras Town	July 30, 1858	Calcutta	Aug. 4, 1858	190	63	43	21 Days 10 hrs	1
Mandoon	July 12, 1858	Madras Town	July 16, 1858	50	None	14	None	8
Madras Town	July 11, 1858	Mandoon	July 15, 1858	52	None	4	None	None
Calcutta	June 30, 1858	Madras Town	July 6, 1858	82	110	42	None	8
Ganjam Roads	June 6, 1858	Calcutta	June 10, 1858	14	None	14	None	8
Ganjam Roads	June 5, 1858	Ganjam Roads	June 6, 1858	10	None	32	None	8
Calcutta	June 2, 1858	Ganjam Roads	June 4, 1858	10	None	6	None	None
Ganjam Roads	May 31, 1858	Calcutta	June 1, 1858	10	None	10	None	8
Cocoto Bank	May 31, 1858	Ganjam Roads	May 31, 1858	18	None	13	None	8
Ganjam Roads	May 30, 1858	Cocoto Bank	May 31, 1858	12	None	31	None	None
Kamboon	April 29, 1858	Calcutta	April 30, 1858	150	84	4	3 Days 10 hrs 0	1
Madras Town	March 1, 1858	Kamboon	March 2, 1858	31	None	6	None	None
Nosh Harbour	Feb. 11, 1858	Madras Town	Feb. 11, 1858	14	None	10	None	8
Tavoy River	Feb. 6, 1858	Nosh Harbour	Feb. 6, 1858	31	None	28	None	8
Mergui Harbour	Feb. 4, 1858	Tavoy River	Feb. 4, 1858	33	None	10	None	8
Tavoy River	Feb. 4, 1858	Mergui Harbour	Feb. 4, 1858	12	None	10	None	8
Madras Town	Jan. 30, 1858	Tavoy River	Feb. 1, 1858	43	None	13	None	8
Kamboon	Jan. 30, 1858	Madras Town	Jan. 31, 1858	32	None	14	None	None

Port of Departure.	Date.	Port of Arrival.	Date.	Distance in Nautical Miles.	Average Speed per hour.	Time Steaming in Hours and Minutes.	Remarks.	Number of Days.

Account of the Performances of the Honourable Company's

APPENDIX

APPENDIX C 4.

Monthly Establishment of the Hon'ble Company's Steam Vessel Irrawaddy.

Commander, ...	at	Sa. Rs.	400	per Month,	.....	....	400	0	0
Chief Officer, ...	at	„	200	ditto,	.....	....	200	0	0
Second ditto, ...	at	„	150	ditto,	.....	....	150	0	0
Head Engineer, ...	at	„	208-5-4	ditto,	.....	....	208	5	4
Assistant Engineer, ...	at	„	140	ditto,	.....	....	140	0	0
Carpenter, ...	at	„	35	ditto,	.....	....	35	0	0
Butler, ...	at	„	20	ditto,	.....	....	20	0	0
Cook, ...	at	„	12	ditto,	.....	....	12	0	0
Servant, ...	at	„	8	ditto,	.....	....	8	0	0
Four Sea Cunnies, ...	at	„	16 each	ditto,	.....	....	64	0	0
One Serang, ...	at	„	20	ditto,	.....	....	20	0	0
Two Tindals, ...	at	„	15 each	ditto,	.....	....	30	0	0
Twenty-four Lascars, ...	at	„	9 each	ditto,	.....	....	216	0	0
Two Topazes, ...	at	„	7 each	ditto,	.....	....	14	0	0
Ten Stokers, ...	at	„	16 each	ditto,	.....	....	160	0	0
							1677	5	4
Table Allowance for Commander and Two Officers, at Sicca Rupees 300 per Month, ...							300	0	0
——— Ditto for One Engineer, at Sicca Rupees 2 per Diem, ...							60	0	0
Provision Money for Forty-seven Men as Natives, at Sicca Rupees 4 each per Month, ...							188	0	0
Total amount of Pay and Provision Money, Sicca Rupees, ..							2225	5	4
The Ganges Steamer has a similar Establishment, with this alteration, that, instead of one Head Engineer and an Assistant Engineer, she has on board Two Engineers sent out by the Court, each drawing a Salary of 125 Rupees per Mensem* at this Presidency, and Table Money at the rate of Two Rupees per Diem, which makes her Establishment per Mensem, Sicca Rupees, ...							2247	0	0

* One-half of their Salary payable in England.

APPENDIX C 5.

Statement, shewing the number of Hours under Steam and the Consumption of Fuel, in the H. C. Steamers Hoogly and Burhampootur, from 20th June to 31st December, 1828.

Vessels' Names.	Hours under Steam.	Maunds of Coal.	Description.	Maunds of Wood.	Maunds of Tallow.	Maunds of Oil.
Hoogly, ...	586¾	5544 { 462 / 5082	English. Burdwan.	340	17	11
Burhampootur, ...	406	2823 ——	Ditto.	——	12	6

N. B.—The Diana consumes four cubes of six feet of teak-wood, in five hours.

APPENDIX D.

List of Specimens of Woods, sent from Gualpara to Calcutta by Doctor Francis Buchanan, arranged with the known Woods they most resemble, with a comparative Statement of their weight and strength, &c. and remarks:—furnished by James Kyd, Esq. being the result of his own experiments made at Kidderpore in 1809.—*N. B. the Specimens were not subjected to any particular seasoning.*

Number.	Native Name.	Resemblance to	Weight of each piece planed to one inch square and two feet long.	Specific gravity.	When put on a frame, propped at the ends at the distance of twenty-two inches, and a weight suspended on the middle — broken by	Grain.	Hard or Soft.	Tough, Short or Brittle.	REMARKS.	
			oz.		cwt. qr. lb.					
35	Jujakohi, ...	Mahogany, ..	14½	1044	2 0 7	Close, ..	Soft,	Rather Tough,	Great resemblance, ...	Fit for Furniture; a valuable wood.
78	Daine Oksi, ...	....	10½	756	4 1 20	Open veined,	Hard,	Tough, ..	Like American red oak,	Good Quality,
15	Sida, ...	....	11½	828	4 0 6	Close, ..	Hard,	Tough, ..	....	Ditto ditto,
56	Golsinggur, ...	....	11½	828	3 3 14	Close, ..	Hard,	Tough, ..	....	Ditto ditto,
13	Uluyachama,....	....	9	648	3 1 20	Open, ..	Hard,	Tough, ..	....	Ditto ditto,
31	Sonalee, ...	Oak, ...	12½	900	3 1 9	Open, ..	Hard,	Tough, ..	....	Ditto ditto,
58	Nikori, ...	....	10	720	3 1 6	Close, ..	Hard,	Tough, ..	Like the best English oak,	Excellent do.
57	Tima, ...	....	9½	684	3 0 6	Close, ..	Hard,	Tough, ..	Ditto ditto, ..	Ditto ditto,
68	Kendu, ...	....	11	792	2 3 20	Close, ..	Hard,	Rather Tough,	Ditto ditto, ..	Ditto ditto,
22	Kangta Singgur,.	....	9½	684	2 0 6	Close, ..	Hard.	Short, ..	....	Rather inferior,
A	Piece of English	Oak, ...	9½	684	2 2 20	Close, ..	Hard,	Rather Tough,		
85	Joynol, ...	Beef wood, an Oak of new South Wales,	12½	900	3 1 6	Close veined,	Hard,	Tough, ..	Great resemblance, ...	Good Timber Wood.
60	Chung, ...	....	12	864	4 1 20	Close, ..	Hard,	Tough, ..	All very like, ...	Good Timber Woods.
86	Korra, ...	Saul, ...	12¼	882	4 1 6	Close, ..	Hard,	Tough, ..		
59	Hiloch, ...	....	11	792	2 0 13	Close veined,	Hard,	Brittle, ..		
A	Piece of Morung	Saul, ...	12	864	4 1 6	Close, ..	Hard,	Tough,		
63	Kilkha, ...	....	12½	900	4 2 6	Close, ..	Hard,	Tough, ..		
42	Chikagambhari, .	....	12½	900	4 0 20	Close, ..	Hard,	Tough, ..		
10	Baul, ...	....	10½	756	3 3 13	Close, ..	Hard,	Tough & strong,		
12	Bojornondi, ...	Silgomar	9½	684	3 3 10	Close, ..	Hard,	Tough, ..		
89	Chhatiyan, ...	of	9	648	3 3 6	Close, ..	Soft,	Tough, ..	All more or less like, ..	Good Timber Woods.
54	Momsita, ...	Chittagong,	11	792	3 2 26	Close, ..	Hard,	Tough, ..		
14	Gambhari, ...	....	8½	612	3 2 13	Close, ..	Hard,	Tough, ..		
40	Pangehpitya, ..	....	10	720	3 1 6	Close, ..	Hard,	Tough, ..		
67	Haola, ...	....	8	576	3 1 6	Close, ..	Soft,	Tough, ..		
41	Babla, ...	....	8	576	3 0 13	Close, ..	Soft,	Tough, ..		
88	Kodom, ...	....	8	576	3 0 0	Open, ..	Soft,	Tough, ..		
51	Kohi, ...	....	14¼	1026	2 3 13	Close, ..	Hard,	Tough, ..		
75	Boropatiya, ...	Silgomar of	9	648	2 2 26	Close, ..	Hard,	Short, ..	All more or less like, ..	Good Timber Woods.
18	Bandorkola, ...	Chittagong,	9	648	2 1 6	Close, ..	Soft,	Short, ..		
74	Mogor, ...	....	7	504	2 0 6	Open, ..	Soft,	Short, ..		
44	Panmeya, ...	....	8¼	594	2 0 20	Close, ..	Soft,	Short, ..		
19	Kolpholi, ...	....	8	576	1 1 20	Close, ..	Soft,	Short, ..		

Number.	Native Name.	Resemblance to	Weight of each piece planed to one inch square and two feet. long.	Specific gravity.	When put on a frame, propped at the ends at the distance of twenty-two inches, and a weight suspended on the middle — broken by			Grain.	Hard or Soft.	Tough, Short or Brittle.	REMARKS.	
			oz.		cwt.	qr.	lb.					
4	Kombo, . . .	. . . . .	13½	972	3	2	10	Close, .	Hard,	Tough & strong,	All very like, . . .	Good Timber Woods.
25	Horisungkor, .	. . . . .	12	864	2	3	13	Close, .	Hard,	Tough, .		
24	Nujor, . . .	Soondry, .	15¼	1098	2	2	6	Close veined,	Hard,	Short, . .		
92	Horinhora, . .	. . . . .	11	792	1	3	6	Close veined,	Hard,	Brittle, .		
71	Moj, ...	. . . . .	10½	756	1	0	27	Close, .	Hard,	Short, . .		
A	Piece of . . .	Soondry, . .	15	1080	3	3	6					
38	Amari, ...	. . . . .	10½	756	4	0	27	Close, .	Hard,	Tough, .	All tolerably like.	
28	Gobor Phongyota,	. , . . .	10½	756	3	1	6	Close, .	Hard,	Tough & strong,		
87	Tukra, ...	. . . . .	8½	612	3	1	6	Close, .	Soft,	Tough, .		
66	Jatekorai, . , .	Malacca, .	9	648	2	3	20	Close, .	Soft,	Tough, .	Yellow, colour. . . .	Good Timber Woods.
9	Bhakuri, . . .	Poon, . .	9½	684	2	3	10	Open, .	Soft,	Tough, .		
37	Bhongyera, . .	. . . . .	9	648	2	2	20	Close, .	Hard,	Tough, .		
70	Tokor, . . , .	. . . . .	7	504	2	0	6	Open, .	Soft,	Short, . .	Darker colour.	
26	Bauri, ...	. . . . .	9½	684	2	0	3	Open, .	Soft,	Rather Tough,	Ditto ditto.	
16	Silapoma, . . .	. . . . .	10½	756	3	3	4	Close, .	Hard,	Tough, .		
36	Kangtalechama, .	. . . . .	7½	540	3	2	20	Close, .	Hard,	Tough, ,	Yellow, but exactly the grains and view.	
80	Uriam, ...	. . . . .	9½	684	3	1	6	Close, .	Soft,	Tough, .		
17	Saljam, ...	. . . . .	10	720	3	0	20	Close, .	Hard,	Tough, .	Dark colour.	
1	Bhojgachh, . .	. . . . .	8¼	594	2	3	10	Open, .	Soft,	Rather Tough,	White but exactly the grains and view.	
76	Rosunigapoma, .	. . . . .	9	648	2	3	6	Close, .	Hard,	Short, . .		
45	Chokrosila, . .	Toon, . .	8½	612	2	3	5	Close, .	Hard,	Short, , .	Mostly very like, . . .	Well adapted for Furniture and light work.
46	Poma, . . , .	. . . . .	8	576	2	2	6	Close, .	Hard,	Short, , .	Real Toon colour view and smell.	
8	Jarul, ...	. . . . .	8¼	594	2	0	20	Open, .	Soft,	A little Tough,		
20	Jharwaja Amra, .	. . . . .	7	504	2	0	20	Open, .	Soft,	Short, . .		
90	Palash, ...	. . . . .	7	504	1	3	5	Open, .	Soft,	Tough but not strong, .		
61	Bowgotadhora, .	. . . , .	9	648	1	2	6	Close, .	Hard,	Short, . .		
3	Korice, . . .	. . . . .	6¼	570	1	0	21	Open, .	Soft,	Rather Tough,		
A	Piece of . . .	Toon, . . .	6½	588	2	1	20					
64	Okchi, ...	. . . . .	10	720	3	0	20	Close veined,	Hard,	Tough, .	All very like, ...	Excellent Timber Woods.
34	Makrisal, . . .	Red Jarul,	9½	684	2	0	6	Close, .	Hard,	Rather Tough,		
69	Chalita, . . .	. . . . .	10	720	1	1	6	Close, .	Hard,	Short, . .		
A	Piece of . . .	Red Jarul, .	8½	612	2	0	6					

N. B. Good Timber Woods mean, that they are adapted for general purposes where Timber is used, such as Ship Timber, House Beams, &c. &c.

Number.	Native Name.	Resemblance to	Weight of each piece planed to one inch square and two feet long.	Specific gravity.	When put on a frame, propped at the ends at the distance of twenty-two inches, and a weight suspended on the middle — broken by	Grain.	Hard or Soft.	Tough, Short or Brittle.	REMARKS.	
			oz.		cwt. qr. lb.					
50	Halajeya, ...	American	14½	1044	3 0 6	Close, ...	Hard,	Tough, ..	....	Good Timber Woods.
*58/94	No Name, ...	Hickery, ...	11	792	2 3 6	Close, ...	Soft,	Short, ..	....	
47	Gondsore, ...	Jack, ...	8½	612	2 3 20	Close, ...	Soft,	Tough, ..	Strong smell of aniseed,..	Good Timber Woods.
29	Angchhue,.....	... .	15	1080	2 2 6	Close, ...	Hard,	Brittle, ..	....	
81	Parokupi, ...	....	7½	540	2 2 6	Close, ...	Soft,	Short, ..	Not very like Inferior, ..	Not fit for Furniture.
21	Bukdholi, ...	Chuckrassy, .	14	1008	2 0 20	Close, ...	Hard,	Brittle, ..		
73	Lalpatiya, ...	....	9	648	1 2 20	Close, ...	Hard,	Short, ..		
79	Dophari	....	10½	756	3 3 5	Close, ...	Hard,	Tough, ..	All tolerably like, ..	Adapted for carriage shafts and where toughness is required.
84	Saora, ...	English Ash, .	9½	684	3 0 6	Close, ...	Soft,	Short, ..		
32	Rakhalponi, ...		5½	396	1 3 6	Open, ...	Soft,	Rather Tough,		
52	Khojee, ...	....	5	360	0 1 6	Open, ...	Soft,	Short, ..		
A	Piece of	English Ash, .	9½	684	2 2 20					
62	Kauyakuje, ...	....	10½	756	4 1 13	Close, ...	Hard,	Tough, ..	All tolerably like, ..	Adapted for general purposes.
55	Bhilli,.....	....	9	648	3 3 13	Open, ...	Soft,	Tough, ..		
39	Amla,.....	....	10	720	3 1 6	Close veined,	Hard,	Tough, ..		
65	Moyen, ...	Beech, ...	9⅓	684	2 1 13	Close, ...	Hard,	Short, ..		
72	Chhalpata,.....	....	10⅓	756	2 0 6	Close, ...	Hard,	Short, ..		
2	Hendol, ...	....	8¾	630	1 2 21	Close, ...	Hard,	Rather Tough,		
93	Kurkarhampa, ..	....	8½	612	1 1 5	Close, ...	Soft,	Tough, but not strong,		
82	Pitagachh, ...	....	9	648	3 3 6	Close, ...	Soft,	Tough, ..	All very like, ...	Beautiful close grained, and well adapted for all sorts of Turnery ware.
91	Adkhuri, ...	....	7⅓	540	2 3 6	Close, ...	Soft,	Short, ..		
11	Dudkhuri, ...	Plane Tree, ...	8¼	594	2 0 26	Close, ...	Soft,	Short, ..		
6	Bhodiya, ...	....	9	648	1 3 6	Close, ...	Soft,	Short, ..		
43	Bonjam, ...	....	7	504	1 2 13	Close, ...	Soft,	Short, ..		

* Two Pieces numbered 58, different in quality, were sent; the one is classed along with the Oaks, the other is like Hickery, and is numbered 58/94 to distinguish it.—
Two Pieces were also sent numbered 47, but are both of the same kind.

Number.	Native Name.	Resemblance to	Weight of each piece planed to one inch square and two feet in length.	When put on a frame, propped at the ends at the distance of twenty-two inches and a weight suspended on the middle — broken by	Grain.	Hard or Soft.	Tough, Short or Brittle.	REMARKS.
			oz.	cwt. qr. lb.				
77	Rengla, ...	Fir, ...	5½	2 0 6	Close, ...	Soft,	Short, ..	Very like, with the exception of the smell of Turpentine in it; well adapted for spars and light work like pencil cedar, with the exception of smell; fit for light ware.
A	Piece of Europe	Fir, ...	5¼	2 0 6	Close, ...	Soft,	Rather Tough,	
53	Phutki, ...	Cedar, ...	7	1 3 6	Close, ...	Soft,	Short, ..	
27	Paryat, ...	....	10	3 3 6	Close, ...	Hard,	Rather Tough,	All very like—Inferior Woods.
23	Bagnal, ...	....	9⅓	2 2 20	Close, ...	Soft,	Short, ..	
83	Bankapash, ...	... .	6½	2 0 20	Open, ...	Soft,	Short, ..	
48	Khoska dumor ..	White Jarul,	5½	1 3 20	Open, ...	Soft,	Short, ..	
49	Bhela,.....	....	6	1 0 6	Open, ...	Soft,	Short, ..	
7	Jam, ...	....	4½	0 3 8	Open, ...	Soft,	Short, ..	
33	Amra,.....	....	4¼	0 3 3	Open, ...	Soft,	Short, ..	Very Inferior.
A	Piece of	White Jarul,	8½	3 1 20	Open, ...	Soft,	Rather Tough,	N. B. This was a picked piece, superior to the generality of it.
5	Agor & Sangchie,	Simmul Ruey,	4½	1 0 10	Open, ...	Soft,	Short & spongy,	Inferior—used for Palanquin Poles.
30	Odlaor Hatchanda, ...	or Cotton tree,	4	0 2 6	Open, ...	Soft,	Short & spongy,	
A	Piece of Rangoon	Teak, ...	8½	3 2 6				
A	Piece of Sissoo...	....	10½	4 0 6				

KIDDERPORE,
3d *of February*, 1809.

(Signed) J. & R. KYD,
Master Builders.

APPENDIX E.

Comparative Statement furnished by Captain Johnston, shewing the Expense of employing the Enterprise, and the Ganges or Irrawaddy, on voyages between Calcutta and the Tennasserim Coast.

Monthly Establishment of the Ganges or Irrawaddy, in January 1829, ...			2549
Enterprise ditto, ...		3762	
Deduct excess of the Commander's salary, ...	600		
Ditto of Engineer's salary, ...	200		
	——	800	
		——	2962
			——
Greater expense of Enterprise's establishment,			587
			——
The Enterprise consumes twelve tons of coals per day, and for the above voyage requires no supply on the Tennasserim Coast, to which she has made two voyages within the month, being twenty-six days under Steam, consuming eight thousand four hundred and twenty-four maunds of coals, received in Calcutta, at seven annas per maund,—value, ...			3685
The Ganges or Irrawaddy, in performing the same service, within the same period, would consume seven thousand and twenty maunds, of which four thousand six hundred and eighty supplied in Calcutta, at seven annas per maund, value, ...		2047	
And two thousand three hundred and forty maunds at Tennasserim, provided from Calcutta, at fifteen annas per maund, ...		2193	
		——	4230
			——
In favor of the Enterprise, ...			555
In favor of the Irrawaddy, as above, ...			587
			——
Net difference in favor of the Irrawaddy or Ganges,			32
But the Irrawaddy or Ganges could not carry any Stores, when laden with their full quantity of coals; whilst the Enterprise, being capable of carrying Burdwan coal for twenty-four days' consumption, might, with the above quantity, receive also one hundred tons of Stores (she took one hundred and fifty to Sandoway in April, 1828,) which, if sent in a sailing vessel, would cost fifteen rupees per ton, freight, ...			1500
			——
So that the balance would, sometimes, be turned in favor of the Enterprise, to the extent of, ...			1468 Rupees.

APPENDIX F.

Abstract from the Log of the Honorable Company's Armed Steamer Hugh Lindsay, of the time and rate of performance of the several stages of the passage from Bombay to Suez and back.

Departure from		*Arrival at*		*Dist. in Miles.*	*Time Steaming*		*Average Rate per Hour.*		*At Anchor.*	*Time.*		*Total time on the Passage.*		*Remarks.*
Place.	*Time When.*	*Place.*	*Time When.*		*Days.*	*Hours*			*Place.*	*Days.*	*Hours.*	*Days.*	*Hours.*	
Bombay,	20th March, 5 0 P.M.	Aden, ..	31st March, 1 P.M.	1641	10	20	6	2	Aden,....	5	20			Light Westerly Wind against us throughout,
Aden, ...	6th April, 9 0 A.M.	Mocha,..	7th April, 9 A.M.	150	1	0	6	2	Mocha, ...	0	20½			for the most part light airs, till near Mocha
Mocha, .	8th ,, 5 35 do.	Juddah,.	12th ,, 6 P.M.	517	4	12½	4	6	Juddah,...	4	13			two days Northwester against us.
Juddah,.	17th ,, 7 0 do.	Suez, ...	22d ,, 8 A.M.	628	1	1	5	1	,,	0	0			Three days Land Northwester against us.
		Total from Bombay to Suez, ..		2936	21	9½	5	5		11	53	33	15	
									Suez, ...	4	9			Favorable Wind and Weather.
Suez, ...	26th April, 5 0 P.M.	Cosier, ..	28th April, 8 A.M.	278	1	15	7	1	Cosier,.....	2	10			The last day a heavy Northwester which occa-
Cosier, ..	30th ,, 6 0 do.	Juddah,.	3rd May, 3 P.M.	406	2	21	5	7	Juddah,...	2	16			sioned a slight detention in making the port.
Juddah,.	6th May, 7 0 A.M.	Mocha, .	9th ,, 11 do.	517	3	16	5	7	Mocha, ...	2	10			Favourable weather.
Mocha, .	12th ,, 9 0 do.	Aden, ...	13th ,, 11 A.M.	150	1	2	5	6	Aden,....	5	18			Ditto ditto.
Aden, ...	19th ,, 5 0 do.	Bombay,	29th ,, 6 P.M.	1641	10	12	6	4						Wind favourable throughout.
		Total from Suez to Bombay,..		2992	19	18	6	2		17	15	37	9	
		Grand Total, ...		5928	41	3½	5	7				70		

APPENDIX G.

Extract from a Letter addressed to the Author by W. Cracroft, Esq. of the Bengal Civil Service, dated Dacca, 15th August, 1830.

I HAVE delayed replying to your queries regarding the streams which connect the Burhampootur and Ganges, until I could procure tolerably accurate information. Yesterday I consulted Lieutenant Wilcox, and I now give you the result of what I have been able to ascertain from him, and others.

All the streams from the north of Rungpore, have not bifurcations uniting the two rivers, but only a few of them. Below latitude 25°, there are not so many cross channels as you seem to suppose. The only streams of any importance are the Jenye, the Bungs, and the Lukya; the rest are navigable only during the inundation, except for very small boats, and their mouths are generally choked with sand-banks. The Jenye has been, for some time past, the main branch of the Burhampootur, and very little, if any, further change in that respect will take place for a series of years. The Burhampootur, between the head of the Jenye, and its junction with the Megna, is now fast filling up, and in the dry season it is fordable in more places than one, above that junction and below the head of the Lukya. Mr. Lamb has crossed the Burhampootur at Cuttyadee without wetting his feet, not finding a stream, any where, more than a few inches deep, and which he could not clear with a jump.

The Jenye averages from a mile, to a mile and a half in breadth; at one spot only it is contracted to half a mile, and there the rapidity of the stream is enormous.

The Lukya is always navigable for large boats; but above its head, the Burhampootur is too shallow for navigation during two months of the dry season, and becomes more so every year.

The Bungs is open for about eight months for large boats, and during the dry season only small dinghees can pass the shallows.

The river Banar, which joins the Lukya, is open for large boats ten months in the year.

I can hear of no reflux to the northward, at any season, in any of the connecting streams; except the tide, which in the Lukya runs up to Peetulgunge, and in the Megna to Naldee; but this is only in the dry season.

Steam boats, to be useful on these rivers, must not draw above two feet water, at the utmost, and they should be used as tugs.

The soil between the two great rivers is not, as you suppose, loose earth, but a great deal of it hard (almost indurated) red iron clay, with nodules of Hematites, of which there is no scarcity in the neighbourhood of Dacca. Indeed, no house here of two stories is built without digging down to that stratum. All the hills exist as laid down by Rennell, between Ekdallah, Muddoopoor and Attyah, though not high ones.

I have heard from many persons, but cannot speak from personal observation, that the stream of the Ganges is not only checked in April by the body of water which comes down to Jenye, but is absolutely reversed, when freshes come early in the season from the eastern mountains; and that the outlet is a large stream through the middle of the Delta, the head of which is at Muddoopoor: this river I have seen in threading the mazes of the Delta from Furreedpoor to Seebnibas, and where I crossed it, the breadth was at least a mile and a half.

If this reflux, from Jaffergunge to Pungsa Madhoopoor, be correctly assumed, I think we shall 'ere long have the principal mouth of the Ganges in the middle of the Delta; for this river is *sometimes* fordable between Jaffergunge and Pungsa Madhoopoor. It is however to be observed, that in the dry season the tides sensibly rise and fall at Jaffergunge, but the current is not changed by them. The streams from Sylhet are too inconsiderable, though all well supplied, to keep open the enormous channels of the eastern mouth, which are, in fact, filling up daily, and new islands are forming between Hattiah Sundeep and the main land, which at the present time no more resemble Rennell's map, than our modern maps of the globe resemble one made by the Arab geographers from Ptolemy's crude materials.

APPENDIX H.

Statement furnished by the Commissariat Department in July 1830, *shewing the total expense of conveying Troops by water during two years of peace, the principal Stations to and from which the removes are made, and other particulars.*

* Total expense in the year 1827-28, ...	Rs. 23,475	2	7
Ditto in the year 1828-29, ...	19,511	0	3
In two years, Sa. Rs.	42,986	2	10

The principal Stations are Calcutta, Berhampore (one month allowed for arrival from Calcutta), Dinapore (two months), Benares (two months and a half), Allahabad (three months), Cawnpore (three months and a half), and Meerut (five months)—all on the River Ganges. Other Stations, to and from which small parties occasionally proceed, are Kurnaul (eight months and a half), Agra (six months), and Delhi (seven months and a half)—all on the River Jumna. Half a month extra is allowed for arrival at Berhampore by the Sunderbun route, in the dry season.

The Scale of Tonnage for Troops is as follows :—

An effective European Soldier, ...	50	Maunds.
A sick ditto, ...	75	,,
A Native Soldier or Camp-follower, ...	30	,,
An European Woman, ...	25	,,
An European Child, ...	10	,,

The Tonnage required for an European Regiment of nine hundred or one thousand effective men, including Establishments, would be from fifty-five to sixty thousand maunds.

The season in which trips are made, is generally the rains.

The rates of boat-hire are as follows:

Tonnage, three rupees per hundred maunds, per month.

A Mangee, four rupees per month.

Dandies, three rupees each per month, the number allowed being—

4	for a boat of	200	Maunds,
7	for ..	500	,,
8	for ..	600	,,
11	for ..	800	,,
12	for ..	1000	,,

---

* This is exclusive of Boat-allowance to Officers and Staff, which, by a Memorandum obtained at the Auditor General's Office, appears to have been,—to King's Officers, ... Rs. 31,479
to Company's ditto, ... 136,998
Total in 1827-28, Rs. 168,477

APPENDIX I.

Extract from Captain J. H. Johnston's Letter to the Marine Board, dated the 30th September, 1829.

.... "THE Irrawaddy, whose employment during the three first quarters of the year 1828, was principally on the Tenasserim Coast, and during the last only in Calcutta, made five river trips and towed one ship to sea in that year. She conveyed to and from different ships thirty-eight officers and three hundred and ninety-four men. She made twenty-one passages between different ports, conveying forty-one officers, twelve hundred and thirty-three men, and nine lakhs of treasure. Her services were available during ten months of the year, and she expended fourteen thousand three hundred maunds of coals.

The Ganges, during the same period, made sixteen trips in the river, conveying one hundred and thirty three officers, fourteen hundred and twenty-two men, and two hundred and twenty-one boxes of treasure. She towed in and out of the port nineteen ships, made eleven passages between different ports, and conveyed seven officers, five hundred and seventy-five troops, and twelve lakhs of treasure. She was one hundred and seventy-one days in actual employment, one hundred and seventy available, and twenty-four days under repair; and she consumed twenty-eight thousand maunds of coals."

..... "From such documents as I have been able to procure, the actual outlay per annum for each steam vessel, exclusive of coals, appears to have been forty thousand rupees. Of this sum, thirty-two thousand are for wages and provisions, five thousand for repairs, and three thousand for stores.

The charge for fuel depends on the quantity of actual employment and the locality of the service. The consumption is about eleven maunds per hour, or about two hundred and twenty maunds for every hundred miles, or ninety-six rupees per hundred miles, when the coal is shipped in Calcutta, and three hundred and ten rupees per hundred miles on an average when taken from an outport.

In 1828, the coals expended by the Irrawaddy, as above stated, was about fourteen thousand three hundred maunds, and cost ten thousand rupees. The Ganges consumed twenty-eight thousand maunds at a cost of twelve thousand rupees. The outlay for the two vessels amounted to about one lakh of rupees, or for each, fifty thousand: but the proportion for repairs was less than what, I conceive, will be found to be the average of several years; and although the saving already effected in the wages and victualling will reduce that item more than two thousand rupees per annum in each vessel, or from thirty-two thousand to thirty thousand, I think that, for repairs, a less outlay than seven thousand rupees per annum ought not to be calculated upon. This will bring the annual outlay, exclusive of coals, to forty thousand rupees, and including coals, the expense may be taken at fifty-two thousand rupees, which I consider, at present, their most practicable system of economy.

It is not only difficult, but nearly impossible to make an estimate of the services of steam vessels, employed as the Ganges and Irrawaddy have sometimes been. The quick conveyance of a despatch, of a commissioner, of troops, military stores, and treasure, can be rated at no fixed value. Such locomotive power at the command of a Government, will not fail to make a due impression on neighbouring states, and its effect may be appreciated, though it cannot be priced.

I will, nevertheless, endeavor to value the services of these vessels in a mercantile way. They must then, in the first instance, be considered as part of the stock in trade, valued at their original cost, which was, I believe, four lakhs of rupees; and as the deterioration of property must be taken into the account, wear and tear must be calculated at such a sum as, besides covering the repairs, shall, at a given period, be sufficient to renew the vessel, or to perpetuate the property. This cannot be taken at less than eight per cent. per annum on the original cost, which, on four lakhs of rupees, will be, ... Rs. 32,000

Interest five per cent on capital,	....	20,000
Wages and provisions,	....	57,200
Stores,	....	6,000
Coals,	....	24,000
Total annual expense,	Rs.	139,200

Valuing the services performed by the Ganges in the river, at the price that must have been paid by Government for the hire of other steamers, had their own not been available, she appears to have earned, ... Rs. 53,000

The Irrawaddy's river services may, on the same principle, be valued at, ... 7,600

She was also employed on the Coast of Tenasserim, and between those provinces and Calcutta, making thirteen communications between different ports—a service which three sailing vessels would scarcely have performed at an expence of, ... 25,000

Supposing the locomotive power imparted to the Commisioner of those provinces, being treble that which a sailing vessel could have given him, be represented by the salaries of two assistants less required, the value, twenty-eight thousand rupees, is nearly the same.

The steam vessels effected the interchange of one Regiment on the Arracan Coast. This service would not, in all probability, have been performed by hired sailing vessels for a less sum than .... * 24,000

Their total earnings may therefore be stated at, Rs. 109,600

a sum which, though exceeding by five thousand rupees the annual disbursement, falls thirty thousand short of the real annual expense. Yet, when against this sum is set off the advantage, both pecuniary and physical, consequent on a quicker transit of troops, the saving of interest on treasure conveyed, and the preservation of stores, the account would be balanced, even without throwing into the scale the weight of political acquisition; and I have often been assured by an experienced commander, that he should consider a steam vessel on the Tenasserim Coast, capable of embarking two hundred men, equal to the presence of five Companies of troops."

* Undervalued.

APPENDIX J.

Note by Mr. Seppings concerning the River Steamers, and Up-country Steam Navigation on the Ganges.

Hoogly, ... 158 Tons. ——— Burhampootur, ... 152 Tons.

On the arrival of the machinery for these two vessels, (four engines, each of twenty-five horse power, made by Messrs. Maudeslay and Co. of Lambeth), the Marine Board were desired to have the vessels built. On looking at the plan which was sent out, it was found impossible to procure proper grown timber of teak for the midship part of the frame: it was therefore suggested by Mr. Seppings, the Surveyor of Shipping to the Honorable Company, to build them with straight timber in midships, similar to the Congo, and several other Steamers, intended for shallow water, and to increase the beam from eighteen to twenty feet; this was, in the first instance, approved of, but afterwards countermanded. The Governor General in Council finally decided, that one should be built upon Mr. Seppings' plan, with straight timber in midships, and the other after the Europe plan, *but both with the original beam of eighteen feet.* These vessels are now launched, and employed by Government for various river duties—bringing up troops, carrying treasure, &c. The first, the Hoogly, built upon Mr. Seppings' plan, entirely of teak, at the yard of the Howrah Dock Company, cost, for hull and fittings, without machinery, sixty-four thousand six hundred sicca rupees: she is fastened upon Sir Robert Seppings' new principle, copper-bolted to the upper edge of the wales, and has proved herself a most efficient vessel as regards strength and velocity, having beat the Burhampootur upon a regular trial ordered by Government, and superintended by their Officers. The two vessels ran from Calcutta to Diamond Harbour, and back, the Hoogly beating her opponent half a mile down, and about a quarter of a mile up: the distance between these two places is about fifty miles by water. The Hoogly has made several trips up the country, once as far as Allahabad, a distance of eight hundred miles from Calcutta: in these inland voyages, she was frequently a-ground and in most trying and perilous situations; notwithstanding which, she has not sustained the least damage, and is now equally as good as the day she was launched, as there is not the least symptom of strain or of any defect whatsoever. Since her first voyage, she has had a poop put upon her, with accommodations afore and abaft the paddle-boxes, and some trifling alteration to her rudder.

The other vessel, the Burhampootur, was constructed by the special order of Government, at Mr. Kyd's Dock Yard, and cost eighty-four thousand sicca rupees for hull and fittings, without machinery, having been built upon estimate. The Burhampootur is copper-fastened to the upper edge of her wales, and finished according to the old system of ship-building: she has been employed chiefly between Calcutta and Saugor, with the exception of one short trip up the country (to Burhampore). The hull is at present in good condition: the only alteration she has undergone since launched, is, that accommodations have been added afore and abaft the paddle-boxes.

It is necessary to remark, that the plan sent from Europe, from which the Burhampootur was built, shewed the draft of water at ~~two~~ three feet; whereas that vessel draws, when loaded, four feet forward, and three feet aft (which is about the Hoogly's draft.) Had Mr. Seppings' proposition been adopted, of giving them two feet additional beam, the draft of water would not have exceeded three feet. Since these two vessels were built, it has been recommended by Mr. Seppings, to adopt the American plan of using steamers merely as tugs or floating engine-rooms. To insure such craft being really useful, and thoroughly efficient for such purpose, they must not exceed two feet water, with coals on board for four days (of twelve hours each), and with every thing requisite for starting on service: the propelling force should *not be less than one hundred horse* power, and the boat should not exceed one hundred and ten feet in length, with as little breadth as possible. The engine or engines to be upon the high pressure principle, which it becomes imperative to use on account of *weight* and *room*. With less power and greater draft of water, a vessel, as a tug, will be useless for the navigation of the Ganges, on account of its extreme shallowness in the dry season (scarcely two feet water) and rapid currents from six to nine knots, during the rainy season. If greater power, with reference to what has just been mentioned regarding the peculiarities of the Ganges, can be given to a single boat, so much the better. High pressure steamers are used in America with success, and it is to that country Mr. Seppings recommends the Government to look for information. The Americans have made river or inland steam navigation their particular study; whereas, in England, steam vessels have been almost entirely constructed with reference to deep water, or as sea-going craft.

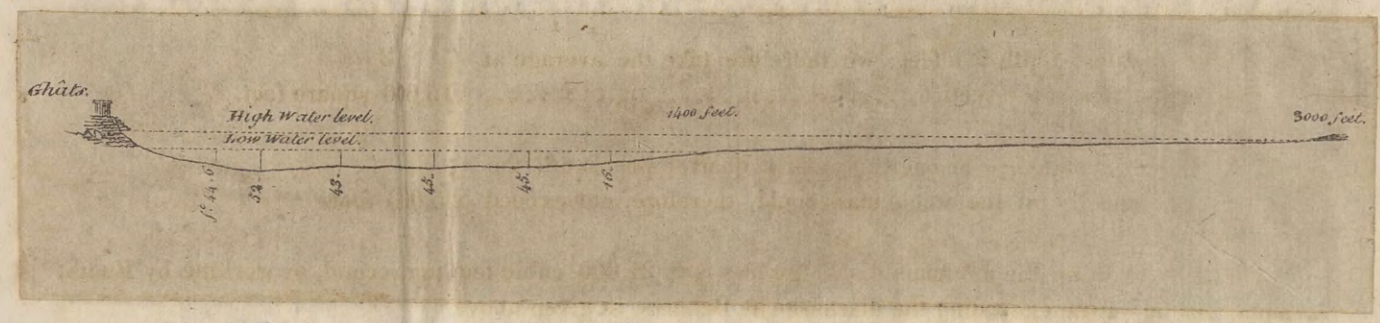
APPENDIX K.

Estimate of the volume of Water discharged by the Ganges and by the Mississippi, and of the relation between their expenditure and supply.

MAJOR RENNELL has stated, that "the quantity of water discharged by the Ganges in one second of time during the dry season, is 80,000 cubic feet; but the river when full, having thrice the volume of water in it that it had at the time when the experiment was made, and its motion being also accelerated in the proportion of five to three; the quantity discharged in a second at that season, is 400,000 cubic feet. If we take the medium the whole year through, it will be nearly 180,000 cubic feet in a second."*

We have no particulars of the experiment above alluded to; but a result, very widely differing in the extremes of both seasons, is obtained from the following calculations.

At Benares, soundings were taken across the river on the 25th April 1829, after a long interval, without rain, when it was at its minimum, or very near it, by which the following section was obtained:



The breadth of the surface water was then ascertained to be.....	1,400	feet.
The average depth	34¾	feet.
And the area of the section.....	48,650	square feet.

At the same time the velocity of the superficial middle current was found to be 2,910 feet per hour, and that of a crossed float-board, suspended with a weight and light bamboo on the surface, so as to be moved by a column of water 36 feet deep, 1,410 feet per hour. The influence of the upper current upon the suspending cord and bamboo attached to it, was so neutralized by the weight underneath, as to be very trifling. Assuming the latter velocity to be a proximate average of the whole mass, the minimum discharge would be about 19,000 cubic feet per second.

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* Memoir of a Map of Hindoostan, 3d Edition, p. 355.

In the freshes, the breadth of the river at Benares widens to..	3,000	feet.
And as it usually rises.....	43	feet.
Its average depth would then be about.....	58	feet.
And the section about.....	175,000	square feet.

Assuming, in that state, a mean velocity of five miles per hour, the force of the upper current being fully equal to six, the maximum delivery will be about 1,285,000 cubic feet per second—nearly sixty-eight times as much as the discharge in the opposite season.

Working the above data of measurements and surface velocity by Buat's Tables, which however do not very well apply to a river having a bed so unequal, we obtain results rather greater, namely, 21,065 cubic feet for the minimum, and 1,372,500 cubic feet for the maximum.

Below Benares, the Ganges receives an accession of volume from several important streams, especially the Gogra, the Gundúk, and the Koosee, whose aggregate waters, in the dry season, must exceed its own. The state of the river, as reported by Mr. Wall, at a spot two miles below Sicrigully, where it was traversed by a sand-bar, gives us an opportunity of computing the discharge of the united stream below, the junction of these rivers, and only thirty miles above the commencement of the Delta. Mr. Wall, on the 9th March, found the breadth to be short of a mile, say	5,000	feet.
And the greatest depth five feet; we therefore take the average at	3	,,
Making the area of the section, ...	15,000	square feet.
The current he stated to be one mile and a quarter per hour: the mean velocity of the whole mass could, therefore, not exceed	5,000	feet.

Thus we obtain for the minimum discharge less than 21,000 cubic feet per second, or working by Buat's formula, 21,900—little exceeding the discharge at Benares, as given above.

At the top of the freshes, we may roughly compute the breadth of the river over the same spot at about	10,000	feet.
Its mean depth at	28	,,
And its section at	280,000	square feet.

The maximum force of the current will then reach seven miles, and the mean of the whole mass will probably be little short of five. Hence we have an apparent discharge of about 1,800,000, or according to Buat, 1,880,000 cubic feet in a second at the maximum—nearly fifty per cent. more than the discharge at Benares, and more than one hundred times in excess of the minimum expenditure at the same place.

The mean discharge throughout the year probably averages about 250,000 cubic feet per second at Benares, where the river is subject to great variations in both height and velocity of current during the rains, and about 500,000 at Sicrigully: both estimates much in excess of Rennell's computation.

The Mississippi at Natchez, (eighty miles above the first fork of its Delta, and corresponding with Sicrigully in relative situation,) when at the lowest ebb, has a breadth of ..... 2,400 feet.

And the depth of the channel being seventy feet, a mean depth of about..... ..... 50 ,,

Which give a section of .... 120,000 square feet.

The mean velocity per hour, from the stagnation of the current in that season at New Orleans, and from Mr. Darby's estimate, that the whole body of the river does not move at an average rate exceeding one mile per hour, we will assume to be then at most 3,000 feet.

Thus we obtain a result of 100,000 cubic feet as the minimum expenditure in one second of time.

We have better means of computing the maximum, as Captain Hall states that the velocity of the current seldom exceeds four miles per hour in any part of the river;
During the height of the freshes, the breadth of the river is ..... 2700 feet.

And its greatest depth one hundred and twenty feet, which will give for the mean depth about .... 100 feet.

The area of the section is then, consequently, about 270,000 square feet; and allowing for the mean velocity in so deep a part of the river, (about two miles and an half in the hour,) the maximum discharge would appear to be about a million of cubic feet in a second.

If these rough estimates can be received as approximating to the truth, we may perhaps assume, with reference to the steadiness and duration of its freshes, that the expenditure of the Mississippi averages, throughout the year, about 550,000 cubic feet per second, which is a little more than the volume delivered by the Ganges, according to the preceding calculation. We will now compare the expenditure of both rivers, with the quantity of rain and snow supposed to fall within the range of their respective courses.

GANGES.

Fall of rain above the Delta.

			Feet.		*Inches.*		*Cubic Feet.*
Square Geographical Miles, ..	332,000	×	6116.^{2}	×	50	=	51,744,214,133,000
Ditto in the Delta, ...	28,000	×	6116.^{2}	×	84	=	7,322,719,376,000
							59,066,933,509,000
Total,....360,000		×	6116.^{2}	×	53	=	59,474,675,040,000

EXPENDITURE AT SICRIGULLY.

						Hours.		*Days.*		
Cubic Feet, ...	500,000	×	60″	×	60′	×	24	×	365	=	15,768,000,000,000

or about 26 per Cent. of the above.

MISSISSIPPI.

Fall of rain and snow above the Delta.

					Feet.		*Inches.*		
Square Geographical Miles,..	886,000	×	6116.[2]	×	18	=	49,711,851,024,000
Ditto in the Delta, ...	14,000	×	6116.[2]	×	60	=	2,618,381,920,000
							52,330,232,944,000
Total,....900,000	×	6116.[2]	×	19	=	53,302,774,800,000

EXPENDITURE AT NATCHEZ.

						Hours.		*Days.*		
Cubic Feet, ...	550,000	×	60″	×	60′	×	24	×	365	=	17,344,800,000,000

equal to about 32 per Cent. of the estimated supply.

APPENDIX L.

Abstract of Soundings, taken by Captain Johnston, upon the River Ganges, in 1828, between the efflux of the Bhaguruttee and Allahabad.

N. B. This Table has been prepared to shew the Shallows caused by the crossing of the stream at every reach: the large divisions correspond with Captain Prinsep's Chart.

Places and Distances.	Going up, 12th September to 1st October.			Returning, 3d to 16th October.		
	Deepest Soundings.	Least Soundings.	Mean of Observations	Deepest Soundings.	Least Soundings.	Mean of Observations
Choka to Paturghatta, 85 miles.	Fathoms.	Fathoms.	Fathoms.	Fathoms.	Fathoms.	Fathoms.
1st Reach to Furrukka Thana, ...	no* bottom.	† $0\frac{3}{4}$	3	no bottom.	$3\frac{1}{2}$	5
2d ,, Rajmahul, ...	ditto.	1	3	ditto.	3	5
3d ,, Akburpoor, ...	ditto.	$1\frac{1}{2}$	4	ditto.	$1\frac{1}{2}$	4
4th ,, Sikreegully, ...	ditto.	$1\frac{1}{2}$	3	ditto.	$2\frac{1}{2}$	4
5th ,, Entrance of Teryagully Pass,	ditto.	$1\frac{1}{2}$	3	ditto.	$3\frac{1}{2}$	4
6th ,, Peerpointy, ...	4	$2\frac{1}{2}$	3	4	$2\frac{1}{2}$	3
7th ,, West end of Nullah, ..	4	$1\frac{1}{2}$	3	5	$1\frac{1}{2}$	3
8th ,, Paturghatta.	6	2	3	no bottom.	$2\frac{1}{2}$	4
Paturghatta to Soorajgurra, 90 miles.						
1st Reach to Colgong, ...	no bottom.	$1\frac{1}{2}$	4	no bottom.	$1\frac{1}{2}$	4
2d ,, Bhagulpore, E. end of Creek,	ditto.	$2\frac{1}{2}$	5	ditto.	no bottom.	no bottom.
N. B. Went through, going up.						
3d ,, Inglis Thana, ditto, ..	5	1	$3\frac{1}{2}$	no bottom.	2	4
4th ,, Jungheera, ...	4	$1\frac{1}{2}$	3	ditto.	2	6
N. B. Went up middle passage, and returned by N. passage.						
5th ,, Monayar Chuk, ...	5	3	4	no bottom.	5	no bottom.
6th ,, Monghyr, ...	5	2	3	ditto.	$2\frac{1}{2}$	6
7th ,, Doodhaila, ...	5	1	$3\frac{1}{2}$	ditto.	1	$4\frac{1}{2}$
8th ,, Soorajgurra, ...	$4\frac{1}{2}$	2	$3\frac{1}{2}$	ditto.	1	6
Soorajgurra to Dinapore, 80 miles.						
1st Reach to Deryapoor, ...	no bottom.	1	4	no bottom.	1	4
2d ,, Bar, ...	ditto.	$1\frac{1}{2}$	$3\frac{1}{2}$	ditto.	$1\frac{1}{2}$	$3\frac{1}{2}$

* Soundings were not tried beyond seven fathoms, as it would, for that purpose, have been necessary to lessen the speed of the vessel.

† As the steamer avoided the deep channels in ascending the river, the minimum of the soundings then taken (the lead was constantly going both up and down,) more frequently represents her approach to the banks, than the depth of water in the shallows of the stream; although the soundings over the latter have been always put down in the table, when they could be distinguished. For the same reason, the soundings on the passage up are no guide to estimate the general depth of the river. Those which were taken on the return, give a minimum average of four and a half fathoms, when the freshes, except below Dinapore, were at about half their usual maximum height; but as in a great part of the channel no bottom was found at seven fathoms, and the excess beyond that depth is at present quite unknown, and judging from the state of the river at Benares, probably very considerable, we cannot assume the average depth to be less than five fathoms, or thirty feet at half fresh, on the whole course between the Delta and Allahabad: it may be considerably more.

Places and Distances.	Going up, 12th September to 1st October.			Returning, 3d to 15th October.		
	Deepest Soundings.	Least Soundings.	Mean of Observations	Deepest Soundings.	Least Soundings.	Mean of Observations
	Fathoms.	Fathoms.	Fathoms.	Fathoms.	Fathoms.	Fathoms.
3d Reach to Phoolbareea, ...	no bottom.	2	3	no bottom.	2	3½
4th ,, Patna, ...	ditto.	1	4	ditto.	2½	4
5th ,, Dinapore, ...	5	1	3½	ditto.	1½	5
N. B. Went up S. Channel, and returned by N. Channel.						
Dinapore to Buxar, 95 *miles.*						
1st Reach to Cheeran, ...	no bottom.	3½	4	no bottom.	3½	5
2d ,, Milkee, ...	ditto.	1	3	ditto.	4	5
3d ,, *Revelgunge*, ...	ditto.	1	3	ditto.	3½	4
4th ,, Seelimpoor, ...	ditto.	3	4	6	1½	5
N. B. Went up by right bank, and returned by left bank and crossed.						
5th ,, Sugdeespoor, ...	no bottom.	2½	3	no bottom.	1½	5
6th ,, Mudoopoor, ...	ditto.	1½	3	ditto.	3½	4
7th ,, Purboodpoor, ...	ditto.	3½	4	ditto.	2	5
8th ,, Gayghat, ...	ditto.	2	4	7	3½	5
9th ,, Bhulea, ...	ditto.	3½	4	no bottom.	3½	5
10th ,, Buxar, ...	ditto.	2	4	6	2½	3½
Buxar to Chunar, 115 *miles.*						
1st Reach to Beerpoor, ...	no bottom.	2½	4	no bottom.	4½	5
2d ,, Ghospoor, ...	4	1½	3	ditto.	2	4
N. B. Went up through a Nullah on N. bank.						
3d ,, Jailpoor, above Ghazeepoor,	6	2	3½	6	2	4
4th ,, Zilmaneea, ...	5	2	3½	5	2	4
5th ,, Chochookpoor, ...	5	2½	4	6	4	5
6th ,, Thanapoor, ...	5	2½	3	5	2½	3
7th ,, Saidpoor, ...	no bottom.	2½	3	no bottom.	3½	4
8th ,, Chundroukee, ...	ditto.	2	3	ditto.	3½	5
9th ,, Bullooa Ghāt, ...	ditto.	1	3½	ditto.	1½	5
10th ,, Kytee, ...	ditto.	2	3½	ditto.	3½	5
11th ,, Benares, ...	4	2	3½	4	3½	4
12th ,, Half way to Ramnagur, ..	no bottom.	2	3½	7	4½	5
13th ,, Sultanpoor, ...	5	2½	3½	6	3½	5
14th ,, Chunar.	5	2	3	5	2	3
Chunar to Allahabad, 110 *miles.*						
1st Reach to Chunka	5	2	3½	6	2	4
2d ,, Kutchwa, ...	6	3	3	6	3	4
3d ,, Bhogaon, ...	5	2	4	no bottom.	2	4
4th ,, Mirzapoor, ...	no bottom.	2	4	ditto.	2½	3½
5th ,, Seebpoor, ...	ditto.	2½	4	ditto.	4	4
6th ,, Buboora, ...	ditto.	2	4	ditto.	3	4
7th ,, Bahadurpoor, ...	5	2½	4	6	3	4½
8th ,, Goura, ...	no bottom.	1¾	3½	no bottom.	5	5
9th ,, Poolwareea, ...	ditto.	2	3	ditto.	2½	3½
10th ,, Deega, ...	5	2½	3	ditto.	4	4
11th ,, Bhouroobpoora, ..	no bottom.	2½	3	ditto.	2½	4
12th ,, Aleepoora, ...	5	3½	4	ditto.	4	4½
13th ,, Taila, ...	no bottom.	3½	4	ditto.	3½	5
14th ,, Barra, ...	ditto.	2½	5	ditto.	2½	5
15th ,, Sursa, ...	5	3½	4	ditto.	4½	4½
16th ,, Dumdumma, ...	4	3	4	5	2	4
17th ,, Monaya, ...	no bottom.	2	3	no bottom.	1½	5
18th ,, Allahabad.	5	1½	4	7	1	4

FINIS.

Names and Distances.	Corner buoy, Eastern Pier, to 3rd October.			Alterations, 3d to 15th October.		
	Soundings. Depths.	Soundings. Times.	Means of Observations.	Soundings. Depths.	Soundings. Times.	Means of Observations.
	Fathoms.	Fathoms.	Fathoms.	Fathoms.	Fathoms.	Fathoms.
1st Range to Broadstairs	3	3	3	do position.		
2d " Ramsgate	4	4	4	Ditto.	3½	4
3d " Margate	3	3	3	do position.	3	3½
4th " Margate Jetty	3	3	3	Ditto.	3½	3½
5th " Reculvers	3	3	3	Ditto.	3½	3½
6th " Herne Bay	3	3	3	do position.	3½	3½
7th " Whitstable	3	3	3	Ditto.	3½	3½
8th " Faversham	3	3	3	Ditto.	3½	3½
9th " Oyster Point	3	3	3	Ditto.	3½	3½
10th " Sheerness	3	3	3	Ditto.	3½	3½
11th " Garrison Point	3	3	3	Ditto.	3½	3½
12th " Chatham	3	3	3	Ditto.	3½	3½
13th " Upnor	3	3	3	Ditto.	3½	3½
14th " Higham	3	3	3	Ditto.	3½	3½
15th " Gravesend	3	3	3	Ditto.	3½	3½
16th " Northfleet	3	3	3	Ditto.	3½	3½
17th " Greenhithe	3	3	3	Ditto.	3½	3½
18th " Dartford	3	3	3	Ditto.	3½	3½
19th " Crayford	3	3	3	Ditto.	3½	3½
20th " Erith	3	3	3	Ditto.	3½	3½
21st " Woolwich	3	3	3	Ditto.	3½	3½
22d " Deptford	3	3	3	Ditto.	3½	3½
23d " Greenwich	3	3	3	Ditto.	3½	3½
24th " Limehouse	3	3	3	Ditto.	3½	3½
25th " Blackwall	3	3	3	Ditto.	3½	3½
26th " Poplar	3	3	3	Ditto.	3½	3½
27th " Limehouse	3	3	3	Ditto.	3½	3½
28th " Ratcliff	3	3	3	Ditto.	3½	3½
29th " Shadwell	3	3	3	Ditto.	3½	3½
30th " Wapping	3	3	3	Ditto.	3½	3½
31st " Execution Dock	3	3	3	Ditto.	3½	3½
32d " Limehouse	3	3	3	Ditto.	3½	3½
33d " Greenwich	3	3	3	Ditto.	3½	3½
34th " Deptford	3	3	3	Ditto.	3½	3½
35th " Woolwich	3	3	3	Ditto.	3½	3½
36th " Erith	3	3	3	Ditto.	3½	3½
37th " Crayford	3	3	3	Ditto.	3½	3½
38th " Dartford	3	3	3	Ditto.	3½	3½
39th " Greenhithe	3	3	3	Ditto.	3½	3½
40th " Northfleet	3	3	3	Ditto.	3½	3½
41st " Gravesend	3	3	3	Ditto.	3½	3½
42d " Higham	3	3	3	Ditto.	3½	3½
43d " Upnor	3	3	3	Ditto.	3½	3½
44th " Chatham	3	3	3	Ditto.	3½	3½
45th " Garrison Point	3	3	3	Ditto.	3½	3½
46th " Sheerness	3	3	3	Ditto.	3½	3½
47th " Faversham	3	3	3	Ditto.	3½	3½
48th " Whitstable	3	3	3	Ditto.	3½	3½
49th " Herne Bay	3	3	3	Ditto.	3½	3½
50th " Reculvers	3	3	3	Ditto.	3½	3½
51st " Margate Jetty	3	3	3	Ditto.	3½	3½
52d " Margate	3	3	3	Ditto.	3½	3½
53d " Ramsgate	3	3	3	Ditto.	3½	3½
54th " Broadstairs	3	3	3	Ditto.	3½	3½
55th " Dandelion	3	3	3	Ditto.	3½	3½
56th " Pan Sand	3	3	3	Ditto.	3½	3½
57th " Tongue Sand	3	3	3	Ditto.	3½	3½
58th " Margate Sand	3	3	3	Ditto.	3½	3½
59th " Girdler	3	3	3	Ditto.	3½	3½
60th " Goodwin Sands	3	3	3	Ditto.	3½	3½
61st " Brake	3	3	3	Ditto.	3½	3½
62d " Deal	3	3	3	Ditto.	3½	3½
63d " Kingsdown	3	3	3	Ditto.	3½	3½
64th " Walmer	3	3	3	Ditto.	3½	3½
65th " Deal	3	3	3	Ditto.	3½	3½
66th " Sandown	3	3	3	Ditto.	3½	3½
67th " Sandown Castle	3	3	3	Ditto.	3½	3½
68th " Deal	3	3	3	Ditto.	3½	3½
69th " Walmer	3	3	3	Ditto.	3½	3½
70th " Kingsdown	3	3	3	Ditto.	3½	3½
71st " Deal	3	3	3	Ditto.	3½	3½
72d " Brake	3	3	3	Ditto.	3½	3½
73d " Goodwin Sands	3	3	3	Ditto.	3½	3½
74th " Girdler	3	3	3	Ditto.	3½	3½
75th " Margate Sand	3	3	3	Ditto.	3½	3½
76th " Tongue Sand	3	3	3	Ditto.	3½	3½
77th " Pan Sand	3	3	3	Ditto.	3½	3½
78th " Dandelion	3	3	3	Ditto.	3½	3½
79th " Margate	3	3	3	Ditto.	3½	3½
80th " Ramsgate	3	3	3	Ditto.	3½	3½
81st " Broadstairs	3	3	3	Ditto.	3½	3½
82d " Margate	3	3	3	Ditto.	3½	3½
83d " Margate Jetty	3	3	3	Ditto.	3½	3½
84th " Reculvers	3	3	3	Ditto.	3½	3½
85th " Herne Bay	3	3	3	Ditto.	3½	3½
86th " Whitstable	3	3	3	Ditto.	3½	3½
87th " Faversham	3	3	3	Ditto.	3½	3½
88th " Oyster Point	3	3	3	Ditto.	3½	3½
89th " Sheerness	3	3	3	Ditto.	3½	3½
90th " Garrison Point	3	3	3	Ditto.	3½	3½
91st " Chatham	3	3	3	Ditto.	3½	3½
92d " Upnor	3	3	3	Ditto.	3½	3½
93d " Higham	3	3	3	Ditto.	3½	3½
94th " Gravesend	3	3	3	Ditto.	3½	3½
95th " Northfleet	3	3	3	Ditto.	3½	3½
96th " Greenhithe	3	3	3	Ditto.	3½	3½
97th " Dartford	3	3	3	Ditto.	3½	3½
98th " Crayford	3	3	3	Ditto.	3½	3½
99th " Erith	3	3	3	Ditto.	3½	3½
100th " Woolwich	3	3	3	Ditto.	3½	3½
101st " Deptford	3	3	3	Ditto.	3½	3½
102d " Greenwich	3	3	3	Ditto.	3½	3½
103d " Limehouse	3	3	3	Ditto.	3½	3½
104th " Blackwall	3	3	3	Ditto.	3½	3½
105th " Poplar	3	3	3	Ditto.	3½	3½
106th " Limehouse	3	3	3	Ditto.	3½	3½
107th " Ratcliff	3	3	3	Ditto.	3½	3½
108th " Shadwell	3	3	3	Ditto.	3½	3½
109th " Wapping	3	3	3	Ditto.	3½	3½
110th " Execution Dock	3	3	3	Ditto.	3½	3½
111th " Limehouse	3	3	3	Ditto.	3½	3½
112th " Greenwich	3	3	3	Ditto.	3½	3½
113th " Deptford	3	3	3	Ditto.	3½	3½
114th " Woolwich	3	3	3	Ditto.	3½	3½
115th " Erith	3	3	3	Ditto.	3½	3½
116th " Crayford	3	3	3	Ditto.	3½	3½
117th " Dartford	3	3	3	Ditto.	3½	3½
118th " Greenhithe	3	3	3	Ditto.	3½	3½
119th " Northfleet	3	3	3	Ditto.	3½	3½
120th " Gravesend	3	3	3	Ditto.	3½	3½
121st " Higham	3	3	3	Ditto.	3½	3½
122d " Upnor	3	3	3	Ditto.	3½	3½
123d " Chatham	3	3	3	Ditto.	3½	3½
124th " Garrison Point	3	3	3	Ditto.	3½	3½
125th " Sheerness	3	3	3	Ditto.	3½	3½
126th " Faversham	3	3	3	Ditto.	3½	3½
127th " Whitstable	3	3	3	Ditto.	3½	3½
128th " Herne Bay	3	3	3	Ditto.	3½	3½
129th " Reculvers	3	3	3	Ditto.	3½	3½
130th " Margate Jetty	3	3	3	Ditto.	3½	3½
131st " Margate	3	3	3	Ditto.	3½	3½
132d " Ramsgate	3	3	3	Ditto.	3½	3½
133d " Broadstairs	3	3	3	Ditto.	3½	3½
134th " Dandelion	3	3	3	Ditto.	3½	3½
135th " Pan Sand	3	3	3	Ditto.	3½	3½
136th " Tongue Sand	3	3	3	Ditto.	3½	3½
137th " Margate Sand	3	3	3	Ditto.	3½	3½
138th " Girdler	3	3	3	Ditto.	3½	3½
139th " Goodwin Sands	3	3	3	Ditto.	3½	3½
140th " Brake	3	3	3	Ditto.	3½	3½
141st " Deal	3	3	3	Ditto.	3½	3½
142d " Kingsdown	3	3	3	Ditto.	3½	3½
143d " Walmer	3	3	3	Ditto.	3½	3½
144th " Deal	3	3	3	Ditto.	3½	3½
145th " Sandown	3	3	3	Ditto.	3½	3½
146th " Sandown Castle	3	3	3	Ditto.	3½	3½
147th " Deal	3	3	3	Ditto.	3½	3½
148th " Walmer	3	3	3	Ditto.	3½	3½
149th " Kingsdown	3	3	3	Ditto.	3½	3½
150th " Deal	3	3	3	Ditto.	3½	3½
151st " Brake	3	3	3	Ditto.	3½	3½
152d " Goodwin Sands	3	3	3	Ditto.	3½	3½
153d " Girdler	3	3	3	Ditto.	3½	3½
154th " Margate Sand	3	3	3	Ditto.	3½	3½
155th " Tongue Sand	3	3	3	Ditto.	3½	3½
156th " Pan Sand	3	3	3	Ditto.	3½	3½
157th " Dandelion	3	3	3	Ditto.	3½	3½
158th " Margate	3	3	3	Ditto.	3½	3½
159th " Ramsgate	3	3	3	Ditto.	3½	3½
160th " Broadstairs	3	3	3	Ditto.	3½	3½
161st " Margate	3	3	3	Ditto.	3½	3½
162d " Margate Jetty	3	3	3	Ditto.	3½	3½
163d " Reculvers	3	3	3	Ditto.	3½	3½
164th " Herne Bay	3	3	3	Ditto.	3½	3½
165th " Whitstable	3	3	3	Ditto.	3½	3½
166th " Faversham	3	3	3	Ditto.	3½	3½
167th " Oyster Point	3	3	3	Ditto.	3½	3½
168th " Sheerness	3	3	3	Ditto.	3½	3½
169th " Garrison Point	3	3	3	Ditto.	3½	3½
170th " Chatham	3	3	3	Ditto.	3½	3½
171st " Upnor	3	3	3	Ditto.	3½	3½
172d " Higham	3	3	3	Ditto.	3½	3½
173d " Gravesend	3	3	3	Ditto.	3½	3½
174th " Northfleet	3	3	3	Ditto.	3½	3½
175th " Greenhithe	3	3	3	Ditto.	3½	3½
176th " Dartford	3	3	3	Ditto.	3½	3½
177th " Crayford	3	3	3	Ditto.	3½	3½
178th " Erith	3	3	3	Ditto.	3½	3½
179th " Woolwich	3	3	3	Ditto.	3½	3½
180th " Deptford	3	3	3	Ditto.	3½	3½
181st " Greenwich	3	3	3	Ditto.	3½	3½
182d " Limehouse	3	3	3	Ditto.	3½	3½
183d " Blackwall	3	3	3	Ditto.	3½	3½
184th " Poplar	3	3	3	Ditto.	3½	3½
185th " Limehouse	3	3	3	Ditto.	3½	3½
186th " Ratcliff	3	3	3	Ditto.	3½	3½
187th " Shadwell	3	3	3	Ditto.	3½	3½
188th " Wapping	3	3	3	Ditto.	3½	3½
189th " Execution Dock	3	3	3	Ditto.	3½	3½
190th " Limehouse	3	3	3	Ditto.	3½	3½
191st " Greenwich	3	3	3	Ditto.	3½	3½
192d " Deptford	3	3	3	Ditto.	3½	3½
193d " Woolwich	3	3	3	Ditto.	3½	3½
194th " Erith	3	3	3	Ditto.	3½	3½
195th " Crayford	3	3	3	Ditto.	3½	3½
196th " Dartford	3	3	3	Ditto.	3½	3½
197th " Greenhithe	3	3	3	Ditto.	3½	3½
198th " Northfleet	3	3	3	Ditto.	3½	3½
199th " Gravesend	3	3	3	Ditto.	3½	3½
200th " Higham	3	3	3	Ditto.	3½	3½
201st " Upnor	3	3	3	Ditto.	3½	3½
202d " Chatham	3	3	3	Ditto.	3½	3½
203d " Garrison Point	3	3	3	Ditto.	3½	3½
204th " Sheerness	3	3	3	Ditto.	3½	3½
205th " Oyster Point	3	3	3	Ditto.	3½	3½
206th " Faversham	3	3	3	Ditto.	3½	3½
207th " Whitstable	3	3	3	Ditto.	3½	3½
208th " Herne Bay	3	3	3	Ditto.	3½	3½
209th " Reculvers	3	3	3	Ditto.	3½	3½
210th " Margate Jetty	3	3	3	Ditto.	3½	3½
211th " Margate	3	3	3	Ditto.	3½	3½
212th " Ramsgate	3	3	3	Ditto.	3½	3½
213th " Broadstairs	3	3	3	Ditto.	3½	3½
214th " Dandelion	3	3	3	Ditto.	3½	3½
215th " Pan Sand	3	3	3	Ditto.	3½	3½
216th " Tongue Sand	3	3	3	Ditto.	3½	3½
217th " Margate Sand	3	3	3	Ditto.	3½	3½
218th " Girdler	3	3	3	Ditto.	3½	3½
219th " Goodwin Sands	3	3	3	Ditto.	3½	3½
220th " Brake	3	3	3	Ditto.	3½	3½
221st " Deal	3	3	3	Ditto.	3½	3½
222d " Kingsdown	3	3	3	Ditto.	3½	3½
223d " Walmer	3	3	3	Ditto.	3½	3½
224th " Deal	3	3	3	Ditto.	3½	3½
225th " Sandown	3	3	3	Ditto.	3½	3½
226th " Sandown Castle	3	3	3	Ditto.	3½	3½
227th " Deal	3	3	3	Ditto.	3½	3½
228th " Walmer	3	3	3	Ditto.	3½	3½
229th " Kingsdown	3	3	3	Ditto.	3½	3½
230th " Deal	3	3	3	Ditto.	3½	3½
231st " Brake	3	3	3	Ditto.	3½	3½
232d " Goodwin Sands	3	3	3	Ditto.	3½	3½
233d " Girdler	3	3	3	Ditto.	3½	3½
234th " Margate Sand	3	3	3	Ditto.	3½	3½
235th " Tongue Sand	3	3	3	Ditto.	3½	3½
236th " Pan Sand	3	3	3	Ditto.	3½	3½
237th " Dandelion	3	3	3	Ditto.	3½	3½
238th " Margate	3	3	3	Ditto.	3½	3½
239th " Ramsgate	3	3	3	Ditto.	3½	3½
240th " Broadstairs	3	3	3	Ditto.	3½	3½
241st " Margate	3	3	3	Ditto.	3½	3½
242d " Margate Jetty	3	3	3	Ditto.	3½	3½
243d " Reculvers	3	3	3	Ditto.	3½	3½
244th " Herne Bay	3	3	3	Ditto.	3½	3½
245th " Whitstable	3	3	3	Ditto.	3½	3½
246th " Faversham	3	3	3	Ditto.	3½	3½
247th " Oyster Point	3	3	3	Ditto.	3½	3½
248th " Sheerness	3	3	3	Ditto.	3½	3½
249th " Garrison Point	3	3	3	Ditto.	3½	3½
250th " Chatham	3	3	3	Ditto.	3½	3½
251st " Upnor	3	3	3	Ditto.	3½	3½
252d " Higham	3	3	3	Ditto.	3½	3½
253d " Gravesend	3	3	3	Ditto.	3½	3½
254th " Northfleet	3	3	3	Ditto.	3½	3½
255th " Greenhithe	3	3	3	Ditto.	3½	3½
256th " Dartford	3	3	3	Ditto.	3½	3½
257th " Crayford	3	3	3	Ditto.	3½	3½
258th " Erith	3	3	3	Ditto.	3½	3½
259th " Woolwich	3	3	3	Ditto.	3½	3½
260th " Deptford	3	3	3	Ditto.	3½	3½
261st " Greenwich	3	3	3	Ditto.	3½	3½
262d " Limehouse	3	3	3	Ditto.	3½	3½
263d " Blackwall	3	3	3	Ditto.	3½	3½
264th " Poplar	3	3	3	Ditto.	3½	3½
265th " Limehouse	3	3	3	Ditto.	3½	3½
266th " Ratcliff	3	3	3	Ditto.	3½	3½
267th " Shadwell	3	3	3	Ditto.	3½	3½
268th " Wapping	3	3	3	Ditto.	3½	3½
269th " Execution Dock	3	3	3	Ditto.	3½	3½
270th " Limehouse	3	3	3	Ditto.	3½	3½
271st " Greenwich	3	3	3	Ditto.	3½	3½
272d " Deptford	3	3	3	Ditto.	3½	3½
273d " Woolwich	3	3	3	Ditto.	3½	3½
274th " Erith	3	3	3	Ditto.	3½	3½
275th " Crayford	3	3	3	Ditto.	3½	3½
276th " Dartford	3	3	3	Ditto.	3½	3½
277th " Greenhithe	3	3	3	Ditto.	3½	3½
278th " Northfleet	3	3	3	Ditto.	3½	3½
279th " Gravesend	3	3	3	Ditto.	3½	3½
280th " Higham	3	3	3	Ditto.	3½	3½
281st " Upnor	3	3	3	Ditto.	3½	3½
282d " Chatham	3	3	3	Ditto.	3½	3½
283d " Garrison Point	3	3	3	Ditto.	3½	3½
284th " Sheerness	3	3	3	Ditto.	3½	3½
285th " Oyster Point	3	3	3	Ditto.	3½	3½
286th " Faversham	3	3	3	Ditto.	3½	3½
287th " Whitstable	3	3	3	Ditto.	3½	3½
288th " Herne Bay	3	3	3	Ditto.	3½	3½
289th " Reculvers	3	3	3	Ditto.	3½	3½
290th " Margate Jetty	3	3	3	Ditto.	3½	3½
291st " Margate	3	3	3	Ditto.	3½	3½
292d " Ramsgate	3	3	3	Ditto.	3½	3½
293d " Broadstairs	3	3	3	Ditto.	3½	3½
294th " Dandelion	3	3	3	Ditto.	3½	3½
295th " Pan Sand	3	3	3	Ditto.	3½	3½
296th " Tongue Sand	3	3	3	Ditto.	3½	3½
297th " Margate Sand	3	3	3	Ditto.	3½	3½
298th " Girdler	3	3	3	Ditto.	3½	3½
299th " Goodwin Sands	3	3	3	Ditto.	3½	3½
300th " Brake	3	3	3	Ditto.	3½	3½
301st " Deal	3	3	3	Ditto.	3½	3½
302d " Kingsdown	3	3	3	Ditto.	3½	3½
303d " Walmer	3	3	3	Ditto.	3½	3½
304th " Deal	3	3	3	Ditto.	3½	3½
305th " Sandown	3	3	3	Ditto.	3½	3½
306th " Sandown Castle	3	3	3	Ditto.	3½	3½
307th " Deal	3	3	3	Ditto.	3½	3½
308th " Walmer	3	3	3	Ditto.	3½	3½
309th " Kingsdown	3	3	3	Ditto.	3½	3½
310th " Deal	3	3	3	Ditto.	3½	3½
311th " Brake	3	3	3	Ditto.	3½	3½
312th " Goodwin Sands	3	3	3	Ditto.	3½	3½
313th " Girdler	3	3	3	Ditto.	3½	3½
314th " Margate Sand	3	3	3	Ditto.	3½	3½
315th " Tongue Sand	3	3	3	Ditto.	3½	3½
316th " Pan Sand	3	3	3	Ditto.	3½	3½
317th " Dandelion	3	3	3	Ditto.	3½	3½
318th " Margate	3	3	3	Ditto.	3½	3½
319th " Ramsgate	3	3	3	Ditto.	3½	3½
320th " Broadstairs	3	3	3	Ditto.	3½	3½
321st " Margate	3	3	3	Ditto.	3½	3½
322d " Margate Jetty	3	3	3	Ditto.	3½	3½
323d " Reculvers	3	3	3	Ditto.	3½	3½
324th " Herne Bay	3	3	3	Ditto.	3½	3½
325th " Whitstable	3	3	3	Ditto.	3½	3½
326th " Faversham	3	3	3	Ditto.	3½	3½
327th " Oyster Point	3	3	3	Ditto.	3½	3½
328th " Sheerness	3	3	3	Ditto.	3½	3½
329th " Garrison Point	3	3	3	Ditto.	3½	3½
330th " Chatham	3	3	3	Ditto.	3½	3½
331st " Upnor	3	3	3	Ditto.	3½	3½
332d " Higham	3	3	3	Ditto.	3½	3½
333d " Gravesend	3	3	3	Ditto.	3½	3½
334th " Northfleet	3	3	3	Ditto.	3½	3½
335th " Greenhithe	3	3	3	Ditto.	3½	3½
336th " Dartford	3	3	3	Ditto.	3½	3½
337th " Crayford	3	3	3	Ditto.	3½	3½
338th " Erith	3	3	3	Ditto.	3½	3½
339th " Woolwich	3	3	3	Ditto.	3½	3½
340th " Deptford	3	3	3	Ditto.	3½	3½
341st " Greenwich	3	3	3	Ditto.	3½	3½
342d " Limehouse	3	3	3	Ditto.	3½	3½
343d " Blackwall	3	3	3	Ditto.	3½	3½
344th " Poplar	3	3	3	Ditto.	3½	3½
345th " Limehouse	3	3	3	Ditto.	3½	3½
346th " Ratcliff	3	3	3	Ditto.	3½	3½
347th " Shadwell	3	3	3	Ditto.	3½	3½
348th " Wapping	3	3	3	Ditto.	3½	3½
349th " Execution Dock	3	3	3	Ditto.	3½	3½
350th " Limehouse	3	3	3	Ditto.	3½	3½
351st " Greenwich	3	3	3	Ditto.	3½	3½
352d " Deptford	3	3	3	Ditto.	3½	3½
353d " Woolwich	3	3	3	Ditto.	3½	3½
354th " Erith	3	3	3	Ditto.	3½	3½
355th " Crayford	3	3	3	Ditto.	3½	3½
356th " Dartford	3	3	3	Ditto.	3½	3½
357th " Greenhithe	3	3	3	Ditto.	3½	3½
358th " Northfleet	3	3	3	Ditto.	3½	3½
359th " Gravesend	3	3	3	Ditto.	3½	3½
360th " Higham	3	3	3	Ditto.	3½	3½
361st " Upnor	3	3	3	Ditto.	3½	3½
362d " Chatham	3	3	3	Ditto.	3½	3½
363d " Garrison Point	3	3	3	Ditto.	3½	3½
364th " Sheerness	3	3	3	Ditto.	3½	3½
365th " Oyster Point	3	3	3	Ditto.	3½	3½
366th " Faversham	3	3	3	Ditto.	3½	3½
367th " Whitstable	3	3	3	Ditto.	3½	3½
368th " Herne Bay	3	3	3	Ditto.	3½	3½
369th " Reculvers	3	3	3	Ditto.	3½	3½
370th " Margate Jetty	3	3	3	Ditto.	3½	3½
371st " Margate	3	3	3	Ditto.	3½	3½
372d " Ramsgate	3	3	3	Ditto.	3½	3½
373d " Broadstairs	3	3	3	Ditto.	3½	3½
374th " Dandelion	3	3	3	Ditto.	3½	3½
375th " Pan Sand	3	3	3	Ditto.	3½	3½
376th " Tongue Sand	3	3	3	Ditto.	3½	3½
377th " Margate Sand	3	3	3	Ditto.	3½	3½
378th " Girdler	3	3	3	Ditto.	3½	3½
379th " Goodwin Sands	3	3	3	Ditto.	3½	3½
380th " Brake	3	3	3	Ditto.	3½	3½
381st " Deal	3	3	3	Ditto.	3½	3½
382d " Kingsdown	3	3	3	Ditto.	3½	3½
383d " Walmer	3	3	3	Ditto.	3½	3½
384th " Deal	3	3	3	Ditto.	3½	3½
385th " Sandown	3	3	3	Ditto.	3½	3½
386th " Sandown Castle	3	3	3	Ditto.	3½	3½
387th " Deal	3	3	3	Ditto.	3½	3½
388th " Walmer	3	3	3	Ditto.	3½	3½
389th " Kingsdown	3	3	3	Ditto.	3½	3½
390th " Deal	3	3	3	Ditto.	3½	3½
391st " Brake	3	3	3	Ditto.	3½	3½
392d " Goodwin Sands	3	3	3	Ditto.	3½	3½
393d " Girdler	3	3	3	Ditto.	3½	3½
394th " Margate Sand	3	3	3	Ditto.	3½	3½
395th " Tongue Sand	3	3	3	Ditto.	3½	3½
396th " Pan Sand	3	3	3	Ditto.	3½	3½
397th " Dandelion

(POSTSCRIPT.)

APPENDIX M.

Abstract from the Log of the H. C. Steamer Hoogly, shewing her daily progress and hours of steaming from Calcutta to Benares, during the Months of October and November 1830, *by the Jellinghee route.*

DATE.	*Started from.*	*Arrived at*	*Distance.*	*Hours Steaming.*		REMARKS.
				°	′	
Oct. 14	Calcutta, ...	Barrackpore,.....	15 Miles,	3	25	Boats in tow—Sonamooky, Music Boat and a Bauleah.
16	Barrackpore,.....	Chogdah, ...	31	5	10	„ Sonamooky and Bauleah.
17	Chogdah, ...	Kishnuggur, ...	45	12	05	The passage through the Jellinghee was performed in thirty-five hours and five minutes. We found the current strong on entering this river from the Hoogly, but decreasing in strength as we approached the upper end, which will appear on reference to the daily distances: the least water found was six feet.
18	Kishnuggur, ...	Hurrah, ...	20	9	30	
19	Hurrah, ...	Gopeenathpore, ..	51	12	00	
20	Gopeenathpore, ..	Jellinghee,.....	58	11	40	
21	Jellinghee,.....	Rampore Bauleah,.	20½	7	30	Detained several hours of this day to receive Coals at Surdah.
22	Rampore Bauleah,.	4 Miles below Godagaree,	22½	7	00	Experienced a strong current today in many places from the confined state of the deep water channels.
23	4 Miles below Godaguree,	Mohungunge, ...	40	12	00	Sonamooky and Music Boat in tow.
24	Mohungunge, ...	Rajmahl, ...	22½	10	20	This day a strong and irregular current—received coals.
25	Rajmahl, ...	Kuchwarucourt, ..	28½	12	0	
26	Kuchwarucourt, ...	Bharaghaut, ...	41	12	30	Received coals here; also at Moonghyr, Dinapore and Ghazeepore.
27	Bharaghaut, ...	Russelpore, ...	32	12	20	
28	Russelpore, ...	Monghyr, ...	16½	5	20	
29	Monghyr, ...	Simeeria, ...	28	10	0	GENERAL REMARKS.
30	Simeeria, ...	Raniserai, ...	36	11	15	The result shews the average progress of the vessels to have been three and a half miles per hour, or thirty miles per day. This passage has been particularly favorable up the Ganges, from the Channels being generally better, more especially those off Chuprah which caused so much delay on former occasions, and which are now equal to the best, containing plenty of water for vessels of greater draft than the Hoogly or Burhampootur: but the despatch was in a great degree owing to better pilotage arrangements, the pilots having been made to survey their respective distances, until properly acquainted with the ground and channels.
31	Raniserai, ...	Patna, ...	25	8	00	
Nov. 1	Patna, ...	Daccapore, ...	10½	3	10	
3	Daccapore, ...	Revelgunge, ...	25	7	00	
4	Revelgunge, ...	Bullea, ...	42	10	30	
5	Bullea, ...	Buxar, ...	14	5	00	
6	Buxar, ...	Ghazeepore, ...	31	8	30	
10	Ghazeepore, ...	Chandroutee, ...	45	10	10	
11	Chandroutee, ...	Benares,.....	20	5	45	
						(Signed) S. RANSON, *Chief Officer Hoogly Steamer.*
Days 24, including short stages.			720 Miles.	202	10	

Date.	Starting from.	Arrived at.	Distance.	Average time.	REMARKS.
				h. m.	
Oct. 14	Cachima	Bamankabore	18 Miles	3 32	Route lay from Sounkoorky, passing four and a Bantaba.
15	Bamankabore	Cherekeh	21	6 30	
16	Kamankabore	Kabankeh	32	13 00	Two burnt through the Jallingare route. We found the country very hilly and stony, and from the Bantaba, on entering this town, we had to ascend a steep hill.
17	Cherekeh	Kamankabore	32	13 00	
18	Kabankeh	Hunter	25	9 30	
19	Cherekeh	Cobenamphore	21	13 00	
20	Bamankabore	Jallingare	23	11 30	
21	Cobenamphore	Bantaba	18	7 00	Passed through Sounkoorky and Bantaba.
22	Jallingare	Bantaba	18	7 00	
23	Hunter Bantaba	{ Cadiakoro / 4 Miles below }	25½	9 00	Entered a strong country, in many places thickly wooded, and full of game. Crossed a small river, and then ascended a steep hill, from the top of which we had a fine view of the country. Descended to the Cadiakoro, which we found to be a fine river, about 200 yards wide, and very deep. Crossed in canoes.
24	Bantaba	{ Cadiakoro / 4 Miles below }	25½	9 00	Ferried over.
25	Bantaba Bantaba	Bantaba Bantaba	30½	9 30	Passed through Bantaba.
26	Bantaba	Bantaba	30	10 0	
27	Bantaba	Bantaba	30	10 0	GENERAL REMARKS.
28	Bantaba	Bantaba	30	10 0	
29	Bantaba	Bantaba	30	10 0	
30	Bantaba	Bantaba	30	10 0	
31	Bantaba	Bantaba	30	10 0	
Nov. 1	Bantaba	Bantaba	30	10 0	
2	Bantaba	Bantaba	30	10 0	
3	Bantaba	Bantaba	30	10 0	
4	Bantaba	Bantaba	30	10 0	
5	Bantaba	Bantaba	30	10 0	
6	Bantaba	Bantaba	30	10 0	
7	Bantaba	Bantaba	30	10 0	
8	Bantaba	Bantaba	30	10 0	
9	Bantaba	Bantaba	30	10 0	
10	Bantaba	Bantaba	30	10 0	
11	Bantaba	Bantaba	30	10 0	

(Signed) R. MANSON.

Capt. Gen. Staff, Commdg. Expedition.

APPENDIX M.

(POSTSCRIPT.)

Abstract from the Log of the H. C. steamer "Hooghly," employed for daily Progress and Points of attaining from Cachima to Bantaba, during the Months of October and November 1880, on the Jallingare route.

APPENDIX C 3.

Account of the Performances of the Honorable Company's Steam Vessel Irrawaddy, during the Year 1828.

Port of Departure.	Date.	Port at which Arrived.	Date.	Number of hours on Steam.	Number of hours under sail without Steam.	Number of hours at Anchor with Fires lighted.	Treasure Freight.	Passengers.				Expenditure of		Expenditure of		REMARKS.
								Officers.	Europeans.	Natives.	Horses.	Coals.	Wood.	Oil.	Tallow.	
												Tubs of 3 Mds. each.	Mds.	Mds.	Mds.	
Rangoon,.....	Jan. 20, 1828	Amherst Town,..	Jan. 21, 1828	25	None	14	None	None	None	None	None	None	500			Strong breezes and high sea for the most part.
Amherst Town, ..	Jan. 30, 1828	Tavoy River,....	Feb. 1, 1828	43	None	12	None	4	None	16	None		130			Moderate for the most part.
Tavoy River, ...	Feb. 4, 1828	Mergui Harbour,	Feb. 4, 1828	18	None	10	None	6	None	20	None					Moderate winds and hazy.
Mergui Harbour,	Feb. 7, 1828	Tavoy River,....	Feb. 8, 1828	22	None	10	None	6	None	20	None	180				Fresh northerly breezes and hazy.
Tavoy River, ...	Feb. 8, 1828	Zeah Harbour,..	Feb. 9, 1828	24	None	38	None	4	13	29	None			4	8	Moderate breeze and hazy, westerly.
Zeah Harbour, ..	Feb. 11, 1828	Amherst Town,..	Feb. 11, 1828	11	None	10	None	4	13	29	None					Light breezes and hazy, westerly.
Amherst Town, ..	March 1, 1828	Rangoon, ...	March 2, 1828	24	None	6	None	None	2	None	None	None				Fresh land and sea breezes and fair.
Rangoon,.....	April 22, 1828	Calcutta,.....	April 29, 1828	120	34	7	Sa. Rs. 6,25,308	1	None	5	None	540	120			Strong westerly breezes for the most part.
Calcutta, ...	May 29, 1828	Saugor Roads, ..	May 31, 1828	17	None	31	None	None	None	None	None					Very strong southerly breezes and a high sea.
Saugor Roads, ..	May 31, 1828	Coolie Bazar, ..	June 1, 1828	12	None	13	None	3	100	None	None					Very strong breezes and cloudy.
Coolie Bazar,....	June 2, 1828	Saugor Roads, ..	June 3, 1828	13	None	15	None	3	90	None	6	416	None			Strong southerly winds, &c.
Saugor Roads, ..	June 3, 1828	Calcutta, ...	June 4, 1828	13	None	9	None	None	None	None	None					Light breezes, southerly, and fair.
Calcutta, ...	June 7, 1828	Saugor Roads, ..	June 9, 1828	19	None	23	None	3	90	None	None					Moderate breeze and rain.
Saugor Roads, ..	June 9, 1828	Calcutta, ...	June 10, 1828	14	None	14	None	4	95	None	None	180				Light airs and rain.
Calcutta, ...	June 24, 1828	Amherst Town,..	July 6, 1828	95	140	45	None	3	None	30	None	210	None	20	30	Fresh breeze and high sea from south-west.
Amherst Town, ..	July 11, 1828	Rangoon, ...	July 12, 1828	27	None	4	None	None	None	None	None					Light breezes, southerly, and rainy.
Rangoon, ...	July 15, 1828	Amherst Town,..	July 16, 1828	26	None	14	None	2	4	None	None	100	None			Very strong breeze and heavy sea.
Amherst Town, ..	July 23, 1828	Calcutta, ...	Aug. 4, 1828	180	82	42	Sa. Rs. 2,40,048	1	2	20	None	478	55			Very hard squally weather; rain and a heavy sea.
Calcutta, ...	Aug. 9, 1828	Saugor, ...	Aug. 10, 1828	16	None	36	None	20	None	None	None					Moderate breeze and fair.
Saugor, ...	Aug. 13, 1828	Floating Light,..	Aug. 14, 1828	7	6	10	None	None	None	None	None	400	None			Light airs for the most part—towed H. C. ship Hibernia from Saugor, &c.
Floating Light, ..	Aug. 14, 1828	Calcutta, ...	Aug. 16, 1828	26	3	28	None	8	None	None	None					Engines out of order.
From 7th to 9th October 1828, employed steaming H. C. Ship Investigator,.....					52.—The Vermin, &c. completely destroyed.											
N. B. 12th, 13th and 14th November, 1828. The Steam up for the purpose of working the Engines on trial, ...												165	None			
Calcutta, ...	Nov. 16, 1828	Barrackpore, ...	Nov. 16, 1828	3	None	24	None	None	None	None	None					Fair weather, light northerly breeze.
Barrackpore, ...	Nov. 17, 1828	Calcutta, ...	Nov. 17, 1828	3	None	20	None	1	None	109	None					Fine weather, winds northerly.
Calcutta, ...	Nov. 18, 1828	Akyab, ...	Nov. 22, 1828	85	None	16	None	1	None	109	None	110	None			Strong easterly breezes mostly.
Akyab, ...	Nov. 23, 1828	Calcutta, ...	Nov. 25, 1828	59	None	3	None	2	None	108	None			5	7	Fresh northerly breezes and fair.
Calcutta, ...	Nov. 28, 1828	Akyab, ...	Dec. 1, 1828	62	None	22	None	1	None	110	None					Moderate breeze, northerly, and fair.
Akyab, ...	Dec. 2, 1828	Calcutta, ...	Dec. 5, 1828	62	None	17	None	1	None	108	None	530	None			Strong breeze from W. & N. W. and hazy.
Calcutta, ...	Dec. 8, 1828	Sandowy, ...	Dec. 14, 1828	112	None	44	None	1	None	102	None					Strong easterly gales & cloudy weather & rain.
Sandowy,.....	Dec. 16, 1828	Kyouk Phyoo, ..	Dec. 16, 1828	14	None	17	None	1	None	86	None	760	150			Easterly winds and hazy weather.
Kyouk Phyoo,....	Dec. 17, 1828	Calcutta, ...	Dec. 21, 1828	80	None	22	None	1	None	86	None			13	9	Strong Nrly. & N. W. breezes & cloudy weather.
Calcutta, ...	Dec 23, 1828	Sandowy,.....	Dec. 27, 1828	82	None	22	None	1	None	107	None					Winds variable and cloudy weather.
Sandowy,.....	Dec. 29, 1828	Calcutta, ...	Jan. 4, 1829	87	45	14	None	1	None	139	None	650	70			Strong northerly breeze and heavy sea.

C. H. WEST, *Commander.*

NOTE.—Between the 16th November, 1828, and 12th July, 1829, the Irrawaddy steamed 2379 hours, and sailed 393 hours, making, per log, 14,285 miles, and direct 14,050 miles, which makes the average rate of the whole distance run, something more than five miles per hour.