scious of our own movement) that they were narrower in the former case and broader in the latter than they really are. Apply this reasoning to sound waves, and it will be seen that if we are approaching a source of sound the sound waves should seem narrower, that is, the tone higher, while if we are receding from the source of sound the sound waves should seem broader or the tone deeper.

Experiment has shown this to be so, the change of tone being found to correspond precisely with that shown by calculation to be due to the measured rate of motion toward or from the source of sound. A rough observation of the change of tone can often be made during railway traveling, especially in America, where, besides steam whistles, bells are used. For it will be found that the tone of the whistle or bell of a passing engine lowers markedly at the moment when in passing the whistle or bell ceases to approach and begins to recede.

Now as light travels in a series of waves, it is manifest that the same law must apply to light as to sound. If we are approaching a source of light of one definite tint, the light waves will be shortened and therefore the tint changed in the direction from red toward violet in the spectrum. If we are receding from such a source of light, there would be a similar change, but in the opposite direction, that is, from whatever the tint might be to a tint somewhat nearer the red end of the spectrum. All that would be necessary in such a case would be that the velocity of approach or recession should be comparable with the velocity of light, or 186,000 miles per second.

Doppler's idea was that movements of recession or approach among the stars might be indicated in this way, the stars of ruddier tints being those which were receding from us, and those of bluer tints being those which were approaching. He overlooked the circumstance that the stars do not shine with definite tints, but with white light, that is, with all the colors of the rainbow combined. It would be impossible to judge by the sound wave test of the approach or recession of something moving with noisy clatter, as to determine by the color test whether a star is approaching or receding. But if among the sounds producing a noisy clatter were only one whose tone was distinct and known we might, despite the noise, determine the question of approach or recession. So if we can select even among the multitudinous tints forming the light of a star a single tint which we know, that tint will tell us of the star's approach or recession, if only the rate of such motion is great enough to cause measurable displacement of the known tint toward either the red or the violet end of the spectrum.

Now in the spectrum of Sirius, as already mentioned, the lines of hydrogen are very strong; they are quite unmistakable also *as* the lines of hydrogen, so that the astronomer can compare any given line of hydrogen—say the one in the red part of the spectrum—with the corresponding line of hydrogen as given by the glowing gas in one of his tubes.

The comparison so made by Dr. W. Huggins, the most skillful of our English spectroscopists, showed that Sirius was receding from the earth at the rate of more than twenty miles an hour. Later observations at our chief national observatory confirmed his results.

So far only what was originally likely enough had been recognized. The observation, like others applied to the stars, showed a more rapid rate of motion among the stars than many astronomers had supposed to exist. In particular the theory of M. Otto Struve that stellar motions average between three and four miles per second was roughly shaken. But I had already shown from other considerations that Otto Struve was probably mistaken.

But of late years the evidence obtained at Greenwich has tended to show that the motion of Sirius is diminishing. And now it is found that the motion of recession has become so slow that we may expect it presently to change into a motion of approach—which may probably increase, reach its maximum, then diminish, change into a motion of recession, and so forth, as though Sirius were traveling in a mighty orbit with movements alternately carrying him toward and from our sun.

Now Peters and Auwers long since showed that the thwart motion of Sirius (that is, the star's apparent motion on the vault of heaven) is affected by a peculiarity indicating orbital motion. Mr. Alvan Clark, the celebrated optician of Cambridge, Mass., discovered a companion of Sirius which has been regarded as probably the cause of the motion of Sirius—*not* the center round which Sirius is traveling, but the cause of the motion of Sirius around the point which is their common center of gravity. The orbit estimated from either star as a center has a diameter not less than 100 times greater than the orbit of the earth round the sun, yet (so great is the combined mass of the two stars) the period of circuit is less than half a century.

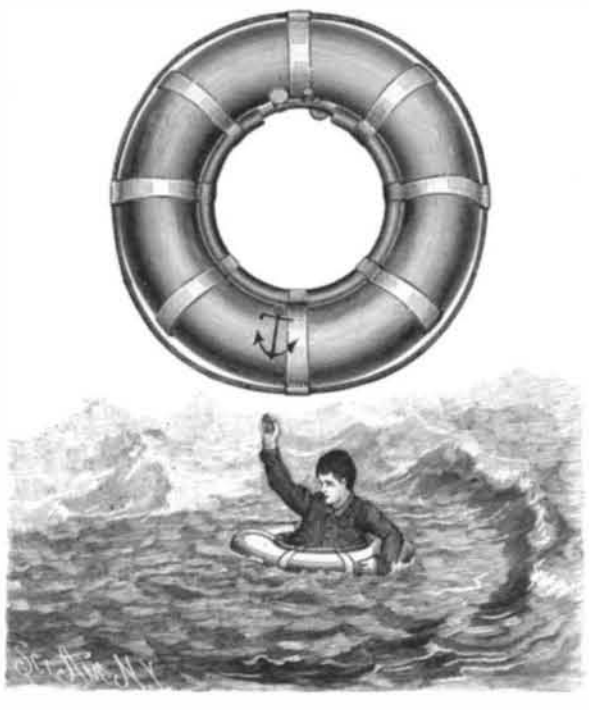
Supposing the mass of Sirius to be ten times greater than the mass of the faint companion, the orbit of Sirius around the common center of gravity would have a diameter certainly not less than nine times that of the earth's orbit, and the average velocity of Sirius in that orbit would be not less than a fifth of the earth's velocity in her orbit, while when nearing perihelion a much greater velocity than this might be attained. Supposing that a portion of the velocity which is in the direction toward and from us to be about ten miles per second, and the system to be traveling at about the same rate from the sun, the apparent velocities in the direction of the line of sight would range from rest to a rate of recession of about twenty miles per second.

Whatever be the actual movements of Sirius, orbital or otherwise, it is clear that the new method of measuring motion is capable of giving us such information about these movements as cannot but help us notably in the determination of their true character. The same method applied to Procyon and other leading stars will probably do more to enable science to interpret the constitution of the stellar heavens than any method devised since astronomy became a science.—*Knowledge.*

AUTOMATIC WAVE LUBRICATING LIFE BUOY.

The life buoy herewith illustrated consists of a seamless brass reservoir running entirely around the inside. The oil is filled in through a hole in the top, which is then covered by a cap which screws on. On each side of the upper part of the oil tube is placed a rose—similar to those placed upon sprinkling cans—so that when the life buoy is hung upon the vessel's stern no oil can escape; but the moment it is placed horizontally the liquid begins to escape and covers the sea with a thin film of oil, spreading out rapidly on every side until a large circle is formed, within which the person who has fallen overboard may rest until rescued by the boats.

This buoy is the invention of Mr. G. Foster Howell, and



HOWELL'S AUTOMATIC WAVE LUBRICATING LIFE BUOY.

is manufactured by Mr. D. Kahnweiler, of 146 Worth Street, New York city, of whom further particulars may be obtained.

Harnesses for Fire Engine Horses.

A trial lately took place in the U. S. Circuit Court, Northern District of New York, in which the presiding judge gives in his decision several very interesting particulars. It was the action of Worswick Manufacturing Company *et al. v.* City of Buffalo *et al.* Judge Coxe's decision is as follows:

The complainants are the owners of Letters Patent No. 171,190, granted December 14, 1875, to Edward O. Sullivan, for improvements in harness for fire engines. The patent relates not only to the construction of the harness, but also to the manner of suspending it above the horse. The object of the invention is to enable the horses to be kept unharnessed until the moment of the alarm, and then to attach them to the engine with great expedition. One man is thus enabled to do the work of three under the old system. The harness is made in sections, is permanently fastened to the neap or thills, and suspended from the ceiling by means of straps and spring catches, so that it may be dropped upon the horses and quickly secured.

Before the use of this apparatus, horses were kept continually in harness night and day. The result was that they were irritated and galled, and the harness was injured and soon destroyed by the constant rubbing which this irritation occasioned.

There can be no doubt regarding the utility of the invention. Its advantages may be summarized as follows: relief to the horses, expedition in reaching the fire, durability and reliability of the harness, economy in the employment of firemen and harness makers. And when it is remembered that promptness in arriving at a fire has often prevented a great conflagration, the indirect benefits can hardly be estimated.

The claim in controversy is the third. It is in these words:

3. The combination, with a harness for a fire engine or like apparatus, of a device for suspending said harness above the place occupied by the horse when attached to the apparatus, substantially as and for the purpose set forth.

The defenses interposed are, first, the claim is void for the reason that there is an attempt to patent a mere abstraction—the idea of suspending a harness from the ceiling in a particular place; second, the defendants do not infringe if the claim is confined to the particular mechanism described in the specification; third, the patentee was not the original inventor.

So far as the records of the Patent Office show, Sullivan was the first to enter this field of invention. No other patent, American or foreign, is introduced to anticipate or limit the claim referred to. It should, therefore, be construed, broadly, to cover any similar apparatus which suspends a harness in substantially the same manner. The details of construction both in the harness and the suspending apparatus are non-essentials, inferior, and subordinate to the principle embodied in the patent, which is the paramount and superior consideration. The man who first conceived the idea of suspending the harness above the horse and put it into successful and practical operation is the one who conferred the benefit, and is entitled to the reward. It would be an exceedingly illiberal and narrow construction to hold that he should be deprived of the fruits of his ingenuity by one who simply changed the form of the harness or of the device by which it is suspended. No principle is better settled than that a mere abstract idea is not the subject of a patent, but that principle has little application here for the reason that the inventor has put his idea into tangible shape and given it form and substance. For years the problem was how to get the engine to the scene of the fire in the shortest possible time. By a combination of old devices Sullivan has reduced time to the minimum, and accomplished a confessedly beneficial result. It is not an abstraction he seeks to secure, but the apparatus by which the idea is carried out. With the claim thus construed, and in view of the state of the art, very little need be said upon the question of infringement.

The defendants have adopted an analogous combination. The harness and hoisting apparatus used by them are substantially the same as those described in the patent. They have quite likely introduced some improvements; they have employed the well known mechanical equivalent of a pulley and weight for a coiled spring; they suspend the whole harness and attach no part of it to the pole, and there are minor points of difference between the two mechanisms; but in all essential particulars they are alike.

The main effort on the part of the defendants has been to show that Sullivan was not the original inventor. Here the burden is upon them to satisfy the court beyond a reasonable doubt. A mere preponderance of evidence is not enough. The proof must be of such a convincing character that the court can say without hesitancy that the allegations of the answer in that behalf are true. Has such proof been offered? It is thought not.

A fair conclusion to draw from the evidence is that the defendants have succeeded only in casting doubt upon the title of the patentee. Instead of capturing the citadel, they have simply made a breach. True it is that before the patent vague conceptions of the invention had entered other minds; true it is that others had approximated more or less closely to the successful realization. No one had quite reached the goal. The evidence shows that in one instance, while the horse was standing harnessed in the stall, the collar was, by means of a cord, pulley, and weight, raised on his neck to prevent chafing, heat, and irritation. In another case a single harness, without collar and hames, was attached to the thills of a light fire wagon. The harness and thills were elevated to the ceiling by a rope, pulley, and weight. A similar method was at another time applied to the harness of hose carts, excepting that the collar and hames were left on the horse.

There was also evidence tending to show that in 1872, at Louisville, the harness of a hose cart was suspended by a rope and pulley from the ceiling, and that the collar was hinged and was fastened by a snap or spring lock at the bottom. No witness was called who recollected seeing a harness for fire engines suspended prior to the date of the patent. But, if not discredited, the evidence relating to the Louisville apparatus would certainly have the effect of restricting the claim within exceedingly narrow limits. The complainants have, however, succeeded in showing that there may well be a mistake both as to the time when and the manner in which the harness was suspended at Louisville. The chief and assistant chief of the fire department of that city during the year 1872 never saw or heard of the apparatus described by the defendant's witnesses. The chief next in succession, who previous to his elevation to that office had been in and about the engine houses for twenty years, gave like evidence. A member of the Cleveland fire department, who came to Louisville in 1879 for the purpose of explaining and introducing the Sullivan apparatus, testified that he visited the different engine houses, but saw nothing at all resembling a swinging harness. The Louisville firemen were surprised and pleased with the invention, and it was immediately adopted by them. It must, therefore, be said within the rule heretofore adverted to that the defendants have not succeeded in establishing their defense.

Decree given for an injunction and an account, with costs.

Protecting Steel and Iron from Rust.

Professor Calvert has recently made the interesting discovery by practical tests, that the carbonates of potash and soda possess the same property of protecting iron and steel from rust as do those alkalies in a caustic state. Thus it is found that, if an iron blade be immersed in a solution of either of the above carbonates, it exercises so protective an action that that portion of the iron which is exposed to the influence of the damp atmospheric air does not oxidize, even after so extended a period as two years. Similar results, it appears, have also been obtained with sea water, on adding to the same the carbonates of potash and soda in suitable proportion.