term hysteria, which showed itself in subjective pains at the back of the neck, tenderness of the spine, and frequently of the skin generally. There was no apparent lesion in any important organ, and she appeared to be the possessor of a greatly demoralised nervous system, which was easily overwrought, no matter what amount of moral pluck appeared to be put forth to resist an attack. After wearing the glasses for three years constantly her whole being seemed to change, so great was the relief. All headaches and difficulty in obtaining sleep disappeared, the appetite improved, and she became more companionable at home; but there was evidently, with all this improvement, a disordered state of the nervous system not yet removed; the tenderness of the spine remained more or less, and the health was still subject to variable and unaccountable fluctuations. I made up my mind that though the head pains had been so far cured by the use of glasses, yet the long struggle in pain and toil of educational work had so far damaged the peripheral nerves that some other means of cure must be attempted.

I could multiply instances in which varying degrees of this kind of nervous demoralisation occurred; but generally there is either nerve-resisting power or neurotic recuperation sufficient to enable the individual to recover if the sight be fully corrected. I am perfectly convinced that until the sight had been corrected all such treatment as I have indicated would be useless. If carefully looked into, this appears to me to suggest some very important conclusions in relation to the community at large. I see children driven to do their work although suffering from defective sight, constant headache, and restless nights, which result in great exhaustion of the nervous system, disturbance of the various functions of the body, and a disinclination to innocent and beneficial child-play, all of which is with perfect ease set to right by a correction of the optical defect which causes it. But supposing that a naturally nervous subject grows up under these conditions, the right evolution of some of the nervous system is undoubtedly endowed with morbid action, as well as the formation of the character disturbed. The causes are evident: the consequences, I believe, will be found in some of the neuroses which I have endeavoured thus imperfectly to describe.

There are conditions and pains associated with these *head pains*, and commonly attributed by the patient to disease of the eyes, since the eyes are frequently affected. I refer to the pain in and around, due to carious teeth, and these pains are frequently coincident with other—if I may so call them—ophthalmic neuroses. The existence of apparently quiescent carious lower molars causes invariably a point of pain in the temporal region; but the upper molars, when carious—one or all it may be—cause pain above the outer part of the eyebrow of the same side. Decay of the incisors and canines or bicuspid, mostly quiescent in the mouth, commonly causes pain either in the eye or about the inner side of the orbit above the diseased teeth. The extraction of the offending teeth invariably removes the local pain. These conditions were so frequently referred to diseases of the eye, that it became necessary to localise pains in the head so as to correctly diagnose their origin, and hence reach the cause.

Mr. CARTER gave further details of a case mentioned by Mr. Hewetson, and of other cases in his practice.—Mr. BICKERTON spoke of epileptic attacks as being determined by ametropia and want of convergence, and cured by the use of glasses.¹—Dr. REID asked if those were cases of high degree. He generally supposed that the cases which gave most trouble were those of moderate degree, where the ciliary muscle made an attempt to overcome the ametropia.—Mr. HEWETSON replied that the large majority of cases giving trouble were in those in whom there was a small optical error; in the higher degrees the accommodation “throws up the sponge,” but in the lesser degrees there is a constant attempt at ciliary correction.

¹ Mr. Bickerton, since the reading of this paper, has seen a case of epilepsy occurring in a lady of 30, whose eyes were naturally highly hypermetropic, but have become the subjects of conical cornea. She, of her own accord, avoided reading, etc., as being “sure to bring on an attack.”

UNDER the new Army Bill, to be laid before the Parliaments of Austria-Hungary, medical students will be called upon to serve six months in the ranks, and six years in army hospitals or field ambulances.

MEDICAL MAGISTRATE.—Dr. A. H. Kelly, Parsonstown, late Staff Surgeon R.N., has been appointed to the Commission of the Peace for the King's County.

SAILORS AND THEIR EYESIGHT, INCLUDING COLOUR-BLINDNESS.

Read in the Section of Ophthalmology at the Annual Meeting of the British Medical Association, held in Glasgow, August, 1888.

By T. H. BICKERTON,

Oculist to the Liverpool Royal Infirmary.

IN the discussion following a paper on “Colour-Blindness in the Mercantile Marine,” read last year before this Section at Dublin, Mr. Nettleship made a remark to the effect that, in the absence of proof of accidents having occurred through the defective eyesight of sailors, but little attention would be paid to the subject. He suggested, and his suggestion was endorsed by the *BRITISH MEDICAL JOURNAL*, that evidence should be collected of accidents which have actually happened from mistakes as to the colour of signals, or from other defective eyesight, believing that such evidence would form a real fulcrum on which to work.

Acting on that suggestion, I have during the past year been on the look out for facts which in any way bore upon this point; but the difficulties in the way of obtaining evidence of this nature are great.

In the first place, the question of eyesight can scarcely yet be said to enter into the inquiries held as to the causes of shipping accidents. Secondly, if perchance defective vision has appeared as a possible cause, it has been passed unnoticed by the press; and, finally, it is to the interest of those employing sailors with defective eyesight to be silent about the deficiency in case of accident.

It is not my intention in this paper to discuss the regulations, or rather the want of regulations, which allow colour-blind and defective-sighted men to enter the sea service.

In the *BRITISH MEDICAL JOURNAL* will be found ample proof of the thoroughness with which the general aspect of this subject has been treated, and, should further corroboration be required, it is to be found in the admirable paper, by Dr. Brailey, “On the Tests of Vision best adapted for Service at Sea,” in the “Cantor Lectures on Colour-Blindness,” by Mr. Brudenell Carter; and in a paper “On Colour-Blindness with relation to Railway and Sea Signals,” written by our Vice-President, Dr. Wolfe, as far back as 1879; and if the opinions of these and other experts have had but little or rather no effect upon those who should be responsible for the safety of the sea-travelling public, no additional general statements are likely to be of benefit. While we may regret the state of affairs which require for what is so obviously necessary such proofs as suggested by Mr. Nettleship, we shall, I think, be best furthering our cause by acting on that suggestion. Therefore, my remarks to-day will consist mainly in the relation of cases of accident in which the colour-sense has been called in question; of cases of accident in which the evidence has shown that it should have been called in question; of a case where, although a mistake as to the meaning of a light was made, the good vision and prompt action on the part of an officer was the means of preventing a serious calamity; and of cases of pilots with defective eyesight.

The first case is one known to most, if not to all, present; but in a paper of this description it is convenient to mention it. It is to be found on page 6 of the Annual Report of the Supervising Inspector-General of Steam Vessels to the Secretary of the Treasury, dated Washington, 1880,¹ and reads as follows: “On the night of July 5th, 1875, there was a collision near Norfolk, Va., between the steam tug *Lumberman* and the steamship *Isaac Bell*, the former vessel bound to, and the latter from, Norfolk. The accident occurred at about 9 P.M. on an ordinarily clear night, under circumstances which until recently seemed more or less mysterious. The master of the steamer and all his officers made oath that at the time signals were made to the tug, the latter was from one to two points on the steamer's starboard bow, and consequently the steamer's green light only was visible to the approaching vessel. Yet the master of the tug, whose statement was unsupported by any other testimony, asserted that the steamer's red light was exhibited, and he signalled accordingly. The discrepancy in the statements was so great, that many persons uncharitably charged the master of the tug with being intoxicated, although no evidence was ever offered in support of the charge. By this accident, ten persons lost their lives. Upon a visual examination of this officer under the rules during the past summer,

¹ For this information I have to thank Dr. Joy Jeffries, of Boston.

namely, four years after the accident happened, and during which time there had been no question as to his sight, by the surgeon of the Marine Hospital at Norfolk, he was found to be colour-blind, two examinations having been accorded him, with an interval of ten days between them."

Fig. 1.—A, actual position of steamship, *Isaac Bell*. C, its green light, which was taken for a red one. B, supposed position of *Isaac Bell*. D, original position of the tug, *Lumberman*. E, the course the tug-master took in order to pass astern, as he supposed, of the steamer, and thus directly causing the collision.

The second case I have come across will be found mentioned in the *Shipping and Mercantile Gazette and Lloyd's List*, dated June 29th, 1881. The paragraph runs thus: "Colour-Blindness, New York, June 18th.—The pilot of the steamer *City of Austria*, which was lost in the harbour of Fernandina, Florida, last April, is proved to be colour-blind. In this way it would appear he mistook the buoys, and his mistake cost the owners 200,000 dollars (£40,000). An examination showed that, at a distance of more than six feet, he could not distinguish one colour from another. The physicians attribute the defect to an excessive use of tobacco. The services of the Marine Hospital surgeons were tendered to the local authorities without fee two years ago, but were declined."

These are the only two cases I know of where colour-blindness has been positively asserted as the cause of accident. In the following case the steamer *Toronto* on the night of January 18th, 1888, ran down the Norwegian barque *Freidis* in the Irish Channel, on which occasion thirteen lives were lost. The evidence given at the Board of Trade inquiry as to the lights seen may be briefly summed up as follows. The captain, the mate, and the quartermaster saw first a red light and then a green one. The look-out man saw no red light, only the green light. Asked if he was colour-blind, he replied that he was not, and that he had never made a mistake in reporting the colour of a light; and, in answer to the question as to what in his opinion was the cause of the collision, he had no hesitation in stating that it was owing to his own captain porting his helm. In a letter published and commented upon in the leading Liverpool shipping paper, the *Journal of Commerce*, referring to this case, it is remarked that "the negative evidence of the look-out man that he did not see the red light cannot weigh against the positive evidence of the captain, two officers, and the quartermaster that they did see it, and it has yet to be ascertained why it was not seen by him." In this remark we shall undoubtedly agree; for, although there is no evidence that he was colour-blind, neither is there any evidence that he was not. Common sense would say, "Have the man tested;" but the wisacres who adjudicate these matters do not consider such matter-of-fact methods necessary, and prefer to ask the question: Did anyone ever know a sailor who acknowledged

himself colour-blind? This case is also of more than usual interest from a statement made by the captain of the *Toronto* in giving his evidence—namely, that "they only had one look-out on the steamer, because they always had two officers on the bridge, who invariably saw a light sooner than the look-out." The importance of this remark cannot be overrated; and when we find that it is the opinion of a man who for nineteen years has held the position of captain, and who has, in addition, never before had a casualty, its importance becomes the greater. Is this opinion a solitary one; or should we, if inquiry could be made, find it a general one? Are we to consider that the post of "look-out" is a superfluous one? For that is what this captain's statement practically amounts to. If there are any who think thus, I would advise them carefully to read a speech made by Lord (then Mr.) Brassey in the House of Commons in 1876, for in that speech occurs the following sentence: "That the entire management and manœuvring of a ship by the officers in command might depend on the experience and judgment of the men on the look-out aloft; and, if they were not efficient, the gravest consequences might ensue."

Personally, I am thoroughly convinced that in very many cases this captain's statement is literally true, and there can be none who have had practical acquaintance with sailors who could not call to mind cases of men who, from colour-blindness or defective sight, were utterly unfitted for the responsible position of "look-out" in which they are placed, for it must not be forgotten that not only may a colour-blind or defective-sighted sailor fail to recognise danger when present, but that he actually constitutes an element of danger to the very vessel to which he is intended to be a safeguard.

It must also be borne in mind that in the verdicts given by the Board of Trade Court of Inquiry into the causes of accident, equal, if not more, credence is given to the evidence of the irresponsible "look-outs" than to that of the responsible officers.

In the *Mercantile Marine Service Association Reporter*, vol. xiii, No. CL, page 11, in an article entitled "South American Notes," is to be found the following: "The port (Ceará), such as it is, is situated behind the submerged reef already mentioned, and the channel to get to the anchorage is rather difficult. The pilots, however, are the very best of their kind to be found anywhere, as they can perform their functions—which, as you know, in general require the best possible eyesight—without any sight at all. Captain Lecky, the talented author of *Wrinkles*, mentions he was himself taught a wrinkle in piloting at this place. He knew the way in perfectly well, having been there several times, but took a pilot, as the custom is, all vessels being charged pilotage, whether availing themselves of the services of pilot or not. On the particular occasion in question, while entering, he was struck by the fact that the pilot brought a small mulatto boy with him, and, on observing that the courses steered seemed very erratic and likely to endanger his ship, he inquired further into the matter, and discovered that the pilot was quite blind, and was being prompted by this little boy. Talk of the blind leading the blind and both falling into a ditch; that is nothing to the destruction which may be wrought by a blind pilot."

The statement just quoted would appear almost incredible; but should proof be required of the probability of its correctness, the following incident personally related to me by Captain Henry F. Watt, of Liverpool, will be sufficient corroboration. I give it to you in the same words in which it was given to me, and to which statement Captain Watt kindly affixed his signature.

"The pilot came aboard at Patras at 8 p.m. to conduct my steamer, *Charles Morand*, to Vostitza. I took her clear of the shipping in harbour, and then handed her over to the charge of the pilot. For the first hour a labourer was on the bridge assisting the pilot to make out the lights, but, getting tired, he went below. Finding the pilot was keeping close to the shore, and noticing that he never looked at the compass, I became suspicious of his eyesight, and during the next hour myself hauled the ship off the shore several times. About midnight, the atmosphere being fairly clear, the pilot announced that he had arrived off Vostitza, and could see the light. I could see no light, and stopped to sound, and then hauled in for what the pilot said was the harbour. The ship was just moving when the look-out man sang out that she was within a stone's throw of the beach, and just as I got the telegraph full speed astern, she ran ashore. But for my suspicions she would have gone full speed on to the rocks."

A second case of defective eyesight occurring in a pilot, I also

give in the words in which I took the statement down, but in this case my informant asks me not to mention his name. "Time midnight. My steamer was bound to London with a valuable and perishable cargo, and every hour was therefore of great importance. The Trinity pilot came on board off Dover, and took charge in the usual course. There was a spring flood tide, with a violent gale from the north-west, with rain squalls, but the atmosphere was clear. At the Gull lightship, the pilot, to my great annoyance, slowed down. On arriving at the Tongue light-vessel, the pilot said that he could not see the next light—the Princes Channel lightship—and that the weather and tide made it too risky to enter the river. The North Sand Head, the North Foreland, the Tongue, and the Princes Channel light were perfectly visible to me, but the pilot declined to go on. I then called the mate on to the bridge, and asked him if he could see the Princes Channel light. He immediately answered 'Yes sir,' and at the same time pointed it out. The pilot now proceeded, but anchored off the Chapman, and would not go any further. The ship lost twelve hours in time, and over £100 in money, by this delay, and I am of opinion that had the pilot's eyesight been equal to his duties, this loss would not have occurred."

Fig. 2.—A, Ushant Light, twice white, once red. B, French mail steamer, its red light being mistaken for the light of Ushant. C, advancing steamer, with D the course taken, narrowly escaping a collision.

The captain who related the following case to me, entitled it "*Mauvais quart d'heure* aboard a steamer." I give it to you in his own language. "Position, off Ushant, a north-east gale with very heavy squalls of hail; in the squalls, atmosphere thick; between the squalls, very clear. Bound to Rouen, and standing in on an E. by S. course, to try and make Ushant. Look-out man reported the red revolving light off Ushant, which is twice white and once red. I could not make it out clearly, but there were two officers on the bridge, one of whom had passed Ushant many times recently, and knew the light well. I had not seen Ushant for fifteen years. In the middle of a squall, when night glasses were of no use, the second mate reported that he saw breakers, and I put the helm hard a-starboard, and made the nearest shave of a collision possible to make. It turned out that the light taken for Ushant was the red electric light of what appeared to be a large French mail steamer, and that the breakers were nothing else but the tail water of her screw. Sailors will appreciate the

gravity of this incident better than landsmen." Had the so-called breakers been seen one half minute later than they were, a collision would have been inevitable.

I now come to a case of more than usual interest. It is one which, so far as I am aware, has not been mentioned before in connection with this subject; and if the conclusions which I have formed after a close reading of the evidence commend themselves to you, it will be, I think, unnecessary to seek further for cases of accident due to defective eyesight. I refer to the loss of H.M.S. *Vanguard* in the Irish Channel on September 1st, 1875. The particulars of that disaster are briefly these. Four men-of-war (*Warrior*, *Hector*, *Vanguard*, and *Iron Duke*) weighed anchor at Kingstown Harbour for Cork. Shortly after sailing the vessels ran into a bank of fog. Whilst in this fog the speed of the *Vanguard* was reduced while that of the *Iron Duke* was maintained, and the not unnatural sequel of the one running into the other occurred, seventy minutes sufficing to send upwards of a quarter of a million of money to the bottom. The court-martial on the loss extended over nineteen days; the evidence was minute, and the court came to the conclusion that the loss of the ship was due to six causes, which, however, it is scarcely necessary to mention here. In addition six officers were reprimanded, two of them being dismissed their ship. That four of these causes had practically nothing to do with the disaster will be seen by the fact that the Lords of the Admiralty, in commenting on these six said causes, cut them down to two, namely (a) to the reduction of speed of the *Vanguard*, and (b) to the sheering out of line and quitting station by H.M.S. *Iron Duke*. No one will question the statement that however much the *Iron Duke* had sheered out of line, the collision could not have occurred but for the reduction of speed on the part of the *Vanguard*. But the slowing of the *Vanguard* was not the initial cause of the accident; it was in itself but the effect of a cause, and we must inquire what it was that led to the slowing, for in that lies the real cause of the disaster. On that point the evidence is very definite; we find that the slowing of the vessel was a direct consequence of a report by a "look-out" man that a ship was crossing the bows of the ironclad, and it was to avoid running this ship down that the captain gave the order to slow. And when we find that this "look-out" man had defective vision, that in evidence he stated that his sight was "not good on all occasions," that he had "on two or three occasions been treated for defective eyesight," and that "the sight of his left eye was a good deal stronger than that of his right," when we find that of five look-out men placed equally well for seeing, this man alone saw the ship; and when again we find Mr. Hunt, First Lord of the Admiralty, stating from his seat in Parliament that "indeed the vessel seemed to be the veritable phantom ship," and again that "from the evidence there could be no such ship," are we not justified in coming to the opinion that the ship ahead was indeed but a phantom of this "look-out" man's disordered vision, and that in his defective vision lay the true cause of the accident?

I fail to see how a case better proving the correctness of our contention, that defective eyesight in sailors is sufficient to, and frequently does, lead to accident, could be found. And, if further corroboration of this case is required, it may be found in the quotation from the Parliamentary report of a speech delivered on this disaster by Lord Brassey, which reads as follows: "Was it not unsatisfactory that the men who were placed in the most responsible positions, such as look-out men and signal men, were only ordinary seamen? An ordinary seaman was stationed as look-out man at the top masthead of the *Vanguard*, who had been only eight months in a sea-going ship. The entire management and manœuvring of a ship by the officers in command might depend on the experience and judgment of the men on the look-out aloft, and if they were not efficient, the gravest consequences might ensue. The seaman placed as look-out on board the *Vanguard* was an ordinary seaman, and it was in consequence of his reporting a ship ahead that the *Vanguard* stopped and the collision followed. It turned out that *this seaman had been twice treated for blindness in the right eye, which was the organ directed to the supposed ship*" (the italics are my own).

It is scarcely necessary to add that this deficiency of vision on the part of the look-out man was much too trivial a condition to be taken into consideration either by those who formed the court or by the Lords of the Admiralty. It was sufficient and necessary for them to find a cause, and I can quite understand their being influenced by some such feeling as that six causes ought to be sufficient without troubling to find a seventh, and that in reprim-

manding six officers and dismissing two of them their ship they had done their duty. The official account of the court-martial does not say how they rewarded the defective-sighted look-out man; for all we are aware he is still on the look-out for some more phantom ships, and I have very little doubt but that when found he will do his best to make use of them.

And now I must bring this paper to a close. Were it not that I have no right to encroach further, nor even for so long, on your time, I could relate other cases, each of which has some special feature; but I trust the additional evidence I have brought forward will be deemed sufficient to justify the medical profession in continuing to press the Legislature for precautionary measures. Individual companies are now doing what they can to obviate those preventable dangers arising from defective eyesight or colour-blindness in their sailors; but individual action is not enough, and it is deplorable that the Government of the country has not taken the subject up and settled it once and for all. The means recommended by their Select Committees for the Prevention of Collisions at Sea and for the Prevention of Loss of Life at Sea are and must remain futile, so long as they continue to ignore the very essential of safety—namely, perfect eyesight—on the part of officers and men. Surely it would be wiser to avoid danger than to provide for it.

There has recently sailed from this city of Glasgow a vessel² which may well be considered an ornament and a credit, not only to the men who designed and built her, but also to the nation to which she belongs. We can rest assured that the company to which she has gone will take every care that she is manned by men of good quality, and free from all physical defects such as colour-blindness and defective sight. In their hands she will be safe from all the perils of land, of rock, and of shoal, for she has simply to be kept away from them and she is secure against the worst of weather; but all the vigilance and care on the part of her officers and men cannot prevent her from being run into, if, on the colliding vessel, colour-blind or defective-sighted men hold the command, and that such a possibility should exist is, to my mind, a disgrace.

The subject is not a medical one; it is a national, or rather an international one, and the keen interest manifested by the public, as instanced by the copious correspondence following a suggestion that a possible factor in the cause of the railway disaster at Arlsey Junction was colour-blindness on the part of the engine driver, or by the equally copious correspondence which followed an excellent leading article on colour-blindness in the *Times* of December 6th, 1881, is to my mind sufficient evidence that were the facts (1) that there is no official test whatever as to a sailor's eyesight; (2) that a man may be the subject of any of the various forms of eye disease, may have any degree of blindness, or may be so shortsighted as to be unable to see distinctly more than a few inches in front of his nose, and yet be at perfect liberty to be a sailor, and to become an officer; (3) that although there is a compulsory colour examination—in many cases a most inefficient one—to be passed before a sailor can become an officer, there is no check to a colour-blind man being a sailor, or to his remaining one to his life's end; that were these facts placed fairly before them, public opinion would obtain for the subject of "sailors and their eyesight" that attention which so far the medical profession has demanded in vain.

² City of New York, Inman and International Line.

MEDICAL MAGISTRATES.—In a list of gentlemen appointed Justices of the Peace for Lanarkshire there occur the names of John Henry Beath, C.B., M.D., Hillhouse, Hamilton, and John Forrest, M.D., Calderview, Motherwell.

BEQUESTS.—The bequests of the late John Griffith, of 6, Hanover Terrace, Regent's Park, who died on September 21st, aged 91, include £4,000 to the London Hospital; £4,000 to Guy's Hospital; £4,000 to the Middlesex Hospital; and £4,000 to St. Mary's Hospital, Paddington.—Those of the late Mr. William Adam, of No. 3, Tenterden Street, Hanover Square, who died on July 27th at Forfar, include £500 each to St. George's Hospital, King's College Hospital, Middlesex Hospital, St. Mary's Hospital (Paddington), and Charing Cross Hospital; £600 to the Hospital for Incurables (Putney); £400 to the Association for the General Welfare of the Blind; £300 each to the Hospital for Epilepsy and Paralysis (Regent's Park), St. Thomas's Hospital, the Hospital for Diseases of the Throat (Golden Square), the Infirmary at Forfar, and the Cancer Hospital (Brompton).

COLOUR-BLINDNESS, WITH DEMONSTRATIONS OF NEW TESTS.

Read in the Section of Ophthalmology at the Annual Meeting of the British Medical Association held in Glasgow, August, 1888.

By KARL GROSSMANN, M.D.,

Ophthalmic Surgeon to the Stanley Hospital, Liverpool.

To employ people in positions for which they are, for some reason or other, unfit, is not a wise action; but when such a post on which the welfare of life and property depends is entrusted to anyone completely incompetent, such a proceeding is unjustifiable, not to say reckless. To urge before you the great dangers arising from the employment of colour-blind individuals as railway servants and seamen would be quite superfluous, as no one here could possibly be of a different opinion. Any contribution, however, which will show to the laity at large that we are not mere "theorists," and that our grievances are well founded, will deserve the thanks of everyone, and all the more so if such practical *demonstratio ad oculos* acts at the same time as an easy means of detecting colour-blindness—a means which can be applied by anybody without special knowledge or assistance. I believe it is principally due to a want in this direction that the practical points in reference to colour-blindness have not yet been generally acknowledged.

But before demonstrating to you an apparatus constructed with special view to the points mentioned, I beg leave to make a few theoretical remarks on colour-blindness. I am not going to give you either a long history of the first observations on colour-blindness, from John Dalton onwards, nor do I intend to tire you by exposing at length the different theories on colour-perception. These are elementary points known to every medical student. For the sake of simplicity, I shall confine my remarks to-day to that kind of colour-blindness which is by far the most frequent, namely, red-green-blindness.

A colour-blind person may be defined as one who mistakes as alike, or nearly so, certain colours which appear quite different to the normal eye. Holmgren, modifying Seebeck's tests with coloured papers, uses a bundle of about 150 different coloured skeins of worsted, out of which all those similar to a given one have to be selected. It is clear that if the selection be large enough, a certain colour may be matched as identical with the test specimen. Stilling combined two such colours to form a pattern of the one on a ground of the other. By this way, a colour-blind eye will see a single colour only. Stilling had thus plates printed; and although he succeeded finally in overcoming the great technical difficulties in the reproduction, still his plates were not perfect, and failed often, and this principally from a theoretical mistake, for which I think I have found out the reason. I return to this point in a moment.

For convenience sake, I want to introduce here a new word: I will call "twin-colours" a pair of different fundamental colours¹ (both simple and in combinations) which appear identical to the colour-blind eye. It requires long and often repeated working with very intelligent patients, and the harvest is not over rich; still it gives us a fair insight into the way colours appear to them.

To mix pigments is the way Stilling pursued; and although this is in one sense the easiest mode, it has the disadvantage of producing subdued tints only. For brilliant colours I resorted again to aniline-dyed wools. The way I finally adopted for comparing colours easily is shown by this tail of wools (exhibited). It contains 102 colours, each arranged so that it is shaded gradually from dark to light, from knot to knot being of one shade. There are altogether 1,744 different tints. The mode of comparing colours here is extremely convenient, the only thing required is to pick out two colours which seem very nearly the same, and then to run the one tint along the shades of the other. On this plate which I pass round you will find a good collection of such twin-colours. In order to verify their apparent identity, I resorted to the mode adopted by Cohn, and embroidered letters of the different wools. Of the specimens I show here, let me draw your attention to some of the yellows and greens, which are particularly valuable, as I shall explain presently.

In searching through the colours, I found that to some pairs a third fundamental colour could be added, thus completing the

¹ Fundamental colours: yellow, blue, red, green.