The most striking results of careless operation were shown, however, in the matter of overheating. In the case of the naturally-ventilated schools the cooperation of both janitors and teachers is required in order to secure good results, and, where so many persons are concerned, it is practically impossible to reach a maximum of efficiency. Such results as that indicated in Fig. III for School 33 could scarcely be attained where window ventilation plays any large part.

In fan-ventilated schools, on the other hand, the whole responsibility rests (or should rest) with the janitor, and either very good or very bad results may be attained, according to his intelligence and responsibility. The continuous records obtained by our recording thermographs brought out the importance of the operating factor with startling clearness, and four of our curves are reproduced herewith to illustrate the variation which occurred (Figs. IV and V).

In order to remedy this condition we urged that a thermograph of some improved type be installed in each school building

FIG. V—AUTOMATIC TEMPERATURE RECORDS IN A BADLY-OPERATED NATURALLY-VENTILATED SCHOOL—PUBLIC SCHOOL NO. 25, MANHATTAN

and that the records obtained be carefully inspected and made the basis for an efficient control of ventilating systems and janitorial service and we recommended that these records be supplemented by periodical studies of temperature and volume of air at the room inlets.

CRITERIA FOR SCHOOL-ROOM AIR

The chief value of these investigations lies perhaps in their possible use as a basis for comparative studies in the schools of other cities, which are greatly needed, if scientific records are to take the place of opinion in the field of school ventilation.

The results obtained in regard to dust and bacteria seem to indicate that, so far as these suspended matters are concerned, the air of the New York schools is in a satisfactory condition, without any special measures of protection, provided we regard the air of New York as good. Personally, I know the air in New York City is better than in some cities, it is also worse than in some other cities. The topographic conditions are an important factor. The general air conditions can and should be improved, for example by more extended washing down of the streets. I have not ceased in my hopes furthermore to see the city wash down its streets at suitable intervals with proper disinfecting solutions.

So far as carbon dioxide is concerned, our results indicate that it is comparatively easy, either with or without the use of fans, to keep the air in a schoolroom so changed that its carbon dioxide will average well under 10 parts per 10,000 and will rarely exceed 12 parts. This test furnishes an excellent measure of air change and under ordinary conditions such an air change is essential in order to remove odors and preserve a freshness agreeable to the senses. Where air is recirculated, however, with washing or chemical treatment to remove odors, the carbon dioxide standard may have to be relaxed still further, although it will always be of value as an index of what is going on in the way of air dilution.

III. A Physiological Study of "Crowd Poison"—In view of the claim of Rosenau and Amoss that specific proteid com-

pounds of human origin can be detected in respired air by the delicate physiological reaction of anaphylaxis, we devoted considerable attention to this point. Dr. D. R. Lucas, who conducted this part of the investigation, was able to demonstrate easily the presence of such specific proteid substances in the saliva under carefully controlled conditions, but was unable to detect them in material condensed from the breath or in air heavily contaminated by the respiration and exhalation of dogs and human beings. We were forced to conclude that "there is at present considerable uncertainty as to the presence of such specific proteid substances in demonstrable amounts in respired air and that there is absolutely no evidence of the presence of any organic substances of a deleterious nature in such air."

Similar experiments carried out simultaneously and independently by Dr. Charles Weisman at Columbia University and published as a Doctor's Dissertation have led to the even more definite conclusion that "the results of these experiments disprove the statements of Rosenau and Amoss that the breath

contains 'volatile' protein and that such 'volatile' protein is an important respiratory factor."

While subsequent investigations may prove it different, at present we may agree, in large part at least, with the conclusion reached by Flügge eight years ago, *viz.*, "Whenever in closed, crowded rooms certain impairment of health ensues, such as headache, dizziness, nausea, etc., these symptoms are to be attributed solely to heat retention."

Overheating seems to be the chief evil to be guarded against in school ventilation at present. Associated with this is regulated humidification.

COLLEGE OF THE CITY OF NEW YORK

THE NEW YORK STATE COMMISSION ON VENTILATION AND ITS PROBLEMS

By C.-E. A. WINSLOW¹

Rudolph Hering has well said, in his recent address as President of the American Public Health Association, that the subject "of supplying suitable air to enclosed spaces, of heating, ventilating and removing foul air, is one which as yet is not sufficiently well understood in detail, and on which there are still opposing opinions. In fact, of all of the branches of sanitary engineering at the present time it needs most investigation and most study." In the last few years, however, a new and encouraging interest has been manifested in the study of ventilation problems. Among the various signs of this awakening none is perhaps more significant than the creation of the New York State Commission on Ventilation to undertake a broad and fundamental study of the physiological and mechanical problems which underlie the art of air conditioning. For the first time, in this country, at least, a sum of money is to be applied toward the solution of these problems which, though small in comparison with the magnitude of the task, is large enough to give

¹ Chairman, New York State Commission on Ventilation.

hope of substantial results. The Hodgkins Fund of the Smithsonian Institution has made possible the publication of a number of individual researches on the relation of the atmosphere to health which have become classics. College and health departments and committees from many societies have made important contributions to the subject. There has not before, however, been any body which could attack the whole problem under such favorable circumstances as can the New York State Commission on Ventilation.

This Commission was made possible by the assignment to its use of the sum of \$50,000 out of a munificent gift made for various social investigations by Mrs. Elizabeth Milbank Anderson to the New York Association for Improving the Condition of the Poor (Mr. J. A. Kingsbury, *Director*). The Commission was made an official State Commission by appointment of the Governor on June 25, 1913. Its members, who serve without pay, are Mr. D. D. Kimball (Ventilating Engineer), Prof. F. S. Lee (Professor of Physiology in Columbia University), Dr. J. A. Miller (of the Bellevue Medical School and Hospital), Prof. E. B. Phelps (late of the Massachusetts Institute of Technology and now Chemist of the U. S. Hygienic Laboratory in Washington), Prof. E. L. Thorndike (Professor of Psychology in Columbia University), and the writer. Its objects are "to examine and investigate the subject of ventilating systems in the public schools and other public buildings of the state, and the proper installation of the same to the end that a thorough and effective system, which will assure an adequate supply of fresh air, under the best conditions, will be maintained." In his statement in regard to the appointment of the Commission the Governor pointed out that "the problem is far from simple." He continued, "It is much more than an engineering problem, for the best scientific experts have not determined what conditions should be met by the engineers. Even the most fundamental facts which must lie at the basis of any efforts to ventilate our school buildings, have not been scientifically determined by any experiments which have been made thus far. It is not known, for example, and cannot be known without more adequate experiments than have been possible up to this time, what temperature should be maintained in public school buildings. Indeed, it has not even been proven whether a constant temperature or a varying temperature is more beneficial. We do not know scientifically what degree of humidity should be maintained in our schoolrooms.

"I am informed, also, that it has not been proven what amount of carbon dioxide in the air is possible before the air becomes detrimental to health. In other words, there is no scientific proof for some of the most fundamental factors involved in the problem of ventilation. On the other hand, I have been assured that if careful scientific studies were made with the express purpose of measuring some of the unknown factors, such studies could be reasonably expected to put us in possession of data which would enable the scientist to tell us with some degree of accuracy what those fundamental conditions are which should be maintained in schoolrooms if they are to be beneficial to the health of children."

Other speakers have so ably presented the positive results of previous studies of ventilation problems during the last ten years that I need not dwell upon what has already been achieved. We may take it as established that changes in the oxygen or carbon dioxide content of the vitiated air of rooms never remotely approach the limits at which harmful physiological effects can be produced. We may safely assume that specific organic poisons are absent from breathed air since all recent experiments along this line have yielded negative results. We may conclude with reasonable certainty that the symptoms of discomfort in a badly ventilated place are due to the physical condition of the air in respect to temperature, humidity and movement, and not to any chemical properties whatever. All

this represents solid and important progress. I wish to-night, however, rather to call your attention to the lacunae in our knowledge, which this new Commission is to try in some small measure to fill in.

In the first place, since as scientific men we must ask not only what happens under a given set of circumstances but how and perhaps why it happens, we need to know much more than we now do as to the mechanism of the bad effects produced by atmospheric heat and moisture. Through what means is the difficulty in giving off bodily heat translated into the sense of discomfort, the headache, the drowsiness and the other symptoms experienced in a warm room? There are many suggestive possibilities. One of the most striking recent hints is the observation of the English physiologist Barcroft that under the influence of external heat the dissociation curve of the hemoglobin is so altered, presumably as a result of decreased alkalinity, that oxygen is less rapidly absorbed. If this result is confirmed it may be that in a badly ventilated room we really suffer from oxygen starvation after all, not however as a result of oxygen deficiency in the air, but as a result of the effect of temperature upon the chemical properties of the blood. Allied to this problem of the causes of discomfort in stagnant, overheated air is that of the relation of such air to various diseases. Discomfort and disease may of course be due to the same factors but such is by no means necessarily the case. We know that tuberculous and anemic children improve when exposed to the influence of moving currents of cold, dry air. It would be of the greatest scientific importance and perhaps of much practical value to know by what physiological reactions this is brought to pass.

The upper limit beyond which our room temperatures should never be allowed to go is clearly indicated by the experiments to which reference has been made and it seems certain that except for old people it should be fixed at least as low as 70°. As to the lower limit, however, we are far more in doubt. In this country we are apt to consider 65° quite cool enough, while in England, rooms are usually kept 5° lower. It is maintained by some advocates of open-air schools that the unheated air of winter ranging from 50° to 0° is more desirable than either. It seems probable that the problem is complicated by the existence of a "danger zone" of temperature, low enough to cause a dangerous chill, but not low enough to stimulate the defensive reactions with which the body defends itself against more severe cold. It is certainly complicated by a considerable power of gradual acclimatization, by which the defensive mechanisms adapt themselves to a higher or lower air temperature in the course of days or weeks. It would seem, however, that there must be a certain range of temperature which is most favorable to maximum efficiency with a minimum expenditure of bodily energy. On the basis of the fundamental human instinct for keeping warm in winter I doubt very much whether this range will correspond with the chance variations of the winter temperature in a northern climate; but I am quite open to further light upon the subject.

We must distinguish between favorable conditions of normal air temperature and the possible value of sudden brief variations therefrom. It is maintained with good reason that any uniform temperature maintained for long periods may be distinctly harmful by lowering the tone of the heat regulating mechanism and by robbing the body of valuable nervous stimuli. The good effects of cold baths are well recognized and "cold air baths" may be equally beneficial. Closely allied to the question of variations in temperature is that of air movement. At temperatures over 70° F. strong air currents which may carry off the excess heat in the aerial blanket surrounding the body are essential to comfort. Even at low temperatures air currents certainly exert a pleasant and wholesome stimulating effect within certain limits. What these limits may be, however, we do not clearly know, and we

do not understand the exact nature of the bad effects produced by chilling of the body surface, particularly of the local chilling caused by what is commonly termed a draft. The value of moving air under certain circumstances is unquestioned; but so is the harmfulness of "drafts." Where the threshold lies between the two, and why it lies there, is what we need to determine.

The problem of humidity is almost as complicated as that of temperature. We know a good deal of the upper limits of high temperature combined with high humidity. We know that low humidity combined with low temperature produces grave chilling effects but where the permissible upper limit of humidity lies at a given low temperature has not been carefully worked out. As to the supposed harmful effects of low humidity combined with high or moderate temperature we are almost wholly in the realm of conjecture. We are told that schoolroom air is drier than the desert of Sahara; and as Professor Baskerville has pointed out, the air in the New York schoolrooms is certainly pretty dry. Dry hot climates, like that of Egypt are, however, sought out for their health-giving properties and the claims that the dry air of our rooms in winter overstimulates the cutaneous nerves causing nervousness and restlessness and injures the respiratory membrane so as to promote nose and throat disease, while a reasonable assumption, has as yet no firm basis of experimental observation. So far as I am aware, there are no sound data by which we may determine whether, with a temperature of 70°C. , the humidity should be 25 per cent or 50 per cent or 75 per cent of saturation.

One of the first things that strikes an observer on entering an unventilated room is the odor, produced by decomposing organic matter in the mouths, on the bodies, and on the clothing of the occupants. Highly offensive to one coming in from a purer outside air, these products are usually imperceptible to those who have been in the room while they have been accumulating and whose olfactory nerves have been gradually accustomed to them. It is of course possible that even when unperceived these bodies may exert some subtle, harmful influence, but there is not the slightest evidence that such is the case. In any event it seems reasonable to demand for decency's sake that the air of occupied rooms should not be malodorous. It is somewhat an open question, however, how far such conditions should be met by ventilation and how far by a rise in general standards of personal cleanliness.

In regard to the dust content of the atmosphere, the serious danger from comparatively large particles of mineral matter such as are produced in stone-cutting, needle grinding and the like, is well established both by animal experimentation and by statistical study of the incidence of tuberculosis in the dusty trades. Whether the very minute dust particles, largely of organic nature, which to the number of a million or so per cubic foot may be found in ordinary schoolroom air have any such significance at all is another question, to which we have at present no answer. The chief argument for the use of air washers is in most cases the possibility of freeing the atmosphere from such dust particles. We know that where delicate physical instruments are in question, it is essential to wash ordinary city air. The respiratory passages are, however, equipped with an excellent mechanism for self-cleansing and it is altogether possible that the ordinary dust content of the atmosphere is a negligible factor. I do not believe that we have at present any valid reason for advocating the washing of normal city air on sanitary grounds.

With regard to the bacteria in air, evidence is reasonably clear that they have no serious sanitary significance. Local pollution takes place by the discharge of mouth spray immediately in front of an infected person; but such spray quickly falls to the ground and does not in any sense constitute general aerial pollution. The experience of modern hospitals in which

various diseases are treated in the same open ward without cross infection, provided only direct transfer by nurses and other attendants be avoided, is reasonably conclusive on this point. The heavier dust particles deposited on surfaces do contain considerable numbers of mouth cocci and some tubercle bacilli, however; and the possibility that an appreciable danger might exist from dust stirred up in clouds as by gymnastic exercises in a dirty schoolroom seems to be well worthy of further study.

These questions to which I have briefly referred are all concerned with the physiological problem of precisely what air conditions are most favorable to the human organism. The mechanical problem of how to maintain a given set of air conditions is far better understood. Many existing ventilating plants yield unsatisfactory results, it is true, but there are three good reasons for this, none of which are related to any shortcomings in the art of the ventilating engineer. In the first place, until recently he has been told by the hygienist that the prime object of ventilation was to remove noxious gases rather than to regulate air temperature and humidity, so that he has naturally laid stress on air volume rather than air conditioning. In the second place he has rarely been given appropriations to do his work as he felt it should be done and in the third place he has still more rarely been able to count on an intelligent and conscientious operation of his plants after they have been built.

The first of these difficulties is now cleared away by the recognition on the part of all competent authorities that the chief aim of ventilation is to provide a moving current of cool air. This necessarily implies a separation of the two processes of heating and ventilation which have been so disastrously intermingled in the past. Cooling, not heating, is the task which should be closely associated with ventilating and a constant supply of cool air to remove the heat produced by human metabolism and by the combustion of illuminants is the fundamental end to be attained. It is interesting to note that Rietschel in the last edition of his standard work on ventilation bases his calculations of air volume primarily on heat removal, and on carbon dioxide dilution only secondarily and in certain specified cases. The substitution of this clear and definite aim for the old idea of mere air dilution will go far to make ventilating practice purposeful and efficient.

There are, however, still many purely mechanical problems which require further elucidation. Taking first natural ventilation or air interchange through walls, cracks, chimneys, windows and the like there is need for further data than we now possess as to the amount of leakage through walls under varying conditions of temperature and external wind movement. There is need of more exact knowledge as to the amount of ventilation through chimneys and ducts and windows with similar variables in weather conditions and as to the resulting circulation of air within the rooms.

The question of the adequacy of such natural ventilation by the admission of untempered air and the necessity or desirability of artificial or fan-ventilation is one of the most vigorously debated points in contemporaneous discussions. It is clear that with one or two persons in a large room window ventilation is adequate and sufficient. As soon as the factor of crowding comes in, however, difficulties begin to appear. In hospital wards the consensus of opinion seems to be in favor of natural ventilation. The patients have a comparatively ample air space. They are warmly covered and are doing no manual work. The windows are, or may be, under the constant control of skilled attendants. In a schoolroom these favorable factors are all wanting and in very cold weather it is usually found to be quite impossible by window ventilation to maintain properly cool conditions at the interior side without chilling those nearest the windows. In the ordinary factory workroom conditions for natural ventilation are even more unfavorable. It seems to me probable that in most schools and factories artificial ventila-

tion with tempered air (either warmed at its point of admission to the room or warmed at a central point and blown in by fans) is generally essential to good atmospheric conditions. The limits of occupancy and of outside weather conditions within which such artificial ventilation is needed deserve careful study, however. If it is possible in a room of a given type, perhaps by the use of special window ventilators to insure good diffusion and to maintain good air conditions without fan ventilation during the greater part of the year it might be reasonably maintained that the expense of artificial ventilation was hardly justified, for the removal of atmospheric odors on a few extreme winter days when the worst evils of bad ventilation could be eliminated by avoiding overheating and on the windless days of moderate temperature when window ventilation is inadequate to remove the heat produced within the rooms. I am inclined to believe that the number of days of the latter class in schoolrooms open to winds on only one or two sides is likely to be large, and that the difficulty in securing proper supervision of window ventilation is sure to limit its practical value very seriously. The whole matter, however, is worthy of open-minded investigation.

Intimately connected with this question of the limits within which artificial ventilation is necessary—and fundamental in artificial ventilation itself—is the problem of the necessary volume of air to be supplied under various conditions. On the older conception of carbon dioxide dilution it was easy to derive constants of air supply. To-day we must calculate our necessary volumes of air on the basis of heat removal. Assuming no heat loss through walls and ceilings and assuming that incoming air must not be below 60° nor outgoing air above 70°, 2000 cubic feet of air per hour will be required to take up the heat produced by a single person and 1500 cubic feet will be required to take up the heat of a single gas burner. The first figure happens to be almost exactly that deduced on the theory of carbon dioxide dilution. The amount of heat loss through walls and ceiling will modify this constant to an almost infinite degree with variations in building construction and weather conditions. Professor Bass in his experiments at Minneapolis has found it possible to reduce the air supply to a fraction of this amount without objectionable results.

Perhaps the most important mechanical problems of ventilation are those which relate to the distribution of air between different rooms and the circulation of air within the rooms themselves. German and English experiments on duct construction should be verified and extended. The mistaken claim that a ventilation system cannot be designed which will not be unbalanced by opening windows in some rooms and not in others must be set at rest. In regard to the circulation of air within the rooms there are even more difficulties. Too often a room has been treated as a box to which as a unit it was only necessary to supply a given amount of air. What happened to the air thus supplied, and how far it maintained good conditions in various parts of the room, was left to chance or to the working out of a few crudely generalized principles. I am quite convinced that in most existing installations the number of inlets and outlets is too small to ensure at all times a reasonably good distribution of air. Prof. Bass's results, to which reference has been made, were accomplished by supplying air through individual inlets at each desk. This is an extreme case but we need to know with some exactness the proper mean between this condition and the usual single inlet and outlet. In connection with this question is the mooted problem of upward *vs.* downward ventilation. My own personal feeling is that it will frequently be best to take advantage of the natural upward tendency of air which is being warmed by supplying cool fresh air below and removing the warmed air above as is done in some of the most successful ventilating systems now in use in auditoria and factories. The objection felt to drafts of cool air is the limiting factor in this system, however, and we must not rest on

abstract generalizations but on careful studies of the variables involved in practical operation.

The most important contributions to the art of ventilation in recent years have certainly been the experiments on recirculation of air at Minneapolis and at Springfield, Mass. If it is possible, as the theory of the newer ventilation would suggest, and as these studies seem to indicate, to use the same air over and over again, merely adjusting its temperature and humidity and washing or ozonizing to eliminate odors, the cost of operating a ventilating system may be cut from one-third to one-half and the whole practice of ventilation will be revolutionized.

Finally, there are many minor mechanical problems which require further study. The efficiency of various types of air washers should be carefully compared as has recently been done in certain installations by Professor Whipple of Harvard University. The use of ozone machines as an alternative to air washers for deodorizing deserves further consideration, although physiological investigations, both in this country and in Germany, throw serious doubt upon the advisability of this procedure. The distillation of objectionable gases from dust on heating surfaces is an interesting and important question; and there are many more to which I cannot even allude in this hasty review.

More than enough has been said, to indicate the need for light upon many of the physiological and mechanical problems which underlie the art of ventilation, and to illustrate the fact that the New York State Commission on Ventilation has quite enough to occupy its energies. We are only at the threshold of our work and have at this time only questions to ask and no answers to give. Our staff is now practically organized, however, with Mr. G. T. Palmer as Chief of the Investigating Staff and Mr. Joseph Herzstein as Secretary and we shall begin actual work before the end of the month. Through the courtesy of the Board of Trustees of the College of the City of New York two experimental rooms have been equipped in the Biological Laboratories of the College in which any desired conditions may be maintained. Here it is hoped that the fundamental physiological problems may be so worked out as to determine with reasonable definiteness what atmospheric conditions in regard to temperature, humidity, air movement and the like are most favorable to human health and efficiency. Special studies will also be made here in regard to the distribution of dust particles and bacteria in the air and the physiological effects of dusty air in promoting tuberculosis.

Through the courtesy of the Board of Education of the City of New York experimental schoolrooms are included in the plans for one of the new buildings to be completed in 1914 in which air of any desired condition can be admitted and withdrawn from any point. In these rooms the favorable air conditions determined in the City College experiments may be tested out on a practical scale and detailed studies may be made in regard to air circulation. The latter should be supplemented by special experiments on the mechanical problems of air flow and air circulation, and by tests of various mechanical devices used in ventilation, such as air washers and the like.

Coöperative investigations have been arranged for, under grants from the Commission, which will bring to it the advantage of much previous experience obtained by the leading students of ventilation problems in this country. These will include studies of certain fundamental physical problems of heat and moisture loss at the Massachusetts Institute of Technology (under Professor Phelps), observations on the results of the use of recirculated air in the International Y. M. C. A. College Gymnasium at Springfield, Mass. (under Dr. J. H. McCurdy), investigations of the physiological and psychological results of recirculated air supplied from individual inlets in a schoolroom in Minneapolis (by Prof. Bass), and records of efficiency of

factory operatives under various atmospheric conditions (by Dr. Hollis Godfrey).

The task before us is a large and important one which we approach with a keen sense of responsibility. There are three factors and only three which universally affect the life processes of living beings from one end of the biological scale to the other. These are the physical and chemical conditions of the enveloping

medium, food supply and predacious or parasitic enemies. The first of these factors, in the case of land animals, is solely a question of air conditioning or ventilation. I cannot doubt that when the ideal air conditions and the practical methods of securing them have been worked out with reasonable completeness it will mean an incalculable gain in human health and efficiency.

COLLEGE OF THE CITY OF NEW YORK

CURRENT INDUSTRIAL NEWS

By M. L. HAMLIN

THE MOTOR SHIP "FIONIA"

The Engineer, 117 (1914), 40, has recently published an account of the large passenger and freight vessel "Fionia" and her power plant. The "Fionia" was built by Burmeister and Wain, of Copenhagen, for the East Asiatic Co., to be used on the Bangkok route and is the ninth vessel of her kind that they have launched. She is 395 feet over all and driven by two six-cylinder 2000 h. p.

VERTICAL SECTION OF MAIN ENGINE

Diesel internal combustion engines. The diameter of the cylinders is 740 mm., stroke 1100 mm., and the speed is 100 r. p. m. Each cylinder is mounted on two columns and the columns are coupled together at the upper part on the sides by cast iron plates to give fore and aft steadiness; the guides are made fast to the

columns in the ordinary way. The bed plate is like that of an ordinary steam engine with open pits, but a steel tray is fitted underneath its whole length, and this with the light steel plate removable doors fitted between the lower parts of the columns allows forced lubrication to be used. A diaphragm piece is fitted across the top of the columns through which the piston rods pass in a light gland, and this prevents any oil which may come down from the pistons becoming mixed with the lighter oil in the crank pit.

The cylinder jackets are cast together in blocks of three and bolted to the columns in the ordinary way.

The cross-heads, connecting rods and pistons follow ordinary steam practice, the piston rod being deeply spigoted into the piston, to which it is bolted by a number of light bolts. In the "Fionia" it was necessary to give up the very nice piston cooling arrangement previously used on the "Lelandia," in which the oil was forced through the shaft up the connecting- and piston-rods and into the piston, whence it was passed down on to the guides where it was cooled to a certain extent. In the case of the new "Fionia," however, it was thought that the volume of oil necessary to cool a 740 mm. piston would present difficulties in recooling, so recourse was had to sea water which is admitted to the pistons by ordinary telescopic tubes.

Reavell air compressors are fitted on the main shaft for supplying injection air, and are supplemented by 200 h. p. Diesel compressors. Two more 200 h. p. four-stroke Diesel engines running at 225 r. p. m. are fitted for auxiliary purposes; one provides current for the auxiliary machinery, steering gear, lighting, etc., while the other acts as a stand-by. In addition to these, there is a crude oil motor simply for the purpose of lighting the ship when in port, where none of the other auxiliaries are required.

BOILER EXPLOSIONS IN CHEMICAL INDUSTRIES IN GERMANY IN 1912

Eleven boiler explosions, exclusive of military, naval and locomotive boilers, occurred in Germany in 1912; of these, seven occurred in chemical or related industries. The *Chemiker-Zeitung*, 37 (1913), 1456, analyzes each of these cases, giving the attendant circumstances, character of the feed water, type of boiler, probable cause of the accident, etc., and these facts may be summed up as follows: All seven boilers were horizontal; in two cases the accidents were due to the water being allowed to run low through carelessness; in the other cases the accidents were caused by weakness resulting in the opening of seams, aided in one case by local overheating due to incomplete removal of boiler scale. In the seven explosions eight persons were killed, one accident only not proving fatal.

BENZOL IN GERMANY

In connection with the liquid fuel campaign it is interesting to learn from the *Jour. of Gas Lighting and Water Supply*, 124, (1913) 1004, that there are now upwards of seventy German makers of benzol represented in the German Benzol Association. An important thing from the motorists' point of view is that