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WAVES AND RAYS.*

BY PAUL SPIES.

It has long been regarded as the ultimate problem of physical science, to bring the manifold phenomena of nature within the reach of the mind, by reducing them to a set of fundamental phenomena of great universality. The causes of such fundamental phenomena it is usual to call forces—gravitation or the attraction and repulsion of electrical particles may serve as examples; and hence we might conceive the business of physics to be the reduction of phenomena to a series of fundamental forces. But one easily perceives that such a manner of comprehension would be little satisfying to us, and certainly much less so, the greater the number of forces might be with which we should have to conceive matter as mysteriously endowed. It must of course be known to you that for this reason modern natural science has striven to represent a single phenomenon of great comprehensibility and simplicity as the ultimate cause for all occurrences in nature—namely *motion*, whether this motion take place in large masses or in the smallest particles of bodies, the molecules, or finally, in the particles of that subtile substance that fills up the whole world, the ether.

The results which physical science has attained in this effort rest, as is probably not unknown to you, upon the consideration of a particular kind of motion which we usually call wave-motion or vibration.

Now that I have undertaken, on the basis of this general aim of natural science, to consider the more special question of the departments of physics in which this kind of motion plays a part, allow me to begin at once with that simple natural occurrence which has given its name to the phenomenon with which we are here concerned. You have all observed waves of water as they occur when the equilibrium of plane water surfaces is disturbed. And you have doubtless noticed two peculiarities of such a motion,—namely, first, that the movement spreads gradually farther and farther and secondly that at the same time the individual particles of water move but little from the place at which they originally lay; that on the contrary the particles of water execute almost exclusively an upward and downward vibratory motion whilst they accomplish the propagation; that, in other words at any definite place a periodically changing condition of things is presented. We can easily imitate this phenomenon by an experiment, which will lead us a step further.

You see here a stretched rubber cord or rope.

Fig. 1.

If I produce a disturbance of equilibrium near one of the extremities by striking the cord, you will observe first the propagation along the cord of the deformation I have produced, and secondly you will perceive it is impossible that any particle should move away from the position it had when at rest. And now you will observe a further phenomenon. The disturbance of the equilibrium is not destroyed when it reaches the extremity which is fixed, but on the contrary is reversed and transmitted back to me. We have here the reflection of a wave before us, a phenomenon which you can also observe in connection with water-waves and to which I shall again recur. I will now take the free end of the cord in my hand and send out along it a succession of shocks, so that the reflected disturbances are constantly met by new ones. You see what the result is. The whole cord vibrates up and down. You perceive no transmission of the rope-wave. On the contrary, a *stationary* vibration, a stationary wave is produced, generated by the coincident effects of the waves reflected from the one side and the fresh ones sent out by me from this. Now it is easy to make the reflected wave meet a fresh one twice in its backward course; to do so I have only to move my hand twice as fast. I thus produce a division of the cord into two parts. You see that an upward vibration of the one part is accompanied by a downward vibration of the other, and *vice versa;* the middle remains almost totally at rest. Again, increasing still more the rapidity of the motion, the cord vibrates in three and now finally in four parts, so that we have two and then three points which remain at rest.

Coming now to the clear establishment of some ideas on the subject, we have in addition to the desig-

* Translated from *Himmel und Erde*.

nations wave-crest and wave-trough, the meaning of which in reference to waves of water explains itself, the notion of ray. By ray we understand simply the direction in which the motion is propagated. In our case this was fixed by the direction of the cord. Water-waves are in the simplest case circular, the propagation taking place in all directions over the surface of the water. The rays, if we should here speak of such, would in this case be disposed like the spokes of a wheel. In both cases the direction in which the vibrations take place is perpendicular to the direction of the transmission: and we have transversal vibrations, transversal waves. By a wave-length we understand generally the length between crest and crest or trough and trough twice taken, so that in the case above given, when the cord was vibrating in two parts, the length of the cord represented a wave-length.

The points which remain at rest are called nodes, the parts lying between, the parts most violently agitated, are called the loops. The measurement of wave-lengths, which here indeed would have been very simple, is universally effected by determining the distance apart of two successive nodes, or what is the same thing of two successive loops ; this distance is equal to half a wave-length. We shall have occasion to make use of this further on.

I have, however, first to present to you another kind of wave. You see here a wave-machine whose principal component part is a spiral spring two metres long suspended by threads (Fig. 2). In order

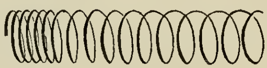

Fig. 2.

that the movements of this spring may be clearly visible there is fixed at every turn of the spiral a polished metal ball on which I will cause to fall a ray of light from the electric lamp. If I strike one of the extremities with my flattened hand I press the turns of the spiral closer together; I produce an accumulation, a condensation. When the turns of the spring again expand they press against their neighbors, and the disturbance of equilibrium thus effected is further transmitted. Each single ball, however, simply performs a movement to and fro about its position of equilibrium. You observe, that though we perceive here nothing whatever that resembles an undulatory motion, this phenomenon nevertheless in so far accords with the one before considered as to exhibit the two properties of wave-motion which we emphasised as characteristic. The resemblance would be still greater if we should quantitatively examine the condition of the spiral, that is to say if we should determine what gradation the degree of the compression assumed in the different turns of the spring.

We can also produce stationary undulations here. You see that I have set the spiral spring so vibrating, after having fastened one of its extremities by a clamp, that it swings back and forth as a whole. The stationary end forms a node of vibration, the free end, which shows the strongest motion forms a loop of vibration. You will now again notice the spiral vibrating in parts—namely so that a nodal point likewise occurs at one-third of the distance from the free end. The distance of this point from the stationary end corresponds to half a wave-length. Notice that the nodal points remain motionless but exhibit an accumulation and scarcity, condensation and attenuation of turns whilst in the loops the places of greatest movement, the turns constantly maintain the same distance apart. As here the motion of the particles corresponds with the direction of the propagation, this wave is called a longitudinal wave.

Now that we are agreed regarding the most important points in the province of the wave-theory, we may pass on to point out the importance of the ideas we have acquired for the theory of sound. When the air effects the transmission of sound it vibrates in so doing in exactly the same manner as did the spiral spring in the preceding example. I might show to you the condition of the air here involved by means of a large column of air, for example by means of the air in this glass organ-pipe, 220 centimetres long. When I blow a note upon this pipe, I produce in it stationary undulations with nodes and loops of vibration.

If we should introduce a small barometer into the pipe, the barometer, if placed at one of the loops would indicate no change of air-pressure, because although there is rapid motion here, there is little condensation or rarefaction. Nor indeed would it indicate any change at nodes of vibration, for condensation and rarefaction succeed each other very rapidly—in this pipe 300 times in a second—so that the barometer is unable to follow it. With the tube which I here hold in my hand and which leads to the barometer, I have connected a little valve, so that when a condensation takes place the air forces itself in but cannot when a rarefaction takes place find its way out. With this valve we will explore the pipe. You perceive the barometer to which the tube leads now reacts very strongly on the note being sounded : the valve is at a node of vibration. I push it further along. Our barometer now shows no result, the valve is at a loop of vibration. Here we again find a node ; and here, on going further along, we again find a loop, so that we have, as you see, explored the condition of the column of air. The air pressure is of course distributed in the manner here found only in the case of the note which I have just produced. For a different note we have a different wave-length, and a different position of the nodes and loops. The barometer, which was not influenced in the last position of the valve, begins to move as soon as I blow a higher note. We are now in a position to measure the wave-length with facility. The distance between two successive loops here—a distance of 55 cm.—gives me as before in the case of the cord-vibration, the half wave-length; so that the complete wave-length amounts to $1\frac{1}{10}$ metres.

I will here point out the important connection between velocity of transmission, number of vibrations and the wave-length. Suppose that I had observed in the case of waves of water in a vessel that they are propagated a distance of 10 metres a second, and I had further observed that at a given fixed point of observation five waves are successively produced during such a time. Plainly then five waves distribute themselves over a space of 10 metres, which would make the length of each individual wave 2 metres. So generally, if we know two of the three quantities, velocity of propagation, number of vibrations, and wave-length, we can find the third. We can, for example, from the wave-length just ascertained, and the number of vibrations before stated, compute the velocity of the propagation of sound by multiplying $1\frac{1}{10}$ by 300. This gives the well-known velocity of 330 metres a second. We shall make use of this principle later on.

If the vibrations excited by a sonorous body strike another elastic body, they throw this second body likewise into vibrations. You know that use is made of this in the phonograph. These motions become especially strong when the body influenced is in condition to make the same number of vibrations as the originally sounding body, when, in other words, it is tuned to the same note. This concurrence of vibration is called resonance. The pair of tuning-forks which you see here will show you this. I will exhibit the phenomenon to you by hanging a little pendulum near one of the tuning-forks. You see the image of the prongs of the tuning-fork and of the pendulum greatly magnified upon this screen. If I rub the other fork with a violin-bow, this one also will give out a sound. You hear it now, and you see how the prong of the fork casts off the pendulum. I will now ask you to suppose for a moment that the gift of hearing had been denied us, but that we knew such an elastic fork, which we should then of course not call a tuning-fork, produced vibrations, and that we wished to ascertain whether these vibrations were capable of effecting an *actio in distans* through air-filled space. In that case we might explore space with a second fork, corresponding to the one first described, and should be able to demonstrate the effect of the note without hearing it. For electric vibrations, of which we shall speak later on, we lack a special sensory-organ of perception, and the propagation of such vibrations has therefore been frequently investigated by means of electrical resonators.

I should like to show you with this pair of tuning-forks still another experiment, one which we execute by producing two wave-systems of different wave-lengths, or what is the same thing, of different numbers of vibrations. I accomplish this by simply encumbering one of the tuning-forks with a little weight. It then vibrates slower than the other. Now I will assume that the one sends out say 100, and the other 99 undulations in a second, so that at a precise moment, say at the beginning of a second, two *condensations* of air coincidently strike your ear. A half-second later, when the first fork has completed exactly 50 and the other $49\frac{1}{2}$ vibrations, a condensation of air again proceeds from the former to the ear, while from the latter a rarefaction reaches it. And not till the end of the second, when the one fork has completed exactly 100 vibrations and the other exactly 99, do they again both influence your ear in the same way. Hence it follows that in the middle of the second the total effect upon your ear is considerably weaker, whilst at the end of every full second the effect will be strongest. The sound will thus rise and fall once in each second. You hear that now. You hear the beats or the tremors, which follow upon one another more quickly, of course, when the difference of the number of vibrations is greater. This phenomenon rests, thus, upon the interaction, or interference, of two wave-systems. Such interferences are, obviously, a characteristic feature of the wave-nature of a phenomenon.

I have already mentioned that the pitch of a sound is deducible from the number of its vibrations. To the lay person this is perhaps the best-known physical fact. You are aware that slow vibrations produce low tones, and that rapid vibrations produce high tones. But not always when we produce regular vibrations do we hear a sound; for that would suppose a distinct capacity of our sense-organs, a capacity which we do not possess as regards too slow and too rapid vibrations. In our room you will find a series of tuning-forks which allow vibrations to be produced up to the number of 50,000 a second. At this, or at least at a somewhat greater number of vibrations, our ear hears nothing. Upon the whole it cannot be said to what extent an increase of the number of vibrations is possible. Vibrations much more rapid than these are not observed in larger masses, as in the prongs of tuning-forks and the like; but they are in the smallest particles of substances, in the molecules; for here since little parts are moved only small distances, rapid vibrations are easily made. These are, as you know, the vibrations of heat and light. The wave-lengths of these vibrations are approximately the size of some few ten-thousandths of a millimetre, the longest being a few thousandths of a mm. in length; so that the smallest organisms which we know of, the bacteria and cocci, are a little smaller than the largest of these waves.

It would lead me too far here, if I should draw from the theory that the phenomena of heat and of light are reducible to vibrations, only the most important conclusions which science has drawn. The choice which I must make applies, in the case of heat-vibrations, to reflection. The important law of reflection is common to water-waves, to sound-waves, and to the type of waves just mentioned. This is the law by which the direction in which a wave-system is reflected from a surface forms with that surface the same angle as the direction does from which the waves proceeded. A body which is thrown against an elastic wall furnishes the best demonstration: for example a ball moving about upon a billiard table. It cannot be difficult, upon the basis of such a law, to construct a surface which will concentrate the rays in a common point. This is done for sound-waves, for example, by the ear-trumpet. You see here a pair of mirrors (Fig. 3) with whose help a similar phenomena may be exhibited. If we generate sound-waves in front of the centre of the mirror standing at the left, they, agreeably to the particular construction of the latter, will be so reflected as to proceed onward in parallel lines. They soon strike the second mirror, 6 metres distant, are there a second time reflected, and finally concentrate themselves at a single point in front of the centre. The two points that thus correspond to each other, and whose position is determined by the construction of the mirrors, are called the foci. We will perform the experiment for heat-rays by placing a glowing-hot ball in one of the foci. An easily inflammable substance, placed in the focus of the second mirror, is ignited as you see at once. If I now really wanted to convince you that the law of the reflection for these heat-rays is the same for sound-rays, I should have to bring a *sound* into the one focus and beg you to step up here singly and be personally convinced whether the sound is clearly concentrated in the other focus. I think you will excuse me from the performance of this experiment.

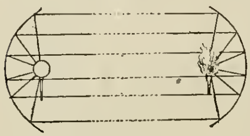

Fig. 3.

Light-rays have the same characteristics as heat-rays, only their undulations are somewhat shorter, and their vibrations follow one another more quickly: we have here, to some extent, higher notes in the tone-scale. But to us human beings they offer a much greater multiplicity and variety than sound, inasmuch as we are, by a wonderful sense-organ, placed in a position to distinguish from one another a whole series of these sounds, namely the various colors.

The assertion that we have before us here actual undulations in the ether, has its mainstay and chief foundation in the fact that a great number of light-phenomena may be shown to be interference-phenomena; and we will now examine a few of these facts, the phenomena, namely, shown by polarised light. What polarised light means is best made clear by means of a rope-wave. Let us suppose that I have caused the rope to vibrate twice in definite time, first upwards and downwards in a vertical plane, and secondly to the right and to the left in a horizontal plane. Obviously, both these wave-systems, notwithstanding the fact that they have equal wave-lengths must exhibit different properties. When they are considered from any one determinate point of view you will see that such modifications of the experiment are only possible with transverse undulations, and not so with the longitudinal vibrations of the spiral spring.

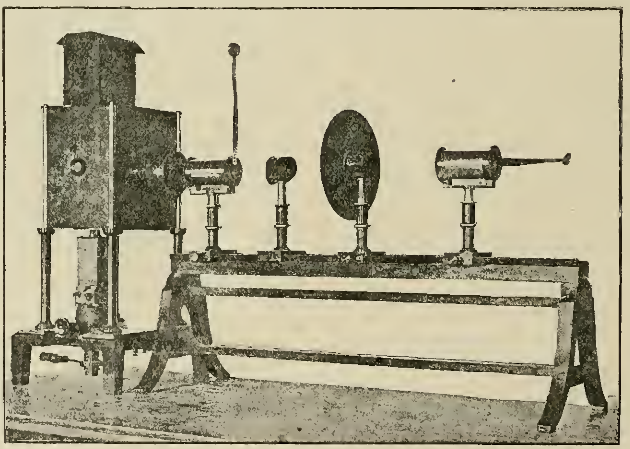

Fig. 4a.

From the lamp there is emitted at this moment a ray of light which produces the luminous circle you see upon the screen. The vibrations which constitute the ray are transversal. But in its present state no one of the planes which you may imagine to pass through the ray, possesses preference over the others. The vibrations take place in all directions that are at right angles to the direction of the ray. Such light-rays are termed *unpolarised* rays. With the help of a special optical apparatus, a so-called *Nicol's prism*, made out of a crystal, I can polarise this ray. (See Fig. 4a.) The undulations now take place wholly in one plane; suppose in that which the pointer fixed to the prism indicates,—that is to say in a vertical plane. Such a prism does not allow undulations in any other plane to pass through it. You see, however, that in the light-phenomenon upon the screen, no change apparently has taken place.

I now introduce a second prism, just like the first. It likewise allows the rays to pass through it, since the direction of the two pointers coincide and the rays that have passed through the first prism strike the second in a favorable position. But if I *turn* the second prism the light gradually becomes fainter and fainter, and now, you will see, it is wholly extinguished: for as is evident from the position of the pointers the planes of undulations are now perpendicular to each other.

I interpose a thin layer of transparent gypsum between the crossed prisms. Light, you see, again appears; but this time it is colored light. This remarkable phenomenon is the effect of a peculiar property possessed by such crystals of doubly-refracting light, or of decomposing a ray of light as it enters it into two separate rays. Each of these two rays, which pursue courses very close to each other, has its own determinate plane of vibration. I have inserted the layer now in such a manner that these two planes of vibration make an oblique angle with the plane of vibration of the first prism; consequently the light polarised by the prism can pass through the layer. But as the planes of vibration of the light after passing through the crystal do not form a right-angle with the plane of the second prism, the latter does not hinder the transmission of the light. This explains why the layer of gypsum in some degree forms a bridge between the crossed prisms. That colors appear here is a consequence of the interference of the two rays produced in the crystal of gypsum.

Just as the union of action in the case of the sound-rays which proceeded from the tuning-forks was shown to be dependent upon the number of vibrations of the respective sounds, so also is this the case with these light-rays. You may form therefore at least some approximate idea of the fact how among all the various systems of undulations contained in the white light of the lamp,—that is, among all the different colored rays,—in some there may be produced by interference an annihilation, and in others a reinforcement. If we give the Nicol's prisms a parallel instead of a crossed position, then in the place of the green this bright red will appear, which is, as you know, the complementary color to green, that is to say, the one which makes it white.

The sort of color that appears also depends very much upon the thickness of the layer of gypsum. As that was the same at all times, the identical crystal being used, our field of view always showed the same color.

But if I concentrate the rays of the light by means of a lens, so that they do not all pass through the crystal at the same angle (as Fig. 4b shows), the feasibility is at once evident of obtaining a variegated colored picture upon the screen. All rays equidistant from the centre ray travel over the same distance in the crystal; for such it is equally thick; and the consequence is that we obtain an image in which the individual colors form concentric rings.

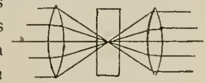

Fig. 4b.

With this, indeed, the phenomenon is by no means completely explained. In particular the statement of the reason why the ring-system (Fig. 5) is broken by a dark cross is lacking. And I do not, moreover, intend to enter into this question. I might show you that there appears here a complementary phenomenon if instead of crossing the Nicol's prisms, we place them parallel. But what I chiefly wish to insist upon is the following: That all these phenomena whose explanation I have here really only indicated can, theoretically, be completely followed out. If a layer of crystal be cut in a definite way and light-rays be permitted to enter it at particular angles, and we set about to determine in what ways the wave systems formed by double-refraction interfere, it is possible to construct a complete idea of the total resultant effect. Experiment always verifies our calculations; indeed there exists a whole series of phenomena, which, like the planet Neptune, were first demonstrated by calculation and afterwards verified by observation. It is plain that these facts bestow a high degree of probability on the wave-theory assumption at the basis of the calculations.

Fig. 5.

The most famous experiment of this kind is perhaps the one due to Faraday, by which this investigator showed for the first time a remarkable relation between light and electricity. He showed that the plane of vibration of light can be turned by an electric current. And I must not omit performing the experiment for you. I place a bit of glass inside a spiral of wire and interpose it between the crossed Nicol's prisms. You see the field of vision remains dark. If we conduct a powerful electric current around the piece of glass by means of the spiral of wire, the glass will receive the remarkable power, exactly as before the layer of gypsum, of making the passage of the light again possible. The field, you see, becomes bright and dark as I close or break the circuit. We have the same effect as in the case of the gypsum, but another cause. I said that the glass acquired the power of turning the plane of vibration ; a more careful investigation of the phenomenon referred to would confirm the statement. That such a turning suffices to allow the passage of the light through the second prism is evident without further elucidation.

This phenomenon was discovered by Faraday, one of the greatest physicists that ever lived, just because he held the opinion that there must exist some connection between the phenomena of light and electricity. And the fact furnishes us, moreover, with a splendid proof that nature loves to throw bridges between the different great departments of her phenomena. That these relations may be followed out much further Faraday surmised and it will become my task, in the second part of my lecture to approach the proposition nearer from this point of view. You will then see that the conception of undulation which we have here taken as our fundamental notion, is able to conduct us a good way further. [TO BE CONCLUDED.]

THE DROSS IS DISCARDED BUT NOTHING IS LOST.

I SAW in a poetic vision the genius of mankind closely bent over his work. I knew it was an allegory and I saw as through a glass darkly, but the allegory had significance.

The genius had before him innumerable glasses and retorts filled with some precious substance. He had some of the vessels on burning coals, others he kept on ice, still others were stored away in an oven. Many of them remained undisturbed as if they contained a liquid that should settle, while others again were being thoroughly shaken.

"What is it that thou hast under thy hands?" I asked.

"I make experiments with the souls of men," said the genius. "I expose them to all kinds of conditions and observe the results."

While thus speaking, the genius poured the contents of two vessels together and set the mixture aside as the beginning of a new life.

"Is that the beginning of a new soul?" I asked.

"No," quoth the genius, "there is no beginning of a new soul. Every soul is a mixture of many souls. Here is the soul of an infant in this almost empty glass. Now I pour into it the contents of other glasses. They are the words of the parents, of the nurse, of brothers and sisters, of all its kin and its friends. When the boy grows, I instil into his mind the teacher's lessons and the ideas which he finds in books, and all that is exposed to certain conditions which make his soul act and react in this or that way, producing original associations of the elements and creating new combinations in his mind. There are precious elements and worthless elements. There is gold, and silver, and clay. These I combine and I separate, I intermingle, and I distil, I blend and I analyse. I discard and I select—and this process goes on and on and on. It began with the appearance of organised life and will continue so long as life continues and men call it evolution."

Looking close I found that all the glasses and retorts were connected by little tubes and their contents were in a constant flux, tending to equalise its substance. Nevertheless this exchange was neither sufficient nor rapid enough to produce even an approximate equality in the different vessels.

"What is an individual soul in this constant flux?" I asked. "Thou art constantly mixing soul with soul! If you succeed in a precious mixture, having distilled it in a special retort, is not all your labor wasted and is not the soul lost when you break the vessel?"

"An individual soul?" the genius replied. "I know not of what thou speakest. I have the soul of mankind before me and not individual souls. An individual soul can mean only the mixture as it appears at a given moment in one of my retorts. But the process of fusion is constant, and whoever attempts to study an individual soul must bear in mind the whole totality of soul-life with which it is connected. What is the individual in this continual change? I take the elements of my compounds from everywhere. Surely there is a vein for the silver and a place for the gold where they find it. Iron is taken out of the earth and brass is molten out of the stone. There is the fining pot for silver, and the furnace for gold. I shall melt the souls of men, and try them, and I shall bray a fool in a mortar among wheat with a pestle that his foolishness may depart from him. There is nothing lost when the dross is thrown away, for the gold and the silver after being separated from the dross will shine brighter than before." P. C.

THE SUNSET CLUB ON CRIMINAL LAW.

BY M. M. TRUMBULL.

THE Sunset Club had a banquet on the 31st of March ; and the supplementary "feast of reason" was a trial of the criminal courts for maladministration of the law. According to the expert testimony offered by the pleaders, the term "criminal" is ironically descriptive, for that evidence makes the courts appear more criminal than the convicts. The Constitution counts for nothing. Wise rules for the protection of the innocent and the conviction of the guilty, are habitually disregarded, and oftentimes reversed. Judicial anarchy animates the proceedings, and throws into moral disorder the intelligent scheme of justice established by ethics and the law.

The debate was opened by Mr. William S. Forrest, a lawyer of large experience and high rank at the bar. He drew an indictment grim and dire against the courts; and he supported it by direct evidence enough to convince anything except that warped and much entangled piece of understanding called a "judicial mind." The argument of Mr. Forrest was well made, and he spoke with boldness and persuasive moral energy. Justice fails because the judges are not learned in the law, because they have not the capacity to understand it, and because when it is brought within their comprehension they have not the moral courage to administer it fairly. Mr. Forrest did not say exactly that, but he said this, "There are wrongs in the administration of criminal law in Cook county, wrongs against the accused, wrongs against the letter and spirit of the Constitution of the State. The rich and powerful are seldom indicted and never tried, well, hardly ever: The criminal court of Cook county exists only to punish the poor. Men are convicted who are innocent. Even in ordinary trials, the forms of law are frequently set aside, and the rules of evidence ignored; the rulings of some of the presiding judges are commonly believed by the bar to be influenced by the press, and popular opinion supersedes the law of the land." If all that is true the vaunted "protection of the law" is abolished by the courts, and the citizens escape imprisonment and fine, as they escape lightning, by good luck.

With a liberality for which the judges ought to thank him, Mr. Forrest graciously conceded that they were only ignorant of the law in its most important qualities, and that in matters of inferior moment they were fairly competent to give judgment. After describing those "who do not understand the first principles of the criminal law," he said, "These same judges give satisfaction in the civil courts, but in the criminal courts they dispose of life and liberty by rulings that shock the moral sense and make justice weep." The praise and the censure do not harmonise well, and Mr. Forrest ought to modify one or the other. It is true that legal knowledge may be deficient in one court, and sufficient in another; but where the judge is morally incompetent in either court, he cannot be trusted at all; he is a failure altogether. The judge, who by reason of moral cowardice will not administer the law according to the very right of it in the criminal courts because public opinion is against the prisoner, will not give judgment fairly in the civil courts, when the wrong side has behind it social influence and political power. What avails it that the judges know something about the law of contracts and the puzzles of a promissory note, if they are ignorant and careless of the laws affecting the very life and liberty of the citizen. Mr. Forrest did not forget that while judicial ignorance occasionally convicted the innocent, it very often acquitted the guilty. And which ever way we may compare the debts and credits the balance is on the side of wrong.

There is an imprecation in the scriptures against the lawyer who "taketh reward against the innocent," and if Mr. Forrest had not forgotten his bible he might have "hurled" it against those prosecuting attorneys who for official reward strive to destroy the innocent, especially by that very dangerous device known as the "special venire." This is a subtle contrivance by which the right of trial by jury is practically taken away from the poor man innocent, and made the deliverance and safety of the rich man guilty. It all depends upon the bailiff, who may pack the jury at his pleasure for the State or for the prisoner, and he generally packs it for the State, because he is a member of the Court House staff, appointed by the sheriff. "If," says Mr. Forrest, "bailiffs do not bring into court men satisfactory to the prosecuting attorney, that officer demands a different class of veniremen, complaint is made to the sheriff by him, the bailiffs are censured and made to feel that they are suspected of being in sympathy with the defense. Now, the bailiffs are each and all active politicians. They are in politics as a business. Their tenure of office is precarious. They must please the State's Attorney in order to hold their positions. The result is that the prosecution controls the bailiffs, and the bailiffs determine who shall be the jurors." To a jury selected in that way the prosecuting attorney appeals for a conviction, and gets it; and also his "reward."

Mr. Elliott, Assistant State's Attorney, tried to counter on Mr. Forrest by saying that "the bailiffs are more likely to be influenced by a criminal lawyer than they are by the State's Attorney," but this, if true, is only an additional argument against the special venire, the very delinquent on trial; nor was Mr. Elliott more fortunate when he said that, "So far as a certain branch of the criminal court is concerned I know that for five years no bailiff has been asked, instructed, or even advised what kind of persons it was desirable should be brought into court." It was plain that Mr. Elliott was speaking for himself alone, for if his disclaimer was intended to apply to his colleagues and his chief, it was refuted by the astonishing statement made by Mr. Forrest that in the Cronin case, "out of 1,116 persons summoned by special venire there were fewer than fifty persons of Irish birth or Irish extraction." Few Roman Catholics were summoned, and these were promptly excluded by the prosecution. "And it seemed to the defense," said Mr. Forrest, "as if every Orangeman and Englishman in town was brought in and presented to them as jurors." This bit of testimony was very strong, and it was a strange coincidence that considering the large number of Irishmen, and the small number of Englishmen in Chicago, the bailiff without being "asked, instructed, or advised" at head quarters, found so many Englishmen and so few Irishmen to sit upon a jury in a case where the defendants were all Irishmen on trial for their lives.

Wrongs, like microbes, multiply wrongs; and in the methods of the bar the bench becomes involved. This was the ominous result of the special venire in the Cronin case. Here we have it in the language of Mr. Forrest. "Defendants counsel day after day, in open court, begged the court to order a drawing from the box. The court refused to make the order. He did however, rule at one time that it seemed to him that the veniremen were all of the same class. Thereupon he ordered the bailiffs to bring in veniremen from the body of the county. That order failed to affect the class of veniremen. Then, as a last resort, he selected a certain bailiff and ordered him personally to bring in daily six workmen out of every twenty-five persons summoned." Here the court in trying to correct the abuse of the special venire made an illegal order. The judge's order to the bailiff amounted to this, "You must not pack the jury *that* way; you must pack it *this* way." It is clear that the court had no more legal right to order the bailiff to summon six men of one kind and nineteen of another, than he had to select six catholics and nineteen protestants, or six tailors and nineteen blacksmiths. The judge meant well enough in prescribing a hair of the dog to cure the bite, on the principle that "like cures like"; but that rule although it may be efficient in therapeutics or in chemistry, is dangerous in the courts of law.

The duty of answering Mr. Forrest had been assigned to Gen. I. N. Stiles, also a lawyer of eminence and great experience but he rather strengthened the main argument of Mr. Forrest, and emphatically said that the special venire system ought to be abolished. He supported the indictment with much additional evidence, and his condemnation of our criminal court practice was contemptuous and severe. He said, "Criminal law is not administered in good faith and with that earnestness and honesty necessary to protect the public interests. Juries are packed in the interest of defendants, and they are packed in the interest of prosecutions. Grand juries are impanelled as often to find no bills as they are to find true bills." This agreement with Mr. Forrest was so important that the points of difference with him became trivial in comparison. These had reference chiefly to the special advantage given to defendants, such as the right to a change of venue, and the "presumption of innocence," which Gen. Stiles regarded as an antiquated and "ridiculous proposition." He did not attempt to excuse the bench and bar for the practices adopted in the prosecution and defense of persons charged with crime. He merely contended that the law was corrupted by both sides; which, indeed was part of the accusation made by Mr. Forrest.

It must have been gratifying to Mr. Forrest, that Mr. William S. Elliott, Assistant State's Attorney, whose Department was on trial before the Sunset club, voluntarily came to the banquet and turned State's evidence against the prosecutors and the judges of the criminal court. With unconscious irony, he said, "The criminal law of this county is administered with a conscientiousness that carries us back to the foot of Calvary." This confession was all that was necessary to complete the triumph of Mr. Forrest, and to establish his case, for the comparison left him nothing more to say. It is the everlasting reproach of the tragedy on Mount Calvary, that the crucified victim did not have a fair trial; and when Mr. Elliott showed the resemblance between the criminal trials in Chicago, and those under Pontius Pilate, he drew a parallel that everybody recognised as true.

BOOK REVIEWS.

The Morals of Christ. By *Austin Bierbower.* Second Edition. Chicago: Charles H. Kerr & Co.

If the author of this work is correct in his opinion, the founder of Christianity had much more system in his moral teachings than he is generally accredited with. Instead of his preaching having reference to the kingdom of God which was at hand, and the repentance necessary to fit man for its citizenship, "every utterance of Jesus bearing on morals was spoken in contemplation of" one or other of the Mosaic, the Pharisaic and the Græco-Roman systems. The object of this essay is to set forth the morality of Christ as a departure from these three representative types of morality, "it being this triple departure, more than anything absolute, on which he puts his chief emphasis, and which, more than anything original, characterised his system." That the teachings of the gospels can be thus arranged is well shown, but the fact has a different significance for us. It proves rather that much of what is ascribed to Jesus belongs to others, and that what is known as Christianity is largely the product of a later age. The title of this work should strictly have been "the Morals of Christianity," but as it is not critical, it must be dealt with in a similar spirit.

From the standpoint of the author, the subject has been well worked out. It is treated in an antithetical style which, although somewhat wearying when carried to excess, will recommend the book to many readers. Such a style is well fitted for pithy remarks, such as, "under the Mosaic morality religion was an effort to reconcile God with man; under that of Christ it has rather been an effort to reconcile man with God;" or "religion was formerly theological; now it is anthropological." The author begins his comparison of Mosaic morality with that of the New Testament by the statement that the former is negative and the latter positive. This was the general character of ancient moral codes, but it would be a mistake to suppose that moral conduct was purely negative. The command "Thou shalt love thy neighbor as thyself," (Lev. v, 18) contains the essence of all active morality, and it has practical application in the direction to leave the gleanings of the harvest for the poor. There is much truth, nevertheless, in the observations that the morals of Christ are a departure, as compared with Mosaic morality, from the objective to the subjective, from the particular to the general, and from conduct to character. These are merely different expressions of the same idea, which is happily stated in the remark that "Christ wished to make morality a means of culture as well as a guarantee of conduct; an agency for the elevation of man as well as for his regulation."

The departure of Christian morality from Græco-Roman morals is dealt with under three heads—from the Interest of the Fortunate to that of the Unfortunate; from the Interest of Self to that of Others; and from Hardness to Kindness. Here as elsewhere the distinctive characteristics of the several systems are well brought out, and we are finally told that the morality of Christ is a protest against being conformed to the state, the church, and the world, respectively represented by the three systems with which it is compared. While Mr. Bierbower's book cannot be described as a great work, it possesses a certain originality in the treatment of its subject which fully justifies the call for a second edition. Ω.

NOTES.

We present to our readers in this number an article that was delivered as a lecture in the Urania of Berlin—an institute founded for the special purpose of spreading a love of nature by popularising natural science. Prof. Paul Spies's address is a very good specimen of the work of the Urania which deserves imitation also in this country, especially in our large western cities. We may mention here that an institution after the model of the Urania has been founded in New York. Spreading a love of nature by increasing among the people a knowledge of nature is very important considering that our whole civilisation rests upon natural science.

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