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—Abstracts of Papers Presented in a Symposium on Environment and its Eff upon Man as a Part of the Harvard Tercentenary Celebration, Harvard School of Public Health, Boston, August 24-29, 1936—

Reported by

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AS A PART of the celebration of the Harvard Tercentenary, a symposium on the environment and its effects upon man was given at the Harvard School of Public Health during August 24-29, 1936. The chief subjects considered were the effects of the social environment, fatigue, air-borne disease, physiological effects of high temperatures and humidities, industrial air conditioning, physiological effects of high pressures, carbon monoxide poisoning, occurrence of gaseous impurities, toxicology of organic vapors and gases, toxic dusts, pneumoconioses, application of air conditioning in normal life and in hospitals, and the set-ups in laboratories of industrial toxicology and industrial hygiene.

The program presented was as follows:

MONDAY—"The Effects of the Social Environment," by DR. LAWRENCE J. HENDERSON, Abbot and James Lawrence Professor of Chemistry, Harvard University, and DR. ELTON MAYO, Professor of Industrial Research, Harvard Business School; "Fatigue," by DR. DAVID B. DILL, Assistant Professor of Biological Chemistry, Harvard School of Public Health; "Air-Borne Disease," by DR. WILSON G. SMILLIE, Professor of Public Health Administration, Harvard School of Public Health; "Bacteria and Pollen in Air," by WILLIAM F. WELLS, Instructor in Sanitary Science, Harvard School of Public Health.

TUESDAY—"The Physiological Effects of High Temperatures and Humidities," by DR. CECIL K. DRINKER, Professor of Physiology and Dean, Harvard School of Public Health; "Industrial Air Conditioning," by CONSTANTIN P. YAGLOU, Assistant Professor of Industrial Hygiene, Harvard School of Public Health; "The Physiological Effects of High Pressures," by LOUIS A. SHAW, Assistant Professor of Physiology, Harvard School of Public Health; "Industrial Operations in Compressed Air," by OLE SINGSTAD, Chief Consulting Engineer on Tunnels, Port of New York Authority.

WEDNESDAY—"Carbon Monoxide Poisoning," by DR. CECIL K. DRINKER; "Occurrence and Significance of Gaseous Impurities," by WILLIAM P. YANT, Supervising Chemist, Health Laboratory Section and Supervising Engineer, Pittsburgh Experiment Station, U. S. Bureau of Mines; "The Toxicology of Organic Vapors and Gases," by DR. JOHN S. FOULGER, Haskell Laboratory of Industrial Toxicology, Wilmington, Delaware; "The Toxic Dusts," by DR. LAWRENCE T. FAIRHALL, Assistant Professor of Physiology, Harvard School of Public Health.

THURSDAY—"PNEUMOCONIOSES:" "Causation," by PHILIP DRINKER, Professor of Industrial Hygiene, Harvard School of Public Health; "Clinical Aspects, Diagnoses, Prevention," by DR. W. IRVING CLARK, Physician to The Norton Company, and Assistant Professor of the Practice of Industrial Medicine, Harvard School of Public Health; "Control," by THEODORE F. HATCH, Instructor in Industrial Sanita[tion], Harvard Schools of E[ngi]neering and of Public He[alth]; "Protective Equipment," by DR. CARLTON [E.] BROWN, Chemist, Gas Section, Pittsburgh Ex[peri]ment Station, U. S. Bureau of Mines.

FRIDAY—"The Application of Air Conditio[ning] in Normal Life," by PHILIP DRINKER; "The Appli[ca]tion of Air Conditioning to Hospitals, by CONS[TAN]TIN P. YAGLOU; "A Laboratory of Industrial To[xi]cology," by DR. W. F. VON OETTINGEN, Direc[tor], Haskell Laboratory of Industrial Toxicology, W[il]mington, Delaware; and "A Laboratory of In[dus]trial Hygiene," by WARREN E. COOK, Chief In[dus]trial Hygienist, State Department of Health, H[art]ford, Connecticut.

SATURDAY—Demonstration in the Harvard Sc[hool] of Public Health, and visits to the Indust[rial] Clinic, The Norton Company, Worcester, Ma[ssa]chusetts; The Fletcher Granite Company, W[est] Chelmsford, Massachusetts; The Fatigue Labo[ra]tory, Harvard Business School.

Monday—August 24

DR. LAWRENCE J. HENDERSON, in speak[ing] on "The Effects of Social Environment," [...] detailed the experience at the Hawthorne Wo[rks] of the Western Electric Company, Chicago, [in] relation to experimental work during a period [of] five years, particularly relating to the social [...] of production in the manufacture of telepho[ne] relays. The principal results as reported in [...] presentation were previously described by [...] North Whitehead in *The Human Factor* (Vol [...] p. 81, 1935). The original "rest room" was [in]stalled in April, 1927, and continued to oper[ate] until 1932, when for reasons not connected w[ith] the experiment, it was abandoned. In gene[ral] there was a gain in production for a number [of] years during this experiment. Lantern sli[des] showing the working conditions of these wo[men] were exhibited in Dr. Henderson's presentat[ion] and the minute-to-minute output was measured [by] means of graphs representing these data. A gr[aph] of weekly output was also shown, and an aver[age] increase in output of 30% was noted. Of parti[cu]lar interest were the data on correspondence [of] fluctuations in output. "Determinations" wh[ich] are similar to mathematical correlations w[ere] made showing high correspondence in one inte[r]val of time except in the instance of one employ[ee]. A series of these "determinations" were given [...] graph, showing a complete collapse in these "[de]termination" relationships four months after [the] first observations were made. At a further inter[val] of three months the best state of integration w[as] observed of any time in the series. Five mont[hs] later, still a different picture was presented by [the] determinations because a rearrangement of seat[ing] of the individuals in the experiment. Thr[ee] months later a reintegration [...]

months later another breakdown occurred. In January, 1932, which was 10 months after the last observation, some adjustment was still going on and apparently the individuals had a feeling of resignation rather than progress. The second experiment reported by Dr. Henderson was in a bank-wiring room, this experiment having been previously described in a monograph entitled "Management and The Worker," by F. J. Roethlistberger and W. J. Dickson. The method in this experiment was two-fold, consisting of indirect, conversational interview and direct observation. The situation here was a little different from that in the relay assembly test room—in the latter instance the cooperation of management and workers was at a higher level and the aims of the two groups were apparently in perfect accord. In the second experiment reported, however, informal organization by the group itself had defeated the purpose of the supervisory organization. No relation between the results of the test and the output was evident, and it is from this that the essayist reasons that output is a form of social behavior. Here supervisory control had failed. This, however, was not due to an insufficiency in the wage plan because the social considerations outweighed the economic considerations. Scientific selection and placement do not secure corresponding results —social conflict is evident in such instances. An important principle to be kept in mind is the resistance to too rapid change in environment, and apparently the chief function of informal organization among employees is this resistance. Ordinarily technical organizations are set up favoring rapid changes, and such changes rob the employee of certain things of importance to him in his work. Scientific management has not well appreciated the significance of real social relationships. The good results of the first experiment were due probably to the equilibrium between the technical organization and the social organization in the group. Social relationships usually call for more consideration than economic phases or the psychology of the members of such groups. Should one not know the real sentiments of others in supervising? The rate of change apparently is most important, and the significant thing in the Hawthorne experiment was that the output rose regardless of the number of hours worked or the rest periods given or not given but changed on or from the test of social relationship changes. Dr. Henderson concluded that "the social environment is what sentiments, routines and rituals make it. From the most perfect family in the world take away the sentiments, the routines, and the rituals, and the residue will be unrelated individuals. No doubt the social environment (various social system) of a factory is in many ways less important and far less perfect than the social system of a good family. But in several respects it is the same kind of thing and, as experience shows, it is in several respects important enough so that it cannot be neglected by anyone who wishes to plan wisely, or even merely to know what he is doing. Environment is at once physical, chemical, biological, psychological, economic and sociological. As a rule we have all the strongest feelings about its sociological properties and the least intellectual awareness of them. Often these are the most important properties of the environment. Let us study, weigh, modify and use them."

DR. DAVID B. DILL, in speaking on "Fatigue," first cited Viteles' definition of this term—stating that really fatigue is "a failure to maintain equilibrium." There has been no proof of the real existence of chemical fatigue products, and boredom is not an explanation of fatigue. Ordinarily the industrial job does not demand a greater increase in the metabolic rate than three times the normal—the individual can increase his metabolic rate 10 times, so that there is a considerable factor of safety. Fatigue may be muscular or sensory in origin. Stevenson's classification was used, which has first for consideration the accumulation of fatigue substances which have not been scientifically demonstrated. In certain experiments in which subjects were worked on treadmills and the lactic acid measured in the blood, it was found that this existed in certain measurable proportions, and it was demonstrated that while lactic acid may be used in measuring fatigue, it should not itself be considered the cause of fatigue. On a group of steel workers for instance, the maximum amount of lactic acid was 13.1 mgs. per 100 cc. and 8.4 mgs. as a minimum with an average of 10.3 and a resting base figure of eight to 12 mgs., bringing this picture into a normal fluctuation. The second consideration is the exhaustion of energy reserves and has especial reference to the reserve of carbohydrates in the body. In a similar group of workers the blood sugar was shown to be a maximum of 142, the minimum 81 and the average 103, which shows no significant change. In such workers also no significant amount of acetone was discovered. In heavy industrial work, therefore, carbohydrate depletion is not an important relationship. Laird states that maltose is probably effective in avoiding difficulty in this connection. Haggard and Greenberg found an increased output after the administration of free meals, but Dr. Dill is not certain that this relationship is a clear one in the avoidance of fatigue, but suspects that there may be some psychological reaction here which was favorable. The third important relationship is the inadequacy of oxygen intake—this is especially noted in cardiacs or in high altitudes where it may have some signifiance. Fatigue in aviators is especially important and may be due to excessive generation of nervous impulses. There is apparently a very wide difference in individual reactions to extreme altitudes. The fourth important consideration is the alteration of the physico-chemical state, and it was here that Dr. Dill specifically related the Youngstown Sheet & Tube Company's experiments relative to the control of heat exhaustion and heat cramps by the administration of salt in drinking water. The water intake in such men varies greatly—being between three and 10 liters per day per man; on hot jobs a man may drink as much as eight to nine liters per day resulting in considerable salt depletion; if continued and a return to normal is not reached within a period of several days a breakdown results. Chemical blood studies of hospital cases showed the occurrence of dehydration and a lowering of the chlorides in the blood to as much as 15%—there was also an increase in the serum quotient and also an increase in the red blood cell count. There has been a great deal of difference in the opinion as to the osmotic pressure but experience has shown that a normal osmotic pressure is maintained. An isotonic salt solution is the real solution of the cramp problem, and a reference to Dr. Kennedy's work at Youngstown was made in this regard. There is no support for the theory that water under a temperature of 50°F. is harmful. It has been found for instance, that water at a temperature of 46° with salt in proper admixture (1/10 of 1%) gives the desired results. More recently considerable experience has been reported with 21 cases of heat cramps by treating them in the hospital with a level teaspoonful of salt every half hour for three doses with as much water as they cared to drink; these men were able to return to work within the next 24 hours after the administration of the treatment. The relationship of the administration of sodium chloride to exhaustion is not so evident as in cases of heat cramps; it is quite possible that in such instances the difficulty may be due to overtime work and the free consumption of liquor. The Boulder Dam experience was also detailed briefly by Dr. Dill. In summary, the mechanics of this problem have been discussed but the various factors are mutually independent and so the problem is extremely complicated.

DR. WILSON G. SMILLIE prepared the next subject on "Air-Borne Disease." Pasteur's experiments and various early theories were first detailed in this presentation. Two important methods of procedure stand out in these investigations, namely, the experimental method and later the use of the microscope. The spontaneous generation theory was very much emphasized and came in for a great deal of discussion. Pasteur set out to investigate this theory and settle it, and he repeated many experiments of previous investigators, attracting the attention of Lister relative to antiseptic surgery. Lister was the first to discover that the use of carbolic acid sprays in operating rooms really had no relation to the occurrence of septic changes in surgical operations. The principle of the transmission of disease by water and by food was the first serious blow to the so-called air-borne theory of disease. The transmission of disease by insects was also a refutation of this theory; for instance, the transmission of malaria and yellow fever by various types of mosquitos served as an illustration. Respiratory disease also was considered as an air-borne disease—Chapin first showed a restricted radius of transmission as evidenced by the distance of droplet transmission and the viability of the infecting agents. More recently there has been an interesting possibility of psittacosis epidemics being air-borne. Because of all these facts it is felt that a reopening of the subject of air-borne infection is timely. As a part of this presentation the physical properties of gases, dusts, and bacteria in relation to air-borne transmission were considered. Air infection was investigated by many different men, among them being successively Pasteur, Tyndall, Michael, Koch, Hess, Franklin, Petrie, Winslow, McDonald, and Wells, the principles being precipitation, filtration, and other methods not so well known. In summary, it should be kept in mind that bacteria in air are passive and not active; that dust in the form of spores is important and that human droplets are also equally significant on certain occasions; bacteria pollution is higher in dirty rooms and under dry summer conditions and does not depend directly upon air currents for dissemination; is heavier in cities. The next research should concern itself very definitely with the be-havior of different bacterial forms in air.

WILLIAM F. WELLS presented the final pa on the Monday program, "Bacteria and P len in Air." In reviewing the history of the a borne theories it was stated that this had be practically abandoned, but within the past f years experiments have shown some interesti results which warrant reconsideration of this id The Wells centrifuge was described and shown lantern slides. Emphasis was placed on the f that droplets dry before reaching the ground a behave much as the air itself. In air-borne inf tion the drying of material and the viability forms under these conditions is especially imp tant. Persistence of viability varies extreme from ½ hour to 96 hours according to the form bacteria. Droplet nuclei from humidifying sy tems show a very definite association with du particles. The droplet nuclei are also found systems using contaminated water for humidif ing. Illustrations were given by lantern slid showing the difference in comparison between t number of bacteria as cultured from outside a air from the sneezing of various individuals, from clinics and wards, and air from cotton mil The essayist suggested that the alpha streptoc cus in air be taken as an index of the contamin tion of air similar to the way in which the Bacill coli is considered in the contamination of wat A discussion of air-borne infection versus conta infection occupied a considerable amount of t presentation — air-borne infection certainly a swers the rapid method of spread of nasophary geal groups of bacteria. Particular emphasis w placed on diseases resulting from nasopharynge organism relative to mortality, morbidity, repo able diseases, days spent in bed from respirato diseases, and also industrial diseases causing lo time—all of which result from infection of th type. Concerning the effect of ultra-violet lig on Bacillus coli, it was found that a fewer numbe of colonies occur in cultures as one approaches th lamp. A difference in humidity causes a variati in the bacteriocidal power and decreases with hi humidity—there being a precipitate drop betwe 50 and 55 relative humidity. The best results we obtained with high pressure quartz lamps. Fr various experiments during the past few year is apparent that sedimentation and filtration a more effective on large particles of dust and ult violet radiation is more effective on smaller pa ticles, particularly those that contain bacteria. I summary, the foundation has been laid for sanita air analysis in these experiments and observati and the control of air in certain instances—in t future a wider application can be made to pract cal problems.

Tuesday—August 25

DR. CECIL K. DRINKER, in speaking on th subject "The Physiological Effects of Hi Temperatures and Humidities," made reference high temperatures both inside and outside of in dustry. Proper consideration should be given the internal environment of the body which water. The neutrality of the body fluids has a p value of 7.3. The hydrogen iron concentration m be expressed as 0.00000005 N; the hydroxyl co centration may be expressed as 0.0000002 N. Th may be a shift of as much as 0.0000001 N. It may, therefore, be concluded that reactions to heat cannot be wide in range but are protective in type. Warm bloodedness is certainly a subject of importance in considering reactions to temperatures; as illustrative of this principle differences in the temperature charts of infants in conditioned and non-conditioned nurseries were exhibited. The subject of sweating is also of significance, and sweating may be either mental or thermal in classification. Reference was made particularly to the work of Y. Kuno in his paper on "The Physiology of Human Respiration." The work of Talbot and Michaelson, at Boulder City, Colorado, was cited particularly in reference to heat cases experienced during the work done on the Boulder Dam. Citations were also made in reference to Shattuck's conclusion relative to the heat effects in different countries. Approximately 4,000 deaths occurred in this country during the last heat spell in the summer of 1936, so that this constitutes a real problem in public health. The effects of tropical climate are important because of individual developments, and cases were cited to illustrate this principle. The basal metabolism is usually depressed in such instances as compared to a minority of cases in which the metabolism has followed a level or has risen. Regular exercise has been found favorable to white men in the tropics. There is a lack of good data and methods of employment selection with reference to heat and heat environment. Humidity and sunlight are relatively unimportant except as adjuncts to temperature effects. In discussing Dr. Drinker's paper, Dr. Shattuck said that there had been an increase of heat effects among the Irish in Massachusetts, and also he made reference to the experience of the British in India.

CONSTANTIN P. YAGLOU, of the Harvard School of Public Health, in presenting the subject "Industrial Air Conditioning," stated that factory work is generally known to lower vitality, increase susceptibility to disease and reduce the span of life. Aside from toxic dusts and gases, which are taken up in other papers, two other serious hazards are recognized; intense heat and sudden changes in temperature. The first part of the paper dealt with the chief occupational diseases in hot and cold trades, and the effects of abnormal air conditions on accidents, efficient working capacity, sickness and mortality. Evidence was presented in tables and charts showing direct relationship between severity of exposure to abnormal air conditions and degree of unfavorable response, as manifested in increased morbidity, mortality, and accident liability, and decreased working capacity. In the control of acute and chronic hazards resulting from excessive heat or cold, ventilation and air conditioning methods are not always effective, and they should be superseded by medical methods. Much has been accomplished by the industrial physician in decreasing sensitivity to external heat by prophylactic methods applied to the worker, by control of fatigue and alcoholic habits, and by periodic examination of the workers for detecting early symptoms and instituting prompt remedial measures. Still greater possibilities seem to lie in the selection and gradual adaptation to high temperature, so that heat-intolerant individuals will not be allowed to take the risk. Such a scheme is now working with considerable success in South African mines.

OLE SINGSTAD, Chief Consulting Engineer on Tunnels, Port of New York Authority, presented the subject "Industrial Operations in Compressed Air." This paper discussed the use of compressed air as an atmospheric medium in which men work below the water level in shaft, tunnel, and foundation construction, and in diving operations. It presented the problems relating to the safety and health of those who are employed in this kind of work, and described the development and extent of the precautionary measures and regulations that are used on the job in the practical solution of these problems. The cooperation of the medical and engineering professions during the past 30 years or more has produced marked success in the control of compressed air illness, as is evidenced by the record given for 15 subaqueous tunnels constructed in the New York district. Some of the more recent trends in the regulation of compressed air work were also noted.

Wednesday—August 26

DR. CECIL K. DRINKER, in discussing the subject "Carbon Monoxide," stated in part that the material on this subject was rather selective. This poison is an old one, having been recognized by Claude Bernard. The plasma of the blood carries little oxygen (0.36 cc. per 100 cc. of blood); while whole blood shows 20 cc. per 100 cc. of blood. The hemoglobin is of great importance to mammals. A practical point is that complete saturation of the blood occurs at a pressure of 100 millimeters of mercury, but at 50 millimeters pressure the blood is 80% saturated—this fact having great significance in observing phenomena at high altitudes. The ability to take up oxygen depends upon the partial pressures of oxygen in the environment. The influence of carbon dioxide and incidentally carbon monoxide is most important in affecting the power of the blood to take up oxygen and in this connection the rationality of the oxygen-carbon dioxide treatment of carbon monoxide asphyxiation was discussed. There is an increase in the number of red blood cells when breathing pure carbon monoxide; in actual practice there may be a decrease or an increase, the decrease being due to contamination by benzol-containing substances. Splenic contraction forces new red blood cell forms into the circulation. There can be no doubt that an anemia accompanies carbon monoxide effects, but it certainly is not of the pernicious type. The acute effects of carbon monoxide are not commonly observed except experimentally. Haldane has given the most graphic description of his own personal experience in the breathing of carbon monoxide in various amounts, and charted his symptoms at different saturations corresponding to different intervals of time. The characteristic finding is weakness in the legs; an increase in breathing begins at a saturation of about 30%. Sudden exposure to large amounts of carbon monoxide provides a rational basis for the administration of oxygen and artificial respiration. The headache which is one of the characterof carbon monoxide over long periods of time provides a rational basis for oxygen and carbon dioxide. In acute cases of poisoning there are vascular changes in the central nervous system, with nerve cell damage shown in different parts of the brain; however, the spinal cord may also be affected. Few survive to show sequelae. In the experience of the New York Consolidated Gas Company in the establishment of emergency stations, 21,000 cases have been gathered since 1926. In mental hospitals having 81,000 cases in 10 years there were 39 cases which were seen which were due directly to carbon monoxide exposure; to these were added four others later, of these 43 cases 10 showed no neurological signs and 10 died before neurological examination was possible. It is significant that over this period of years there have been observed no neurological signs except in instances of history of unconsciousness. There seems to exist a lucid period of seven to 21 days in all instances. Neurological sequelae may or may not be permanent in any instance. Inhalation treatment was started in 1921. It has been amply demonstrated that there have been fewer deaths in the New York experience after the adoption of 7% carbon dioxide oxygen mixture. Methylene blue is distinctly contra-indicated as the treatment of carbon monoxide poisoning, and there have been some cases of untoward results reported from the use of this drug. Finally, it is to be especially kept in mind that artificial respiration should be administered in all cases where the breathing is weak.

WILLIAM P. YANT, of the U. S. Bureau of Mines, presented the subject "Occurrence and Significance of Gaseous Impurities." Many types of gases are to be found in industrial relationships, such as the man-made gases, gases which are made in cooperation with nature, gases resulting from chemical and metallurgical processes, and gases from combustion. In 1777 Cavendish established the constituents of normal atmosphere, and this computation is still used at the present day; the impurities are of relatively little moment in normal atmosphere. Marsh gas is found everywhere, and carbon dioxide is also widely distributed. Hydrogen sulphide exists as an important stratum gas and is of particular importance in petroleum activities. In the coal mining industry gases are of great importance; marsh gas is evolved in great amounts and also contamination from explosives occurs, the U. S. Bureau of Mines having approval regulations to minimize difficulty from this contamination. Oxygen deficiency forms one of the important problems in mines. In considering sewage gases, marsh gas and water are formed and these substances occur also in silos and holds of ships. In manhole gas problems, explosions are due probably to leaks of gas as shown in the Boston experience. In gases which are the result of combustion, there is still a great controversy as to the mechanics of burning carbon and hydrogen compounds. In any kind of combustion, the lack of oxygen makes for the greatest development of carbon monoxide. It is estimated that 50 billion tons of carbon monoxide are produced every year from automobile engines, which has led to the determination showing that there will be one part of carbon monoxide in 10,000 parts of air 1,000 years hence. The Bureau of Mines has been instrumental in forming approval regulations gas appliances which have had some influence the prevention of carbon monoxide poison Carbon monoxide still is produced in considera quantities around blast furnaces and in some sm ers sulphur dioxide is a by-product occurring frequent regularity. Of the chemical conta nants of air, refrigerants and fumigants are of siderable significance. In closing, Mr. Yant st that he would name the gaseous impurity haz in order as follows: low oxygen; carbon m oxide; hydrogen sulphide; the oxides of nitro and sulphur dioxide.

DR. JOHN S. FOULGER, of The Haskell L oratory of Industrial Toxicology, Wilmi ton, Delaware, read the next paper on "The To cology of Organic Vapors and Gases." The creasing use of solvents and of "vapor phase" actions is making the hazard from toxic vap and gases one of the most important in indust medicine. The lack of odor and invisibility vapors, their ability to penetrate clothing and condense on moist surfaces, make exposure p ticularly insidious. Their major route of abso tion into the body, through the lungs, allow rapid distribution to all tissues and especially the central nervous system and the heart. O knowledge of the toxicology of organic vapor scanty. Methods of air sampling and of detec and estimation of individual vapors are not w developed. The pathology of the central nerv system in cases of industrial poisoning is pra cally unexplored. Because of this lack of inform tion all vapors or gases should be considered to until proved otherwise. All containers and ap ratus should be handled with care. Broken p lines and tanks should be approached only workers protected with suitable gas masks gloves. At all times cleanliness of workers and their clothes is essential in prevention of expos Immediate treatment of exposed workers must given carefully, always remembering that pul nary edema, which frequently follows exposure irritant vapors and gases, may also be caused improper use of manual methods of artificial piration. Because many toxic vapors have layed action, complete rest and continued med observation are essential for 24 to 48 hours af exposure.

DR. LAWRENCE T. FAIRHALL, Assist Professor of Physiology, Harvard Schoo Public Health, discussed the subject "The To Dusts." There is considerable overlapping in physical states of dusts, fumes, and gases. susceptibility of individuals is a consideration this subject. Particle size is of relative unimp tance except in the case of silica dust. Vari types of metallic and other dusts were classif Lead poisoning is on the wane but still is an portant subject of control. Arsene is the most portant derivative of arsenic from a toxicolog standpoint. Antimony poisoning is somewhat in industry. Mercury in vapor form is of cons erable importance, although in hatters merc poisoning has occurred from other forms. Ch coal with 5% of iodine has been suggested canister adsorbent of mercury vapor. Toxicolo cally manganese and zinc are somewhat unimp in exposed persons. Spectroscopy is an important examination procedure in establishing harmful concentrations of substances which are toxicologically significant. There are some of the alloys which are of great importance. Cadmium salts are of great toxicological significance and have been increasing in commercial use, (reference was made to Prodan's work). Chromium is of importance largely in the form of dusts and chromates and as vapors emanating from plating tanks. The toxicology of organic compounds in dust form is not so certain at the present time, and it may be said to be important from the point of view of vapors and gases which are coincident with the dust of such organic compounds. It is usually not recognized that sampling methods are as important as analytical methods. Emphasis was placed on local and general effects in regard to toxicological basis of different types of substances. The definition of effects is more difficult in quality than in quantity. There is much more to be done in the study of absorption and transportation of toxic dusts in the human organism.

Thursday—August 27

PROFESSOR PHILIP DRINKER, of the Harvard School of Public Health discussed "Causation of Pneumoconioses." Four different types of reaction are produced by the inhalation of dust—*first,* and most important, are the pneumoconioses, such as silicosis and asbestosis—*second,* reactions caused by the toxic dusts such as lead, cadmium and radium—*third,* the inhalation of metallic fume particles known as metal fume fever—and *fourth,* the inhalation of organic dusts constituting allergic reactions. Definitions of silicosis were referred to, such as those devised by the International Congress on Silicosis at Johannesburg, the American Public Health Association, Sayers and Jones, and Edgar Collis. A lantern slide graph showed the tuberculosis mortality directly proportionate to quartz content of inhaled dust. Hardness and inertness are the important properties of free silica dust. A chemist would not suspect silicon dioxide as being harmful, according to its chemical properties. There is no comparative toxicity table available on the relative potencies of the various forms of free silica. Tables were exhibited showing the mineral composition of a typical granite dust, and also a chemical analysis of the same sample. The chemical relationship between sericite, asbestos and talc was shown. The work of Cummins and Sladden and the U. S. Public Health Service on coal miners was compared. Limestone, dolomite and marble are all soluble dusts and are tolerable in huge concentrations. It has also been shown that gypsum dust is not relatively harmful. Recommendations for rock dusting in coal mines to prevent explosion have officially included the use of limestone, dolomite and gypsum dusts. Reference was made to Zenker's original work on siderosis published in 1867, and the volume was displayed. A tabulation of comparative exposures during many years on different occupations and the computations of the approximate exposure for all such years according to the method of Bloomfield and Dallavalle were demonstrated. Mavrogordato has referred especially to what are known as "dust floods." It is especially to be remembered when reporting dust concentrations that nothing real practical value—such as from 0 to 5, 10 to 20, etc. As a standard of conversion between the gravimetric and volumetric analyses of dust concentrations, the equivalent of one milligram being equal to three million particles was proposed. The original work done by Lanza in 1914-15 on Joplin lead and zinc mine workers in which gravimetric analyses were used is still authoritative and valid. Especial emphasis was placed on size grading when estimating the quartz content of rafter samples. A method which is found to be of practical value is the petrographic analysis of the original material and a chemical analysis on rafter samples, checking back. Of considerable significance was a graph showing the reduction in the occurrence of tuberculosis as dust control was accomplished, based on South African experiences.

DR. W. IRVING CLARK spoke on "Clinical Aspects, Diagnoses, and Prevention of the Pneumoconioses." Pneumoconiosis is a disease of the lung resulting solely from the inhalation of dust. There are a large number of inorganic dusts which will produce slight fibrosis of the lung detectable by x-ray, but not producing functional disability. These are called inert dusts. There are two active dusts which produce disability. These dusts are those of free silica and of asbestos. The pathology of silicosis is characterized by the presence of fibrotic nodules scattered through the lower two-thirds of both lungs. The pathology of asbestosis is characterized by an interstitial fibrosis involving the lower half of both lungs. The symptoms of silicosis and asbestosis are similar, the most important symptom being dyspnea.

THEODORE F. HATCH discussed "Design of Exhaust Hoods for Dust-Control Systems." Dispersion of microscopic dust particles away from a dust-producing machine depends upon the movement of the air into which the particles are thrown and is not dependent upon their mass or the velocity with which they are projected. Consequently, the function of the exhaust hood is to overcome the outward movement of dust-laden air (and draw it into the hood) and not to separate the dust from air in which it is suspended. The problem properly involves two steps: *first,* eliminate or reduce as much as possible all air movement in the zone of dust production; *second,* select the proper shape of hood and locate it to operate with maximum efficiency and determine the minimum rate of air flow through it necessary to draw all dust-laden air into the exhaust system. Some simple rules of procedure and elementary equations for calculating the desired rate of air flow were given, although the experimental determination of the latter under actual working conditions was recommended as the most satisfactory means of establishing the necessary capacity of the exhaust system.

DR. CARLTON E. BROWN, of the U. S. Bureau of Mines, spoke on "Protective Equipment." There has been a confusion in the terminology of respiratory protective apparatus. Dr. Brown's classification of using the word respirator to apply to all types of protective apparatus was illustrated. Atmospheres in which protection is contaminated by objectionable or irrespirable gases or vapors, those contaminated by particulate matter, and finally, combinations of these. Types of service which protective equipment is capable of rendering were classified as continuous, intermittent, and routine. The various approval schedules in effect at the present time as devised by the Bureau of Mines were described. Schedule 21 especially designed for the approval of the efficiency of mechanical filter respirators was discussed in detail. The requirements of a good respirator include adequate protection, reasonable comfort while wearing and a reasonable service period.

Friday—August 28

PROFESSOR PHILIP DRINKER discussed "The Application of Air Conditioning in Normal Life." Distinction was made between ventilation and air conditioning, the former meaning merely to change the air, whereas air conditioning changes the physical properties in the air. The real objective of air conditioning is comfort, and the lay estimate of real air conditioning is comfort at the present time. The factors which should be known in any problem are the temperature, the relative humidity, air movement, carbon dioxide content, odor intensity, dustiness, and finally the degree of ionization. All of these are measurable except odor intensity. The physiological requirements are much easier to satisfy than the so-called psychological requirements. To fulfill the requirements of air conditioning, the human being is treated as an object—giving off a measured amount of carbon monoxide and using a measured amount of oxygen and radiating heat. Reference was made to the Handbook of Ventilating Engineers regarding data on air conditioning as being a valuable reference. The comfort zone as worked out by Yaglou was demonstrated—worked out on the basis of a low air velocity corresponding to 15 to 25 feet per minute and using the convection form of heating. The so-called "effective temperature" scales have been based on comfort and opinion of experimental subjects. Acclimatization is of considerable importance in theatre air conditioning, and the differences between the inside and outside temperatures should not be great enough to cause discomfort. Graphic data have been platted on this subject for reference, and pertain to application to exposures of less than three hours. Reference was made particularly to differences between British and American customs, which were explained on the basis of differences in weight of clothing. For outdoor weather, equipment must be provided on an "extremes" basis since a difference of 60° variation in diurnal temperature is not infrequent. Convection is the principle here. Data on the effects of cold walls were given in the form of a chart. Dust and bacteria are not important problems in air conditioning. Pollen removal is obviously important to certain people. Ordinary bacteria are not taken out in air conditioning. Odor is an old problem, in which we are concerned with body odors, which are somewhat soluble, gases from outside sources, particularly manufacturing, and organic odors which are not water-soluble. All such problems can be treated by oxidizing the odors with agents such as chlorine or ozone, but the excess of the oxidizing agent is the real problem. The use of ozone for recirculation is not practical at the present time. Low concentra[illegible] odors can be dealt with by passage of the [illegible] through activated charcoal, but this is not d[illegible] on an extensive basis at present. There has b[illegible] no progress in tobacco smoke odor control[illegible] washing problems ordinarily accentuate this d[illegible]ficulty. Body odor intensity is related to re[illegible]culation of air, as shown by platted graphs [illegible] introduced by Yaglou. The old standard of 30 [illegible] 50 cubic feet per minute should be changed to [illegible] to 500. Air movement ordinarily ranges in su[illegible] instances from seven to 25 feet per minute. D[illegible]crease in ionization occurs indirectly with the nu[illegible]ber of persons involved—this has no known signi[illegible]cance at present. The commercial application [illegible] humidifying shows a gain in the weight of vario[illegible] types of substances. It has been demonstrat[illegible] that the control of acidity or alkalinity of air c[illegible] be a definite preventive of deterioration of pap[illegible] and bindings. Practical experience seems to i[illegible]dicate that it is better to control the wash wa[illegible] in an air conditioning system than to pass the a[illegible] through a deodorant. Air conditioning can be a[illegible]vocated on the basis of comfort. There are [illegible] adequate data at the present time relative [illegible] health effects.

CONSTANTIN P. YAGLOU discussed "T[illegible] Application of Air Conditioning to Hospitals[illegible] This is a different problem from air conditioning in schools, offices, or theatres. Cooling is be[illegible] accomplished by portable room coolers—here a di[illegible]ficulty is encountered on account of the small si[illegible] of many rooms in hospitals and, therefore, it is [illegible] good procedure to put the apparatus under th[illegible] bed. The experiments were done in this work [illegible] premature nurseries, in the giving of anesthesi[illegible] in the use of oxygen chambers, in the treatment o[illegible] hay fever and asthma, and in the case of the ap[illegible]plication of fever therapy. In experimental work in premature nurseries, it is important to mainta[illegible] a constant temperature and a relative humidity of 65%. With such conditions the gastro-intestin[illegible]al mortality was decreased. The criteria on which the results of these experimental data were finall[illegible] judged were stability of body temperature; i[illegible]creased weight; decrease of the gastro-intestin[illegible] syndromes, and decreased mortality. The pro[illegible]lem is to maintain high humidity—approximatel[illegible] 65%—but the comfort of doctors and nurses mu[illegible] be considered. The temperature is not so impor[illegible]ant, but infants must be kept warm continuously[illegible] The problem of administering gas anesthesia [illegible] the control of static electricity. The answer [illegible] this problem is proper humidity control. The Am[illegible]erican Medical Association figures that 60% m[illegible] be safely and economically used. With this the[illegible] is an air exchange of 10 to 15 times per hour. T[illegible] problem of air conditioning may also be appli[illegible] to the x-ray room. Sterilizing rooms should [illegible] treated by exhaust ventilation. Postoperati[illegible] wards also find this an advantage. In oxyg[illegible] chambers temperature and humidity can be co[illegible]trolled within fair limits. The optimum temper[illegible]ture here is 60 to 65°, with a relative humidity [illegible] 25 to 40 and an oxygen concentration of 40 [illegible] 60%. Slides were shown with a cross-section [illegible] oxygen chamber and a flow sheet of test cond[illegible]tions. Allergy in relation to hay fever can [illegible] controlled by two methods, by desensitization [illegible] by air conditioning. This condition is accompli[illegible]ed chiefly by filtration with a temperature of 70[illegible]

80° and a relative humidity under 65%. Small filter units for the purpose of controlling allergic reactions are now available on the market. In fever therapy, Walker's experimental work was cited relative to the destruction of cancerous tissue. There is a different application in this field. It may be the patient and not the disease that should be treated in relation to air conditioning.

Dr. W. F. von Oettingen presented the subject, "A Laboratory of Industrial Toxicology." Industrial medicine, like the control of contagious diseases, forms part of the large field of preventive medicine. The impressive success gained in the field of prevention of infectious diseases which resulted in the control of such diseases as cholera, typhoid, typhus, plague, and diphtheria, was only possible after their cause had been discovered and their action had been elucidated. Industrial medicine is still hampered in its success by the considerable lack of information regarding the cause of industrial poisonings and especially with regard to the mechanism of action of numerous chemical compounds. This handicap becomes more serious in view of the steadily increasing number of chemicals of the most diversified nature being constantly produced by the chemical industry all over the world. In order to give the industrial physician all the information necessary for the prevention, early detection and treatment of poisonings, it is not sufficient to determine the toxicity of chemical compounds and to elucidate the toxicological symptoms which may be observed under different conditions, but it is more essential to establish the pathological changes in the different organs and to study the effect of such substances on the metabolism and their fate in the organism, because it is frequently not the compound proper but its oxidation or split products which produce the deleterious effect. For these reasons the laboratory of industrial toxicology has to be composed of three departments, toxicology, pathology, and bio-chemistry, which work together in close collaboration. The arrangement of a laboratory of industrial toxicology was discussed, and the lecture was illustrated by lantern slides. In the discussion also a number of special arrangements were included which have been developed for certain specific purposes, such as the production of constant, high dilutions of vapors and toxic gases, of droplets, and of fine suspensions of solids in air. It was pointed out that the complexity of the problems in industrial toxicology requires a study from different angles by men who have had special training in their line, and for this reason it does not appear advisable to set up small units for the study of such questions because these would necessarily suffer from lack of facilities and of the necessary diversified staff. It appears to be more reasonable that small concerns of similar interest collaborate in establishing and maintaining such a laboratory, which would result in a more complete and more detailed knowledge of the toxicological properties of chemical compounds and their potential dangers. Without such knowledge, industrial medicine will be hampered in its progress, and only after these foundations

Warren A. Cook, Chief Industrial Hygienist, State Department of Health, Hartford, Connecticut, presented the subject, "A Laboratory of Industrial Hygiene." The design and equipment of a laboratory of industrial hygiene must be well adapted to the function it is to serve in occupational disease control. The purpose of the laboratory cannot be fullfilled, no matter how complete the physical appointments may be, unless it is manned by a staff trained in making the necessary determinations, in conducting field studies, and in interpreting the results. Qualifications for such personnel are briefly discussed by Gray in a paper which also presents the place occupied by the laboratory in relation to the entire occupational disease control organization. An extensive experience in coping with occupational disease problems has conclusively demonstrated the vital importance of a well designed and well equipped industrial hygiene laboratory. The essentials in the design of an industrial hygiene laboratory have been presented, together with a description of the laboratory from which this paper was contributed. General types of equipment for the industrial hygiene laboratory were discussed, both for field and laboratory operations. Equipment for specific determinations of dusts, metals and metalloids, organic solvents, vapors, gases and illumination were briefly described.

The Injured Workman

—Methods of Handling to Get Him Back on the Job—

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I cannot resist the temptation to emphasize the keynote of the Safety Congress by reminding you that the best method of getting a man back to work is the prevention of his injury. * However, until we reach that Utopia of human perfection, the problem of getting the injured back to work is an important and serious one. While accident prevention methods have markedly decreased the number of those temporarily or permanently incapacitated, the problem once the injury has occurred is fully as important as prevention, as far as that particular individual is concerned.

In discussing the subject, it is understood that the broader viewpoint is taken, i.e., not only in returning the man to work but also getting him back in the best possible status. The question should not be "how soon did you get him back, but how well did you get him back." Have you given him the best possible opportunity for the pursuit of happiness, gainful employment and economic independence as regards himself, his family, industry and society as a whole? This of course must be gauged by the inherent capabilities possessed by the individual before the accident.

Before any method can be devised, there must be a thorough understanding of the problem presented. There is an apparent or dormant reaction