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An historical and descriptive account of the steam engine, comprising a general view of the various modes of employing elastic vapour as a prime mover in mechanics

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Chapter IV. Abstract of evidence before a select committee of the House of Commons on steam navigation.

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CHAPTER IV.

*Abstract of Evidence before a Select Committee of the
House of Commons on STEAM NAVIGATION.**

MR. BRYAN DONKIN was called in and
examined.

WITNESS went down to Norwich, as a volunteer,
to inquire into the cause of the explosion of a steam-
boat. Was accompanied by Mr. Timothy Bramah
and Mr. Collinge. Was of opinion that the im-
mediate cause of that explosion had been the use

* The Committee commenced its sittings May 8, 1817, and consisted of the following highly respectable individuals:— Charles Harvey, Esq. in the chair; Mr. William Smith, Mr. Davies Gilbert, Sir Martin Folkes, Sir James Shaw, Sir William Curtis, Sir Charles Pole, Mr. Alderman Atkins, Mr. Williams Wynn, Sir Edward Kerrison, Mr. Lacon, Mr. Shaw Lefevre, General Thornton, Mr. Edward Littleton, Mr. Finlay, Mr. Leader, Mr. Alderman Smith, Mr. Wrottesley, Mr. Barclay, Sir James Graham, Mr. Swann, Mr. Charles Dundas, Mr. Holmes, Mr. Thompson, and Mr Bennet.

On the 14th of the same month, Sir Matthew Ridley and Mr. Ellison were added to the Committee.

of steam of a very high expansive force; the approximate cause was a deficiency in strength of the end of the boiler. The boiler was cylindrical. The cylindrical part, and one end, was wrought iron; and the other end was cast iron. It appeared to have been previously of wrought iron, but, for some reason, the wrought iron end had been cut out, and a cast iron end substituted in its place.—Was of opinion that any high-pressure boiler so constructed was unsafe. The difficulty of obtaining a proper degree of strength at all times, in the materials of which the boilers were made, arose from the constant deterioration which they must be suffering from the action of the fire, and from the various degrees of expansion and contraction, operating on different parts of the boiler.—Would not choose to use a high-pressure engine, from the danger which arose from their use.—Thought it just to state to the Committee, that there was an advantage to be derived from the use of high-pressure engines on board of boats, which were necessarily loaded differently at different times. This different loading required a different power in the steam engine, and the high-pressure engine was capable of having the additional power given to it without difficulty; whereas, in the lower-pressure engines, they were confined to the power first assigned them.—Scarcely ever saw the low-pressure engine beyond six pounds to the inch.—Had known one boiler worn out in six months, and another used for seven or four-

teen years. The strength of cast-iron boilers was extremely uncertain: cast iron was liable to contract in various degrees in different places, and therefore was liable to break.—Thought that all cast-iron boilers were dangerous when used for steam of high expansive force. It was more practicable to make a boiler of the malleable metals to resist a high pressure, as far as the tenacity of the metals was concerned; but another difficulty occurred which prevented the application of the malleable metals to boilers for high-pressure engines, which was that of rendering the joining of the plates secure.—Believed that wrought-iron boilers were much less frequent than the cast-iron boilers, and in Wolfe's engines they were scarcely used at all.—Should think that the cast-iron boilers would be cheaper than wrought, if made of equal strength.—Considered that in case of the explosion of a cast-iron or a wrought-iron boiler, the cast-iron would be attended with the greatest danger. In employing the malleable metals a simple rending generally took place, so that it would seldom happen that the upper part of the boiler would be torn off; but, in a cast-iron boiler, the fragments would be scattered about, and be more destructive.—The boilers invented by Mr. Linns and Mr. Wolfe were all of them cast iron.—Mr. Wolfe's had been in use nearly ten years. Considered low-pressure boilers as safe from explosion in all instances, used with no farther pressure than six pounds.—Had seen very few boilers

constructed for the purpose of a low-pressure engine, or a condensing engine, that would sustain a pressure of ten pounds without occasioning considerable leakage, or without forcing the joints.—Had never heard of an explosion with the low-pressure boiler of any consequence whatever,—merely giving way of the plates, or the wearing out, not such a bursting as could be called an explosion.—Conceived Wolfe's mode of constructing boilers to be a considerable improvement,—a very material one. Had likewise been told, though without having seen one, that Trevethick had invented a method of making boilers by increasing their length and decreasing their diameter, so as to render them capable of sustaining pressure to a much greater degree than heretofore.—In high-pressure engines the expansive force of steam was very variable, from thirty pounds to one hundred and twenty pounds upon the square inch, or even perhaps higher than that. Instances had been known in which a boiler had been worked at one hundred and sixty and one hundred and eighty pounds.—Had no doubt but Cornwall had derived incalculable advantages from the use of high-pressure engines.—According to the general construction of low-pressure boilers, they were so rivetted together, as to withstand the low pressure they were intended to bear; and they always gave indications of an increase of pressure long before any danger could be apprehended from them either by the

joints giving way, or the steam forcing a passage through.—Had witnessed several experiments on Wolfe's engines, where the object was to ascertain the comparative expenditure of coals or fuel in grinding corn, between his engines and the low-pressure or condensing engines; and the results were decidedly in favour of Mr. Wolfe's engines.—Apprehended that there was no saving of fuel, or very little, in the common high-pressure engine.—The average effect in Wolfe's engine, was the grinding eighteen bushels of wheat with one bushel of coals; while the average effect of Boulton and Watt's engine, or the low-pressure engines, was the grinding of from ten to twelve bushels of wheat with a bushel of coals.

SETH HUNT, Esq. was called in, and examined.

Had formerly been commandant of Upper Louisiana.—Knew that in the United States a great number of steam-boats had been established. The first was at New York. There were then running between New York and Albany, ten boats: two between New York and the state of Connecticut; four or five to New Jersey; besides the ferry-boats, of which there were four. These boats were all worked by low-pressure engines: no accident had ever happened to any one of them: they had been running since the year 1807; and the boats at Albany performed about forty trips each per annum.—They went a distance of a hundred and sixty miles in twenty-one

hours, and came down in nineteen: sometimes a little longer, but never shorter than nineteen; that was the quickest passage.—Some of them went about seven miles an hour in still water: some boats had gone nine, ten, or eleven miles; but that was under particular circumstances. They had come from Newhaven to New York (ninety miles) in six hours and a half, without any sail.—Those which went to Albany passed up the North River; and the others, to Connecticut, passed through Long Island Sound, forty miles broad in one part of it. On the river Delaware there were a number of boats also established, which plied between Philadelphia and Trenton in New Jersey; also others between Philadelphia and Newcastle, and Philadelphia and Wilmington, beside ferry-boats. Several of those boats had low-pressure engines; others had high-pressure engines, from one hundred to one hundred and forty pounds on the square inch, and as high as one hundred and sixty; but those engines were constructed upon Oliver Evans's plan, called the Columbian plan. They were of wrought iron.—There were no boilers cast in America. Presumed that might arise from their not having founderies in which they could cast them sufficiently large. They were all wrought-iron boilers, or copper: all which had to pass through salt water were copper. The boat Etna, which passed between Philadelphia and Wilmington, was a high-pressure engine, and outstripped all the other boats: there

was no competition at all between them. There were boats from Baltimore to Norfolk, which passed a part of the Chesapeake, sixty miles in width. They have been to New London, which was still more exposed; and had been up to New Hertford. Those were low-pressure engines.—The Powhawton steam-boat was built at New York; went into the open ocean; encountered for three days a very severe gale of wind, arrived safe at Norfolk, and up to Richmond. The gentleman was now in England who navigated her; and had heard him say that he felt himself as safe as he should in a frigate; and he said there was this advantage, that the steam power enabled him, when they could not have borne sails, to put the head of the vessel to the sea instead of lying in the trough of the sea, being exposed to be overrun by the waves.—The largest steam-boats in America were those on the Mississippi, the Etna and the Vesuvius which ply between New Orleans and Naches. They were four hundred and fifty tons, and they carried two hundred and eighty tons merchandise, one hundred passengers, and seven hundred bales of cotton, besides the passengers transported to New Orleans.—Remembered only three accidents having happened to steam-boats in America. The first happened on the Ohio, and was occasioned by the negligence and inattention of the engineer, who loaded the safety valve, and neglected to attend the fire. All hands were engaged in hoisting the

anchor: the fire was in a very high state, and of course produced a vast deal of steam that did not escape by the ordinary operation of the engine, which would discharge it and carry it off.—What was called the safety-valve had been improperly loaded and neglected.—The next accident happened not from any fault of any body, but from an act of God: it was lightning, as was satisfactorily explained to the public, both by the passengers, and those interested in the boat. That was at Charlestown, in South Carolina. The pipe which carried the smoke up to the top attracted the lightning, and it went down, and split the boiler.—A third accident happened lately to the Powhawton. She was not in operation when it happened: they were out of fuel; they stopped their boat, and lay still upon the water, while they went after wood; still, however, they kept up their fire; and the steam was so high, that it exploded in that situation, there being no consumption of the steam as it accumulated. Those are the only accidents that ever happened, except such as have happened from vessels taking fire.—No accident had ever happened in America to a high-pressure engine, either in a manufactory or out of it; and there were many engines used in the manufactories, and in flour-mills and saw-mills, constructed upon the plan of Oliver Evans, which acted on the high-pressure principle to one hundred and fifty pounds an inch. He had worked one hundred and sixty, but one hundred and

twenty was his constant average. The fuel, in most places, was wood; at Pittsburgh, and on the Ohio river, it was coal and wood; at Pittsburgh, and at Laceling, and at a hundred other places, there was a solid mass of coal fifty miles square. They drove a shaft horizontally into the hill, and the coals were abundant above their head; in the mountains, as fine coal as any in the world. It was delivered at the houses of the inhabitants at sixteen bushels per dollar.—The number of steam-boats was rapidly increasing upon both the low and high pressure system, because they had different interests and different companies. Mr. Evans being a patentee, they had to give something for the use of his patent; if they could not make their bargain with him, they used the low-pressure engine; but there was a new engine, built for one-third of the money, coming into use in several of the steam-boats, invented in America, a perfect rotatory engine; and it was supposed that it would supersede all other engines.—Knew of no other guard than that of properly constructing the safety valves, and the manner of loading them, so that they could not get on more than a certain weight; they must of course construct them strong enough, and prove them. They were under no Government regulations.—It was supposed that a rotatory engine consumed less coals than one with a reciprocating beam. Twelve bushels of coals, with the rotatory motion,

would perform the same work as the other engine with twenty.

MR. TIMOTHY BRAMAH, of Pimlico, Engineer,
called in and examined.

Did not think that a high-pressure engine, under any guard that could be applied to it, was a safe engine to use in a steam-boat.—Thought that if a boiler was prepared to sustain one hundred pounds, and strained with a force equal to two hundred pounds, it might afterwards, perhaps, break at forty, the straining having injured it.—Apprehended that a boiler, upon a proper construction, of wrought metal, might be tried with a certain force, so small in comparison with that pressure which it was intended to bear, as not to incur any risk of being injured in the proof, and have a complete surplus of strength, so as to enable it to be afterwards used without any danger in the use.—Would recommend the use of two safety-valves, one to lock up; and to have it examined once a week, or as often as might be necessary, to see that its action was perfect.—Had seen many cast-iron vessels burst. The wrought iron generally tore and opened out, to admit of the fluid escaping; it was generally the fluid which did the mischief when the wrought iron was used, and it was both the fluid and the materials which did the mischief when the cast iron burst. The effect in cast metal was to carry the

pieces of the metal to a considerable distance, which was seldom the case in the wrought, unless where there was any cold shut in the metal. The cast would burst like a shell, projecting the particles of the metal to a considerable distance.—Where wrought-iron boilers had burst, the injury sustained by the individuals had arisen from the fluid's escaping, and in cast-iron boilers it had frequently been by the expansion of metal. Copper being purer was not subject to the same danger.

Mr. JOHN TAYLOR, of Stratford, in Essex,
called in and examined.

Was acquainted with the accident which lately happened to the steam-boat at Norwich. Had heard that the plate of cast iron was of inadequate thickness for the strain to be put upon it. With respect to the impropriety of cast iron compared with wrought, had also constructed one of the high-pressure boilers precisely in the same manner: the boiler was proved to one hundred pounds a square inch by the water-proof, commonly used with about forty pounds' pressure; but the cast iron broke one day with less than twenty pounds' pressure of steam; the fracture being caused evidently by the heat expanding unequally, and being kept from going to the form it would otherwise assume.—Had seen the Well-street boiler intended to boil sugar. The thickness was intended to be about two inches, or two inches and a quarter; but by inserting the core unequally,

the thickness on one side was three quarters of an inch; on the other side the thickness of the metal was two inches and a quarter, or thereabouts; therefore, to the general difficulty of cast iron was added a most improper construction.—Understood from the men who were working there, that there had been something like a mercury gauge attached to it, but that the mercury never fluctuated. It was probable there was a pressure of more than one hundred pounds.—Considered that a wrought-iron boiler might be rendered safe by the use of a column of mercury in a siphon or tube of sufficient size. When that mercury was displaced by the expansive force of the steam, which would be regulated by the height of that tube, to admit of the efflux of the steam from the boiler as fast as it was generated by the fire; in that case, the expansive force could not increase in the boiler, the mercury would be blown out, and the steam would escape. Conceived it essential to have a second safety-valve, which should be under the control of the master or proprietor of the works; and there was another small contrivance very important to the safety of the boiler. Boilers had frequently been weakened very much by the water having been evaporated too low. To remedy this, a hole should be previously bored in the bottom, rivetted by a piece of lead, so that the lead would remain perfectly secure as long as it was covered with water; but, the moment the water left it, the lead would melt, and

the steam being blown through the hole, would put out the fire. Besides giving the signal of what was wanted, it would at once put an end to the cause of danger.—Considered that the mercurial gauge acted as a safety-valve, which could not be stopped or put out of order; and it had the advantage of exhibiting, during all times of the boiler's working, the state of the steam within the boiler, by the fluctuation that took place in that column, as indicated by the appearance upon the surface of the mercury. If the mercury became stationary, it might readily be suspected that that tube was stopped; therefore it would point out itself instantly that it had become not what it ought to be. The safety-valve had not that advantage, as it did not indicate any thing till the steam was blown out by raising the weight.

—With respect to the value of high-pressure steam for working engines in Cornwall, of late a most valuable improvement had taken place; and if it was an object to save coal to steam-vessels upon a large scale, high-pressure steam became an object of great importance to them, if applied upon the principle that Mr. Wolfe had in the first place introduced, but which had been applied by Mr. Simms and others. Was of opinion that those high-pressure boilers might be made with equal safety as low-pressure boilers.—Had prepared a statement of the work done by the engines on the principal mines in the county of Cornwall. It stated the consumption of coal and the work

done by every engine therein named; from which it appeared that the average work of engines then in the county of Cornwall was to raise about twenty millions of pounds of water one foot high by the consumption of one bushel of coals: that, by the introduction of high-pressure steam, under the best mode of management, an effect equal to from forty-three to forty-five millions pounds of water was raised to the same height by the same quantity of coal, thereby producing above double the effect.—Apprehended that condensing or low-pressure engines were equally liable to be blown up by the carelessness and inattention of the engineer conducting them with high-pressure engines. In France, at Crusal, some very good engines were erected by Mr. Wilkinson, at a very large work; they were on Boulton and Watt's principle: one of them blew up, and killed several people.—Conceived that the mercurial gauge, if of sufficient bore, might be applied with ease to the high-pressure boilers, so as to produce safety as certainly as the column of water, which was in fact a water-gauge, such as was usually applied to the low pressure.—Conceived that there would be no difficulty in constructing a safety-valve, so as to operate with certainty, and yet be safe from any impediment which the engineer might intentionally place in the way of its operation, without incurring any very considerable expense.

Mr. JOHN COLLINGE, of Bridge Road, Lambeth,
Engineer, examined.

Went to Norwich, in consequence of the accident that happened to the steam-boat there.—Attributed the explosion of that engine to the construction of the boiler. It was composed entirely of wrought iron, except one end, and that was capped with cast iron. The cylindrical part was made of wrought iron.—Was of opinion that any material under very severe pressure was liable to fail, and cast iron for this reason, because, in all large bodies, it was found that the air could not wholly escape in the act of fusion. Had occasionally had large masses of cylinders and pans to break up, and frequently found cells where the air could not escape. There was certainly a much greater dependence upon wrought iron or upon wrought metal; perhaps it would be better to include copper.—In the event of any accident happening to the boiler, the greatest mischief would be likely to arise from cast iron, because cast iron flew off in fragments, and wrought iron from its superior tenacity did not.—Remembered an accident having occurred at Malden, where a boiler, nineteen feet long, was blown off from the seat of its connection with the base. Had found, in making wrought-iron boilers, that, if they were made of metal of a considerable substance, they could not be so well united to make them steam-tight; it was a very

difficult thing to do. The rivets that were applied to wrought-iron boilers were put in hot, and, when they were hammered, to secure the joint, they got cold, shrunk, and did not always fill the hole through which they had passed.—Had no conception that any safety-valve could be applied to render them perfectly secure under heavy pressure.—Thought the mercurial gauge would be the greatest safety for a boat, if it could be judiciously applied.—The condensing engines should not be more than four pounds to an inch; and, if the capacity of the vessel allowed of it, the condensing engines answered every purpose, because the making a wrought-iron boiler would be on such a scale of thickness, that, if more than the usual pressure was applied, the rivets would fail, and constitute a security against any fatal occurrence.—Thought from the power that was wanted into steam-boats, condensing engines were the best engines applicable for that purpose.—Did not conceive it impossible to construct a wrought-metal boiler, with safety-valves properly adjusted to its capacity, and a mercurial gauge, supposing that to be capable of being applied, which should render a high-pressure engine, on board a steam-boat, what might be called perfectly safe.—Thought that in order to give security to the public in travelling by steam-boats, it might be necessary to have an examination of each engine two or three times a year, as it would create confidence.

Mr. WILLIAM CHAPMAN, of Newcastle-upon-Tyne,
Civil Engineer, examined.

Considered all engines, whether high-pressure or low-pressure, as dangerous to the passengers, unless due precaution was taken to emit the steam, when exceeding a given pressure; for, in low-pressure engines, the boilers were always liable to burst, or to alter their force, when the pressure became greater than the resistance. All wrought-iron boilers, but those that were cylindrical in the section, and with hemispherical ends, or portions of spheres, or cones, or conoids, were liable to alter the form by the natural expansive force of the steam, and therefore all boilers of those forms owed their safety to their weakness, because, if weak, they would alter their form without danger, and, if strong, they have been known to bend the iron so abruptly as to break asunder.— There were high-pressure engines, working with a force of from fifty to sixty-five pounds per inch, and no accident had happened to any of them but to one, the safety-valve of which was stopped up by a man sitting upon it purposely. He said, he would have a good start, and surprise them. The consequence was, the boiler blew up, and killed and wounded a very considerable number of people.— Considered that the high-pressure engine could only be rendered safe by having the boiler of the form already described, and the cylindrical part of an unlimited

diameter, with a competent thickness of wrought iron or copper, and the plates secured to each other by a double line of rivets. It was also requisite that there should be two safety-valves, each laden with any determinate weight per superficial inch of the narrowest part of the seat of the valve. One of those valves should be at perfect liberty to be raised at the pleasure of the manager, because sometimes it was expedient to raise it. The other should be under a cover of such description as not to be opened at all at the discretion of the engineer, but with sufficient apertures for the emission of the steam, and for any of the passengers to see that the valve was not made fast. It was also requisite that there should be a mercurial gauge of not less than an inch in diameter, and whose longest limb should not be greater than two inches and one-eighth for every pound per inch upon the safety-valve for each. It was necessary, by occasional inspection, to take care that the mercury did not stiffen by oxydation, occasioned by the heat and motion to which it was in a slight degree liable.—Conceived that a high-pressure engine, thus guarded, might be used with perfect safety on board a steam-boat, so long as the boiler was kept in order; but the boiler bottom was liable to erode or consume by the action of the fire, and therefore required watching.—Thought a boiler might last twelve months, provided its bottom was made of charcoal-iron, beat, not rolled, because there

was a great deal of difference in the grain.— Would recommend all the boilers on board steam-boats to be made either of copper, or charcoal-iron plates, beat under the hammer, and not rolled. The resistance of the cylindrical boilers would be precisely in the inverse ratio of the diameter.

Mr. PHILIP TAYLOR, of Bromley, Middlesex,
Manufacturing Chemist, examined.

Considered the first and most material point to attend to in the construction of high-pressure boilers was, that their diameters should be small in proportion to their capacity; that as small a proportion of the external surface of the boiler as possible should be exposed to the destructive action of the fire; and that that portion of the boiler which was subjected to the action of the fire should be so situate and guarded, that, in case of explosion, the least possible mischief should arise. In all boilers which he had made use of, no portion of the boiler was exposed to the action of the fire, without its being constantly covered with water. In the boilers constructed under his direction, the fire was applied under an arch of not more than two feet and a half in diameter: this provided against any extensive rents taking place in the event of explosion. All the boilers he had hitherto employed had been constructed of malleable iron, commonly known by the name of charcoal-iron, rivetted

together, and secured by strong wrought-iron bolts. From observing the danger arising from the introduction of flat cast-iron ends, had invariably terminated the ends of the boilers by wrought-iron ones, nearly hemispherical: this mode of construction, so far as his experience had gone, combined more strength and durability than any other. The precautions he had used to guard against the nuisance of such boilers, had been by adapting to them two safety-valves; one under the control of the engine-man, the other secured in a strong cast-iron case, locked down, and loaded with such a weight, as would suffer the steam to escape when it had arrived at an improper degree of expansive force; safety-valves not having at all times answered the purpose intended. Had, likewise, in every instance, attached to the boiler a mercurial column, the bore of which was proportioned to the size of the boiler; and considered an iron tube, of an inch diameter, sufficient to guard against accident, when applied to a boiler four feet in diameter and twenty feet in height; because the limit given by such a column came far within the limit of absolute safety. The external limb of the mercurial gauge had, in all cases, been proportioned to the strength of the boiler applied, taking care that the expansive force of the steam would displace the mercury long before any dangerous expansive force would arise. In order to guard against the boiler being injured by the

action of the fire, from a deficient quantity of water in the boiler, had inserted a leaden rivet in such a situation, that it would melt as soon as it was uncovered by the water, and produce an opening, which would suffer the escape of the steam.—Considered cast-iron boilers safe, provided their various parts were made of small diameters in proportion to their capacity; such, for instance, as those constructed by Mr. Wolfe.—Thought that a boiler constructed on this principle was equally safe with those called condensing engines, because a greater attention to strength is always paid in the construction of high-pressure boilers than in the construction of those for low-pressure engines, in proportion to the pressure they have to sustain.—The high-pressure engine, constructed by Mr. Wolfe, employed not only the expansive force of the steam, but also that power which was acquired by its condensing; and the effect in Cornwall had been, that engines on this construction had done double the quantity of work with the same quantity of fuel.—Should consider any measure tending to impede the use of high-pressure engines injurious to the country.

Mr. HENRY MAUDSLAY, of Lambeth, Engineer,
examined.

Never considered high-pressure engines were applicable to boats, because the purpose of high-pressure engines was to save water, and water

could not be wanted on board a vessel; the difference between the one and the other made no saving, either in the weight or expense, taking it ultimately, particularly when steam-boats were properly contrived.—Built the Regent steam-boat with a low-pressure engine. There was a dispute between two men, and one of them swore that he would blow his boiler up but he would beat the Regent in coming up. The man certainly did exert himself as much as he could, and kept his steam as high as he could get it, and it flew out of the safety-valve very frequently, and he hurt his boiler materially from doing so; but he did not beat the Regent: but, if it had been a high-pressure engine, he would either have beat her, or blown up his boiler, because he had the power in his own hand. Had employed two and sometimes three safety-valves: to make it quite easy for the man to move them, had a sort of bell-pull to pull it up every hour, if he pleased, to keep it in action; because, it was clear, the spindle might corrode and stick fast for want of use. Supposing it not touched once a week, it would not be a safety-valve any longer, because a very little friction would add a great many pounds weight to the opposition the steam ought to meet with.—Never knew a low-pressure engine unsafe, but it appeared that high-pressure engines had been.—Conceived that the same motive which would induce the engineer to work it with an improper pressure, would induce him to leave it untouched,

that it might have an improper pressure.—Considered that wrought iron was extremely safe, compared to cast iron.

MR. ALEXANDER GALLAWAY, of Holborn, Engineer, called in and examined.

Would recommend that, for steam-boats, the condensing engines should be used in preference to high-pressure engines; and, for these reasons: In the first place, the great advantage promised from a high-pressure engine was, that it could be worked in a situation where water could not be procured, and therefore it was, for such a situation, a valuable machine; but, in situations where water could be readily procured, it was not so. And in reference to the comparative price between a high-pressure engine and a low-pressure engine, and in reference to the space that it occupied, and in reference to the superintendence that it required, it was decidedly evident no economy was produced. Speaking of it as a matter of safety, it would be necessary to say, that experience had fully proved that the maximum of force to be obtained by a condensing engine was when the steam was rarefied from three to six pounds on the inch. The engine was then by far more efficient than when the steam was rarefied beyond that point. And it would appear equally clear, that whether it was a cast-iron boiler, or a wrought-iron boiler, or a copper boiler, the force of the engine was better performed by steam at

three pounds and a half than at any increased expansive force; the boiler being subject only to three instead of six pounds, it must be less liable to explode or burst at that than at an increased expansive force. Would farther say, that every man that was called to work a condensing steam-engine knew, that, when his steam was at three pounds and a half, it performed a greater quantity of labour than at any other time; for, if it was increased, a vast labour was thrown on the air-pump and the condenser, and the engine retarded; therefore, a man had no inducement to increase the expansive force of the steam, knowing that no useful end could be obtained by so doing, but giving himself additional labour, and consuming more fuel, and performing less work. All boilers on board steam-boats should have the fire in the interior of the boiler, because it was of very little importance, when upon the subject of safety, whether the passengers were to be endangered by an explosion, or whether the vessel was to be weakened in its timbers, or essential securities, by the improper application of the fire to the boiler; would therefore recommend that the fire should be contained in the interior of the boiler, and that there should be an additional safety-valve, which should be solely subject to the superintendence of the proprietor, and that the manager of the machine should have no possible access to it. — Would certainly recommend a wrought-metal boiler in preference to a cast-iron

boiler; and the reason was clear, that the operation of casting, however skilfully managed, was always an uncertain process.—Thought that if an additional safety-valve was applied to a boiler, and that safety-valve placed beyond the power of being interfered with by any person but the proprietor, then the boiler would be secure from explosion, if the safety-valve should be judiciously loaded; but if that safety-valve was even placed beyond the reach of the operator, and at the same time injudiciously loaded, a calamity might take place, the same as if no such security existed.—Under all the circumstances of the case, would most decidedly recommend a condensing engine; a condensing engine, with a wrought-iron boiler; because, when cast iron became subject to high expansion and contraction, the constant repetition of those effects in a very great degree impaired the strength of the boiler.—Would venture to say, that all engines in steam-boats should be subject to regulation and inspection by competent persons. A steam-boat must have a register; and, before such register should be granted, the engine should be inspected, to see whether it was of a character to deserve its being considered safe.—Was quite satisfied, that, taking for granted that condensing and high-pressure engines were judiciously formed, the one would take as much fuel as the other, there would be no material saving, if any; but if two principles were associated together, as in the case of

Wolfe's engine, there would be a considerable saving.

Mr. JOHN BRAITHWAITE, of the New Road, Fitzroy Square, Engineer, called in and examined.

With respect to high-pressure steam, would engage to make a boiler, or direct one to be made, which would defy any engineer, or other person, to blow up, or burst; and had lately erected five boilers, which he was ready to prove to any gentleman, and even to any engineer, that they could not destroy them.—Recommended to Mr. Martineau, for whom he erected them, that, as there had been an accident in his neighbourhood, he ought to have a boiler to bear three times the pressure he meant to put upon it; and, if it did bear that pressure, and they applied two safety-valves, with a mercurial steam-gauge properly weighted and adjusted (one of those safety-valves being at the will of the person about the boiler, and the other locked up) it would be impossible to explode a boiler of that description. Saw the boiler after it was exploded at Wellclose-square; and also conversed with one of the men that was saved, who said, that he had carried an additional weight to put on the safety-valve just before it exploded; that the mercurial gauge there was plugged up, so that it was useless; besides which, instead of the safety-valve being weighted equal to forty-five pounds, they added a double weight, which increased it to ninety

pounds weight upon an inch, and the boiler was very improperly made.—Would recommend wrought-iron boilers in preference to cast on board of steam-boats.

Mr. JOHN HALL, of Dartford, Engineer, called in and examined.

Had only to observe, that he made his boilers of cast iron, and proved them by an hydraulic press, made for the purpose; and had gone as high as two hundred and fifty pounds to an inch, which he considered enough. Nothing happened; and he meant the next time to try what they would bear; and had no doubt they would bear from seven hundred to one thousand pounds to an inch; for he believed they could be made stronger than wrought-iron boilers; wrought-iron boilers being rivetted together, could not be so strong as those cast in a solid mass.—Had a boiler made composed of three tubes on a large one, and two smaller ones below; the lower tubes which were exposed most to the fire, had cracked, generally by cooling, after the engine had done working. Had known that in three or four instances; perhaps in an hour after the engine had done working, the tubes below had cracked, and the other not.—Supposed that in the event of explosion the greatest danger would be from the wrought-iron boiler.—Considered it quite practicable to adjust a safety-valve to a boiler, which should not be accessible to the engineer, but

which should sufficiently protect the boiler from mischief, and which once adjusted, would always act, and might always be depended upon.

Mr. ALEXANDER TILLOCH, of Islington, called in and examined.

Was of opinion, that attending to what should be attended to in every steam engine, and employing proper engineers, a steam engine would be perfectly safe, whether with high-pressure or low-pressure steam. The boilers ought always to be furnished with safety-valves, one of which should be covered, and out of reach, with a box over it, but perforated, so that it might be seen when the steam operated on it. A mercurial-valve is also very good, that is, an inverted syphon, with a column of mercury, proportioned to the purposes for which it is to be employed.—Did not apprehend much danger to arise, in case of explosion, from the mercury, because the tube being always perpendicular, the mercury, when shot out, would fall down in rain. Was of opinion a boiler might be made safe, either of wrought or cast iron; but, for great strain, would prefer cast iron, contrary to the opinion of many people; and the reason for this preference was the same for which it was preferred in making cannon. It was not possible to get thick plates of wrought iron perfect throughout, and it was necessary to trust at last to rivets in joining them; but cast-iron boilers could be made of any strength. Instead of having a

boiler that would stand sixty, it might be made to stand six hundred of either wrought or cast iron. Another reason why he would prefer cast iron was, that the sheet iron corroded much quicker, and was destroyed by oxydation, so that a boiler might be safe when first set up, and stand its proof, but very soon become unserviceable, or at least, comparatively so. Boilers should always be cylindrical, and for an obvious reason: capacity should be got by length and number, rather than by diameter. There was no more danger to be apprehended from steam, as to bursting, than from the employment of condensed air, only that the water might scald: but, as to the danger of the fragments being scattered about, it was the same with air as with steam, and yet all the engineers constantly employ cast-iron receivers, condensers, or air-vessels, where pressure was wanted.—In case of actual explosion should think the greatest mischief would arise from the cast-iron boiler.—Was aware that there might be cavities in cast iron, but a boiler being proved to a strain beyond that it was to be exposed to by heat, the safety of the boiler was secured, for the temperature never could be at that point which would endanger a fracture from that circumstance.

Mr. GEORGE DODD, Civil Engineer, of Oxford Street,

Stated, that out of five steam-boats under his direction, only two had suffered by partial acci-

dents, and these were owing to the carelessness of the engine workers. His boilers were made flat sided, with flat and dome roofs, the largest of them containing at least fifteen hundred rivets, each of which in some measure answered the purpose of a safety-valve.—Was of opinion that to all boilers there should be two safety-valves. The one which would be accessible to the engine worker should be loaded with the minimum of the pressure that the chief engineer saw fit that the boiler should sustain; and that the one which would be inaccessible and locked up should be loaded equal to the ultimatum that he would, under any circumstances, permit the boiler to support.—Would not allow the safety-valves to be loaded with more than half the weight which had been previously tried, and found the boiler was capable of supporting.—Was of opinion that a boiler whose sides and ends were flat, if properly constructed, and of sufficient thickness in the plates of wrought iron, might be safely used on board steam-boats having the low-pressure engine.—In the Richmond steam-boat the fire was entirely surrounded by the water. It was the case also in the *Majestic*; but, in the *Thames*, and in the new boat to Richmond, and the new boat to Gravesend, they were what was called open furnace-mouths. Under the furnace-mouth was placed an ash-hole of cast iron, bedded in clay, and upon fire-bricks.—Recollected the boiler of the *Caledonia*, London and Margate steam-packet, bursting at sea,

by the forcing out of three of the rivets over the furnace-mouth, which extinguished the fire; but it was not productive of any injurious consequences to any of the persons on board; and the Cork and Cove packet-boat in Ireland, with two hundred and fifty officers and soldiers on board, burst her boiler when lying alongside of the transport that was receiving the troops. The bursting made a fissure, or opening, of nine inches by eighteen inches; but the steam which escaped did no injury either to the persons on board or to the vessel; nor does it appear, under any circumstances of the bursting of a wrought-iron boiler at the low pressure, the steam not being more than ten or fifteen pounds to the inch, that the steam which might be suddenly let loose or disengaged would have power sufficient to raise the deck of the vessel, or to injure the parties on board.—The Richmond steam-yacht cost, in the first instance, including the engine, 1800*l.* The engine itself cost about 1000*l.* The Majestic cost about 2000*l.* and the engine about 2000*l.* more. The Thames cost 2500*l.* including the engine at about 1200*l.* The new vessel built to go to Richmond, the hull and joiners' work cost 750*l.*; and an engine of fourteen-horse power and apparatus cost 1170*l.* The new Gravesend steam-yacht, the hull only has cost 750*l.* and the engine 1370*l.*; but there were various other expenses before these vessels could be finished.—Had just got a new boiler from Messrs. Jessop's, of Butterley, for the Thames

steam-yacht, which was charged 215*l.*—A safety-valve would cost about 4*l.* and a mercurial-tube for the same purpose 2*l.*—Had declined purchasing the Norwich steam-packet because it had a high-pressure engine.—Went with a party of German gentlemen from Bremen, who were anxious to make an immediate purchase of a steam-vessel; and they also declined to purchase that, or any of the boats upon the river Yare, solely because they had high-pressure steam engines on board.

MR. RICHARD WRIGHT, of Blackfriars Road, Engineer, called in and examined.

The boiler of the Norwich steam-vessel was eight feet long, with a cylindrical boiler four feet two inches diameter; it was first made with an internal angle iron at one end, and an external angle iron at the other end. In consequence of the internal angle iron having given way, a cast iron end was substituted, which certainly was not accurately performed. It was originally intended to sustain a pressure of forty pounds to the inch.—Should think that both wrought and cast-iron boilers might be used with equal safety; but that, in proving them, they ought to be kept under the pressure a considerable time, say a quarter of an hour, or half an hour. Sudden pressure may cause flaws in a boiler, which may give rise to accident afterwards; but, if under pressure a considerable time, the action of it might be seen.

Mr. JOHN RICHTER, of Cornwall Place, Sugar Refiner, called in and examined.

Was acquainted with the circumstances attending the explosion of the engine at the sugar house in Wellclose Square ; and had attended from time to time, during the whole period of the construction of that boiler, for the purpose of boiling sugar by means of high-pressure steam ; it was necessary they should have a pressure of from six and thirty to five and forty pounds to an inch.—Saw the boiler when the bottom only was put up, and was at that time informed that they had cast the dome part of it, and that it was not sufficient, and that they were casting another. Some months afterwards found that other placed there. Saw them at work ; and was informed by Mr. Haigh, who was the engineer, that they were boiling at eighteen pounds an inch, but found the index of the gauge standing at five or six and thirty.—It was a mercurial gauge, intended as an index, and measuring inches. In consequence of complaints from Constant, the Frenchman, in whose house it was, that it would not do its work, and his fears in pressing it on to do its work, the maker of it became anxious to shew that it would, and a day was appointed for this to be done. Constant, at three o'clock in the morning, began his work, and continued boiling till about eight, but boiling with a great deal of difficulty, because he was afraid of putting the engine to the pressure

he required. He gave it up; he said he would boil no more; and the men in attendance, who belonged to the engineer, went to fetch the engineer. He and his men came down, and persuaded Constant to have the fire lit again. He consented, after a great deal of difficulty, and went to another pan in an adjoining building, and there he was at work when the accident happened. They were urging the steam, and actually had put an immense weight upon the lever of the valve, so as to render it totally useless. This was ascertained by a Frenchman, who saw it, and who stated to the man that he was doing mischief, and doing wrong. He was told to hold his tongue, and mind his own business; that he knew his business, and they knew theirs: the consequence was, that immediately afterwards it blew up. After this accident went every day to the ruins, for the purpose of ascertaining what had been the cause of the bursting; and saw the excavation, until the parts of the boiler, which was of cast iron, were found, and then finding parts of this boiler in different places, the seat of the boiler being where it had been placed, but the rest scattered about in different directions. The bottom of it was two inches and a half thick, the upright sides of the bottom one inch and a half thick; the lower part of the dome was seven-sixteenths thick, and one of the parts at which it must have burst, and where the boiler was completely defective in the casting, was less than the

eighth of an inch thick; it was not thicker than a crown-piece: the wonder is that it stood at all.— It was not intended to be worked above forty-five, and was ordered to be made to sustain the pressure of a hundred pounds to an inch. The whole house was blown to pieces, which arose from the fragments of the boiler striking the story posts, by which the support being taken away, the walls fell inwards.

Mr. JOHN STEEL, of Dartford, Engineer, called in and examined.

If it was required to make the strongest boiler imaginable, should consider cast iron preferable, because it could be got to an unlimited strength of resistance, while wrought iron could only be had of a certain thickness.—Was of opinion that the proof arising from the pressure of cold water was sufficient to ascertain the safety of a boiler, which should afterwards be exposed to the operation of fire, or of highly heated steam; cast or wrought iron being at its greatest strength at 300 degrees of heat, which had never been arrived at yet by steam.—Considered the mercurial gauge, and two safety-valves as essential in the construction of boilers; and was of opinion, that, by the adoption of those precautions, high-pressure steam might be used with safety, either with wrought-iron or cast-iron boilers.

Mr. WILLIAM BRUNTON, of Birmingham, Civil Engineer, called in and examined.

Had been concerned in making boilers for high-pressure engines, which might be so constructed as to become useless before they were dangerous, upon the principle of having the exterior part of the boiler independent of the flue, so much so, that, while the flue is injured by the current action of the fire, the exterior part of the boiler remains, as to strength, unimpaired.—Conceived that a boiler thus formed, when the flue has been worn very thin, and then exposed to a greater pressure than it could sustain, the thin parts of the flue would act as so many safety-valves.—Believed it possible to construct boilers which would bear an expansive force of six hundred pounds to an inch.—Usually employed two safety-valves; one in an iron box under lock and key, and that only at the control of the proprietor, and the other open to the engine-man; and a mercurial gauge as an inverted syphon, which, in the event of the steam being stronger than the mercury can sustain, the mercury will be driven out, and the boiler thereby relieve itself.—In the high-pressure boiler, the injury which would arise from its bursting, would be done principally by the fragments projected; in the low-pressure boiler, the mischief might arise chiefly from the hot water and steam. Could mention two instances in illustration of this; the

first of a low-pressure boiler having given way in the bottom, when a stream of hot water was projected against the engine-man, causing his death; the second instance was of a high-pressure boiler, in which a hole was suddenly opened, the water projected itself, and completely wetted a boy, standing within a yard of the orifice, who was not at all injured thereby. Should say the fragments from the cast-iron boiler would be equally destructive either with a high or with a low pressure. Considered that the fragments from a wrought-iron boiler would be projected with equal force with one of cast iron under equal circumstances.—Knew a wrought-iron boiler which burst with high-pressure steam; and a fragment, the largest piece, was carried to the distance of one hundred and fifty yards.—Was induced to prefer wrought to cast-iron boilers from the examination of several cast-iron boilers, which were cracked or broken in the lower part of them, which appeared to arise from the unequal temperature and expansion in the exterior part of the boiler, which was caused by a quantity of water at all times under the flue, and consequently of lower temperature than the water above the flue; thereby causing the upper part of the boiler to expand in a greater ratio than the under part of the boiler.—For steam navigation, would recommend a wrought-iron boiler, if properly constructed, and, at least, two safety-valves; the one to be placed under the lock and key of the pro-

prietor of the vessel, so secured as not to be accessible to the engine-man; and one over which the engine-man had the usual control.—Would recommend the valves to be nearly flat, or quite so, as they would be less liable to be fastened by the difference of temperature to which the valve and the seat might occasionally be subjected.

Mr. GEORGE DODD again called in and examined.

Had been on board and was well acquainted with twenty steam-boats; knows that there are more than forty in Great Britain; many of which had cost 5,000*l.* others 6,000*l.* and one on the Thames above 10,000*l.*; considered a fair average to be 3,500*l.* each, making the vested capital 140,000*l.* Most of them were fitted up with peculiar elegance and accommodation, the furniture and decorations alone forming an expensive item; they were also very expensive to maintain, especially on the Thames, by reason of the great cost of coal. They were most numerous on the Clyde, where they had been productive of essential benefit to the general commerce and traffic of Glasgow, Port Glasgow, Greenock, and the neighbouring country.—All of them had low-pressure condensing engines, and wrought sheet-iron rivetted boilers, except the remaining steam-boats between Yarmouth and Norwich, and one in Holland, built at Yarmouth; and they were high-pressure engines.

Mr. JOSIAS JESSOP, of the Adelphi, Civil Engineer, called in and examined.

Had no doubt but what the low-pressure boiler was more secure than the high-pressure, yet, from the natural wear and tear, both were liable to accidents. If an accident happened to one of a high-pressure, its consequences certainly would be more dangerous than that of a low-pressure engine.—Thought that to ensure safety, the boiler should be able to withstand the proof of two or three times the pressure to which it was afterwards likely to be put, or rather the pressure to which it should be limited; if, for instance, it was meant to work it at fifty pounds' pressure, and it stood the proof of one hundred and fifty pounds, the presumption would be that it was secure; but, in the course of two or three years, any boiler would wear out.—Would recommend an additional safety-valve, to which the person working the engine should not have access.—Preferred malleable iron or copper for boilers, because it would not burst by an explosion as brittle metal would; it would probably rend at the joints.—Was of opinion that the boiler should be adapted to the shape of the boat; and that being taken for granted, the safety would depend upon the strength of the metal, and not upon the form. It should be made of such strength, that any indenture would not affect it. Although the form approaching to cylindrical was of course

stronger than any other form, that which approached nearest to a sphere was the strongest, but a cylinder with hemispherical ends was best.

Mr. ALEXANDER NIMMO, of Dublin, Civil Engineer, called in and examined.

Was of opinion that the best form for the safety-valve was that of an hemispherical cup, with its convex surface downwards, resting upon a collar, and to the bottom of the cup a weight was to be hung, which had previously been adjusted; by this means, the valve was always steam-tight in every position, yet without danger of adhering, and must be lifted by the steam when it exceeded a given pressure; but the valve might also be lifted by a chain attached to its upper side, which was inclosed within the iron case, and might be drawn up by the engine-man, or any person on board, and which did not allow him to keep it down, or to confine it. Had also found it necessary to prevent the accumulation of water upon the top of this valve, arising from the condensed steam, when escaping; this was done by a small waste-pipe descending from the bottom of the pipe which conveyed away the waste steam. Had thought it advisable to make the steam-valves large, that the weight which was laid on, being of itself large, might easily admit of addition. Employed two boilers communicating, and two safety-valves; and a mercurial gauge, provided with receivers, so as to prevent the loss of the mercury

in case of any sudden collapsation or disengagement of steam, also a tube of glass attached to the boiler, which exhibited the level of the water in the boiler, and precluded any idea of danger in the minds of the passengers.—Was of opinion that the construction of the cast-iron boiler admitted of its being made of wrought iron with equal strength; then the explosion of the cast iron one would be more dangerous, as it would fly in pieces, whereas the other would probably tear. It was scarcely possible to form cast iron everywhere equally strong, and if a part be weaker than the rest, either on purpose or by accident, that would not have the safety that would be obtained by a wrought-iron boiler; for instance, in cast-iron boilers, it was common to have holes, and if these were filled with some metal of different melting temperature from cast iron, more fusible for instance than that, the juncture would part first, and it might be made to tear as a wrought-iron boiler would do; and again, the wrought iron was so much more liable to oxydation than cast iron, that although found very efficient at first, its strength and tenacity might be very speedily altered; for these reasons, cast-iron boilers had been preferred where high-pressure engines were used; and, in small tubes, the tenacity of cast iron could be made greatly to exceed that which could be given to wrought iron in the same form.

Mr. ARTHUR WOOLF, of Pool, in Cornwall, Civil Engineer, called in and examined.

Approved of the cast-iron boilers in preference to any mixture of metals, particularly those composed of a number of tubes; it being always necessary in boilers to have a certain quantity of surface exposed to the action of the fire, to contain heat and steam; and if that were done in one vessel, of course it must be of considerable size greater in diameter than if composed of a number of tubes; and the risk of explosion is in proportion to its quantity of surface.—Considered his patent boilers calculated for every purpose; they were generally adapted to high-pressure steam; his patent was taken out for a safe boiler for a high-pressure engine; indeed, in his own engines, he did not work the steam to that height as was done in what were called the high-pressure engines, as the novelty of his engine was that it worked the steam twice over.—Made his boilers to stand from fourteen to twenty times the pressure he ever made use of, and employed two safety-valves.—Did not think that the wrought-iron boiler would separate into so many pieces as the cast-iron boiler, but had no hesitation in saying, that cast-iron boilers were safer than wrought-iron boilers.—Could make a cast-iron boiler stronger and more to be depended on for great pressure than wrought-iron; but where great pres-

sure was not wanted, wrought-iron could be made sufficiently strong to depend on; and was of opinion, that as great a number of accidents had happened from the bursting of wrought-iron boilers as from cast ones.

MR. ANDREW VIVIAN, Miner and Engineer, of Cambourne, in Cornwall, called in and examined.

Considered that the danger attendant on working steam engines arose from making the steam-vessel of insufficient strength for the steam; every engineer ought to be well acquainted with the power of the steam, and make the steam-vessels in proportion to the strength of the steam required.—Recommended the use of not less than two safety-valves on every boiler where a high pressure of steam was required, and that the boilers be made of sufficient strength, and proved before used.—To prove the boiler, it was first necessary to fill it with water, loading the safety-valves with ten or twelve times the weight required for the engine, and then by injecting water into them, so as to lift those valves with ten times the weight required.—Conceived that a boiler so proved, and furnished with safety-valves, properly adjusted to its contents, perfectly safe in working with steam, whether high or low pressure.—Was accustomed to load the engines in the mines under his direction, to about forty pounds an inch; and the valves were then loaded to

about forty-five pounds.—Thinks it very possible to lock up one of the valves, which may be so constructed as not to be liable to accidents from explosion.—Did not see any reason why, in any situation whatever, the use of an engine should be limited to the low pressure, or that which is usually called the condensing engine.—Conceived that cast iron could be made much stronger than wrought iron, with less difficulty; some of the cast-iron boilers being made two inches thick; and to make a wrought-iron boiler equally strong as that, would be very difficult to be accomplished by workmen.—Had known of no accident with high-pressure steam and cast-iron boilers; but had known an accident happen working with Boulton and Watt's low-pressure engine, which was on the 28th of November, 1811, in Wheal Abraham mine; a wrought-iron boiler, working with low-pressure steam, exploded there, and scalded six men, three of whom died of the burns they received in the course of a week afterwards.—Did not recollect any instance in which a wrought-iron boiler exploded, so as that any persons were killed by the fragments.—Did not conceive that water could issue to any great distance from a high-pressure boiler, as it must soon be steam.—Had never known any persons scalded by the steam or the water issuing from a high-pressure boiler; but remembered many instances of persons being scalded from the same cause by a low-pressure engine, only one of which came

directly under his own eye.—Was quite of opinion, that boilers made of wrought iron for high-pressure engines would soon become leaky, and that too without exploding. Knew an instance of a boiler of that description made, which became leaky and unfit for use in a very short time; the consequence of which was, the working of the mine was stopped, and a great number of people thrown out of employ.—Supposing the only object to be safety to the lives or limbs of the persons who should be surrounding the engine, would, in that case, prefer having the boiler of a high-pressure engine of cast iron, because it could certainly be made stronger than wrought iron for the same expense; while he considered the risk was so small as that it scarcely need be taken into the question, because all explosions might be easily prevented by proving the boiler every time it was cleansed, which he thought should be at least every month.—Had found the use of a high-pressure engine of great advantage to the Cornish mines, which could be proved by the monthly reports.—Conceived that every engine ought to have two safety-valves, and one should be locked up to prevent careless engine-men doing mischief, which low-pressure engines are as liable to as high.—Was of opinion that a high-pressure engine did greater duty with the same coals than a low, which could also be proved by the monthly reports.—Being desired to attend the Hon. Committee on the part of the proprietors of

three of the largest mines in Cornwall, the united mines of Crowan, Dolcoath, and Weal Unity, they wished to state their hope, that the Legislature would not interfere to prevent the use of high-pressure engines, either on board boats, or in any other way.

MR. THOMAS LEAN, Inspector of Steam engines, of Crowan, in Cornwall, called in and examined.

Was employed by nearly the whole of the miners in Cornwall to inspect their engines, and make monthly reports of the work they performed.—Conceived there was no danger whatever in the use of high-pressure steam engines; and for this reason, that, in general, for an engine intended to be worked with high steam, the materials were made stronger in proportion than the materials used for steam of low-pressure.—Considered it of importance that every boiler should have two safety-valves, one of which should be confined from the engine-man.—In a boiler in which great strength was required, would certainly recommend cast iron, and had no doubt but it could be made much stronger than wrought iron, the explosions that had happened in Cornwall having all been in wrought-iron boilers, and from low-pressure steam.—In every boiler that was built, there was one part of it weaker than another, and it was hardly possible for a boiler to be thrown about in fragments to do mischief. Should not feel any hesitation to sit on the cast-iron boilers in Corn-

wall when an explosion took place, being convinced the explosion would take place at the under part.—Was in the habit of working the high-pressure boiler at forty pounds to an inch, while they were proved to three hundred, and that too without injuring the boiler.—Apprehended, that with a boiler so constructed, so proved, and guarded by two safety-valves, there would be no danger whatever in any situation; and was also of opinion, that the high-pressure engines in Cornwall had saved at least two-fifths of the whole consumption of coals in the county; in some instances it had saved three-fifths.

Mr. GEORGE DODD again called in and examined.

Witness wished to offer to the Committee a second safety-valve, which admitted of being locked up so as to be inaccessible to the engineer. This was furnished with a flat bottom, resting upon a flat circular ring; the steam escaping from the sides of the box through apertures, so constructed as that nothing could be introduced to impede its action.

WILLIAM LESTER, Esq. of Lambeth, called in and examined.

Witness attended for the purpose of delivering in the drawing of a valve so constructed, as to prevent the possibility of any person having access to it to prevent its action; it was self-acting entirely from the gravity of a column of water acting upon the valve, which prevented its being

locked by any mode, and it could not adhere because it was not a cone acting in another cone, but a flat surface pressing upon the top of a cylinder; and being enclosed in a box, and the steam getting out at the bottom, no matter could get upon the valve to cause its adhesion.

REPORT.

THE Select Committee appointed to consider of the means of preventing the mischief of Explosion from happening on board Steam-Boats, to the danger or destruction of his Majesty's Subjects on board such Boats; and who were empowered to report their observations and opinion thereupon to the House; together with the Minutes of the Evidence taken before them; have, pursuant to the Order of the House, considered the matters to them referred, and agreed to the following Report:—

YOUR Committee entered on the task assigned them, with a strong feeling of the inexpediency of legislative interference with the management of private concerns or property, farther than the public safety should demand, and more especially with the exertions of that mechanical skill and ingenuity, in which the artists of this country are so pre-eminent, by which the labour of man has been greatly abridged, the manufactures of the country carried to an unrivalled perfection, and its commerce extended over the whole world.

Among these, it is impossible for a moment to overlook the introduction of steam as a most powerful agent, of almost universal application, and of such utility, that but for its assistance, a very large portion of the workmen employed in an extensive mineral district of this kingdom, would be deprived of their subsistence.

A reference to the evidence taken before your Committee, will also shew with what advantage this power has lately been applied, in Great Britain, to propel vessels both of burden and passage; how much more extensively it has been used in America, and of what farther application it is certainly capable, if it may not be said to be even now anticipated in prospect.

Such considerations have rendered your Committee still more averse than when they entered on the inquiry, to propose to the House the adoption of any legislative measure, by which the science and ingenuity of our artists might even appear to be fettered or discouraged.

But they apprehend that a consideration of what is due to public safety, has on several occasions established the principle, that where that safety may be endangered by ignorance, avarice, or inattention, against which individuals are unable, either from the want of knowledge, or of the power to protect themselves, it becomes the duty of Parliament to interpose.

In illustration of this principle, many instances might be given; the enactments, respecting party-

walls in building, the qualification of physicians, pilots, &c. the regulations respecting stage-coaches, &c. seem all to be grounded upon it. And your Committee are of opinion, that its operation may, with at least equal propriety, be extended to the present case, on account of the disastrous consequences likely to ensue from the explosion of the boiler of a steam engine in a passage-vessel, and that the causes by which such accidents have generally been produced, have neither been discoverable by the skill, nor controllable by the power of the passengers, even where they have been open to observation.

Your Committee find it to be the universal opinion of all persons conversant in such subjects, that steam-engines of some construction may be applied with perfect security, even to passage-vessels; and they generally agree, though with some exceptions, that those called high-pressure engines, may be safely used with the precaution of well-constructed boilers, and properly adapted safety-valves; and further, a great majority of opinions lean to boilers of wrought iron or metal, in preference to cast iron.

Your Committee, therefore, in consequence, have come to the following resolutions, which they propose to the consideration of the House :

1. Resolved, That it appears to this Committee, from the evidence of several experienced engineers, examined before them, that the explosion in the steam-packet at Norwich, was caused not

only by the improper construction and materials of the boiler, but the safety-valve connected with it having been overloaded; by which the expansive force of the steam was raised to a degree of pressure, beyond that which the boiler was calculated to sustain.

2. Resolved, That it appears to this Committee, that in the instances of similar explosions, in steam-packets, manufactories, and other works where steam-engines were employed, these accidents were attributable to one or other of the causes above alluded to.

3. Resolved, That it is the opinion of this Committee, that, for the prevention of such accidents in future, the means are simple and easy, and not likely to be attended with any inconveniences to the proprietors of steam-packets, nor with any such additional expense as can either be injurious to the owners, or tend to prevent the increase of such establishments. The means which your Committee would recommend, are comprised in the following regulations:

That all steam-packets carrying passengers for hire, should be registered at the port nearest to the place from or to which they proceed:—That all boilers belonging to the engines by which such vessels shall be worked, should be composed of wrought iron or copper:—That every boiler on board such steam-packet should, previous to the packet being used for the conveyance of passengers, be submitted to the inspection of a skil-

ful engineer, or other person conversant with the subject, who should ascertain, by trial, the strength of such boiler, and should certify his opinion of its sufficient strength, and of the security with which it might be employed to the extent proposed:—That every such boiler should be provided with two sufficient safety-valves, one of which should be inaccessible to the engineer, and the other accessible both to him and to the persons on board the packet:—That the inspector shall examine such safety-valves, and shall certify what is the pressure at which such safety-valves shall open, which pressure shall not exceed one-third of that by which the boiler has been proved, nor one-sixth of that which by calculation it shall be reckoned able to sustain:—That a penalty shall be inflicted on any person placing additional weight on either of the safety-valves.

4. Resolved, That the Chairman be directed to move the House, that leave be given to bring in a Bill for enforcing such regulations as may be necessary for the better management of steam-packets, and for the security of his Majesty's subjects who may be passengers therein.