

CHEMICAL METALLURGICAL ENGINEERING

ESTABLISHED 1902

AUGUST, 1940

S. D. KIRKPATRICK, Editor

MAN-POWER FOR MUNITIONS

WHO WILL operate the many explosives plants and other munitions works that are included in the national defense program? Where will they get the chemists and engineers needed for production and inspection? In the event that the Burke-Wadsworth bill for compulsory military service should be enacted, will there be adequate provisions for exempting technical men if presently employed in "essential" industries? Who is going to define such classifications and when?

These are questions being seriously asked by chemical engineers in many industries. They recall only too well the mistakes that were made in 1917-18. But they also realize that the present personnel situation in this country may be vastly different. The chemical profession has grown so tremendously that today the government has a much greater supply of technical men — both employed and unemployed — from which to draw its requirements. Many of these men had some experience in the World War or have since been concerned with plant operations closely related to the production of chemical munitions. It is only natural that they should want to know when and how their services can best be used.

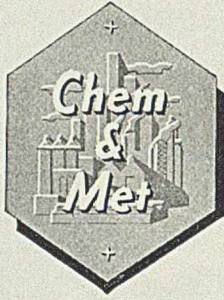
Judging from reports in the technical press of both England and Canada, advanced planning for chemical personnel has not worked out as effectively as was anticipated. The editor of *The Industrial Chemist* (London) has complained that red tape in the Civil Service has bogged down the Office of the Central Registrar and that many chemists and engineers are still available for government service despite that Office's widely advertised shortage of technologists. The editor of *Canadian Chemistry and Process Industries* sees no reason for further restraint on the part of those chemists and engineers who wish to join the armed forces of the Dominion. These men have grown tired of waiting for civilian jobs from their Voluntary Technical Registration Service Bureau, even though they know that the largest plant expansion program in the history of Canadian chemical industry

is just now under construction and operation.

If we are to avoid misunderstandings and disappointments in this country, it is time that we started to study this problem realistically. We should have as soon as possible an advanced analysis of the chemical man-power required for national defense operations and in essential civilian industries. Simultaneously, we should make an inventory of our profession to know the number of chemists and chemical engineers now employed in the different industries and services. A special file should be compiled for those men with previous experience in the manufacture of military explosives or of the basic chemicals needed in the munitions program. Then and then only will we be in a position to advise the government on the necessity for transferring technical men into more essential work or for providing draft exemptions for those whose present jobs are in connection with the defense operations.

Sooner or later this program is also going to involve the setting up of additional training courses for chemical plant operators and inspectors. Older men who have been out of the industry for a long time will not find it easy to recover their old skills and readjust themselves to new processes and equipment. Younger men coming up in the ranks or entering from other industries will require intensive training before they can carry even minor responsibilities in chemical plants.

Summing up: It looks as though we may soon have a chemical personnel problem on our hands. We haven't much information to go on so our first job is to find out how many technically trained men are going to be needed and how many we've got on hand to fill the bill. If shortages in any lines are imminent (inspectors, for example) we should provide adequate training courses in our industries or in the universities. Our job is to help in putting the right men in the right places in the civilian as well as the uniformed arms of defense. It is not going to be easy as English and Canadian experience shows only too well.



FROM AN

ERSATZ—AMERICAN STYLE

To SUPPLY the huge quantities of ammonia needed for the manufacture of TNT and smokeless powder is a problem that has demonstrated the remarkable flexibility of the American chemical process industries. Among other things it has proved that whiskey can be used to make explosives. Here is what is happening:

More ammonia can quite readily be made by transferring present methanol synthesis units from their regular jobs to that of making ammonia. That at first seemed to threaten a serious shortage of methanol. Should such shortage actually appear, however, the remedy will be easy. Ethyl alcohol can be substituted, especially in the anti-freeze field. And the alcohol production capacity which can most readily be expanded is that controlled by various alcoholic beverage makers. These men have expressed their willingness to the government to change over from beverage making to industrial alcohol manufacture if this will help in the defense program.

This type of substitution and interchange among industries explains why there is relatively little chance of serious shortage of many things made by chemical engineers. When whiskey can aid in making high explosives, certainly a great many other seemingly unrelated industries are going to be able to get together to insure against commodity shortages.

RENEWED PRESSURE FOR UNIONIZATION

WHEN TIMES ARE GOOD the labor organizer attempts to extend unionization further into industry. It is not surprising, therefore, that American Federation of Labor often looks at the unionizing possibilities of the chemical industries, and with envious eyes. This group of industries is reasonably stable. Although the workers are well satisfied and well paid, they are also well able to pay union dues. This means that the organizer is looking at a most profitable group of prospects.

Just now American Federation of Labor is starting a new effort to unionize the chemical industries. The organizers know that the approach

cannot be "better wages" or "shorter hours." In both these particulars the chemical workers form one of the most favored groups in America. Quite a different approach is planned. The organizer will claim that the workers are "entitled to a larger share of the income of the industry." A.F. of L. workers are also making a great point of the fact that the chemical industries are vital to military preparedness. The success of the union apparently "depends on war prospects." And there is no hesitation in high places to suggest that if the companies will not help on unionization, the plants "should be struck."

Chemical executives are facing an extremely difficult problem under present circumstances. There is intrinsically no objection to organization of workers. Collective bargaining has been written into the laws of the land, but there is very great objection to several of the unionizers' policies, both those of A.F. of L. above mentioned and the still more vicious claims of C.I.O. That the organizers will undertake to stir dissension and create "incidents" goes without saying. They cannot make progress by reason alone.

Probably chemical industry has already made the most important preparation to protect against the unwarranted claims of the union organizers. That preparation has been the payment of good wages, the provision of safe and comfortable working conditions, and the dealing with all employment problems with sincere man-to-man cooperation. Nevertheless, there are probably some definite sore spots in almost every plant with many workers. It is the job of all executives from the president to the straw boss of a small gang to find and correct these places. It is neither safe nor sensible to wait for them to be the source of further difficulty, even though the organizers call this type of cooperation an attempt "to forestall unions by paternalistic policies."

Two special precautions deserve further mention. In the first place, there can not legally be any effort to prevent organization for collective bargaining. And probably such organization, when it represents the workers and not some remote group of trouble makers, is a step toward good business management. Secondly, the executives must arrange to protect their professional workers from undue pressure. When the college graduate

EDITORIAL VIEWPOINT

who is a scientist or engineer takes a regular operator's job, he is legitimately subject both to any employment rules of the management and to any reasonable approach by union organizers which would apply to other operatives. But the young cadet engineer who is assigned for a *short* period in an operative job, merely as a matter of training for executive or supervisory position, should not be subject to union discipline.

Intelligent consideration of problems such as these will result in a proper classification of the technical and scientific workers in laboratories, development departments, and subordinate administrative positions. Fortunately, the unions have learned that it is not to their advantage to demand that such men join the union.

The spirit of cooperation with his workers will be the test of each executive's skill in the next few months, which may be made more than usually difficult if the union organizers make even part of the effort which they are hoping to exert.

UPSETTING STATUS QUO

TOO MANY PEOPLE seem to go by the motto that "any change is wrong." Under present circumstances that is a very dangerous attitude for any of us to take. It may result in serious interruption of business.

Not every change is good of course. But we should consider seriously any proposed change made by responsible people even though the first impression may not be favorable. Just now that is more than ordinarily a good policy. And the buyer must be willing to open his mind to suggestions for changing equipment or raw materials, or modifying manufacturing processes.

In the effort for rapid defense preparations, certain commodities and certain types of equipment are going to be temporarily unavailable in normal quantities for usual purposes. Certain widths and gages of steel plates, for example, are no longer in stock because of demands from shipbuilders. Purveyors of goods and sellers of machinery will often discover such facts before the purchasing agent or the plant engineer. It is important, therefore, for the man on the purchasing side of the table to consider the seller's recommendations.

And the purchaser has a certain responsibility

for working out plans "to do without," even before he is warned. It is hard to tell where shortages may develop. It will be a good thing to be ready for them even if they never occur.

WHAT PRICE TOLUOL?

UNDER THE IMPETUS of an "emergency" many an industry has been born. World War I was the emergency that gave birth to the American coal-tar and synthetic organic chemical industries. And in a similar manner World War II may be expected to stimulate other chemical processes to bridge the gap between pilot plant and commercial installations.

Petroleum refiners are thinking along such lines as they brush up on their toluol technology these days. They have several toluol processes in the pilot-plant stage ready to go (see pp. 535-537), but the question of price is holding them back. Operating costs for new plants would not be high but amortization charges boost the cost to a prohibitive figure under normal conditions. A war-time emergency with its consequent demand for toluol for TNT might solve the problem nicely by allowing refiners to write off their investments in a comparatively few years. Then competition with coke-oven toluol after the emergency might be feasible.

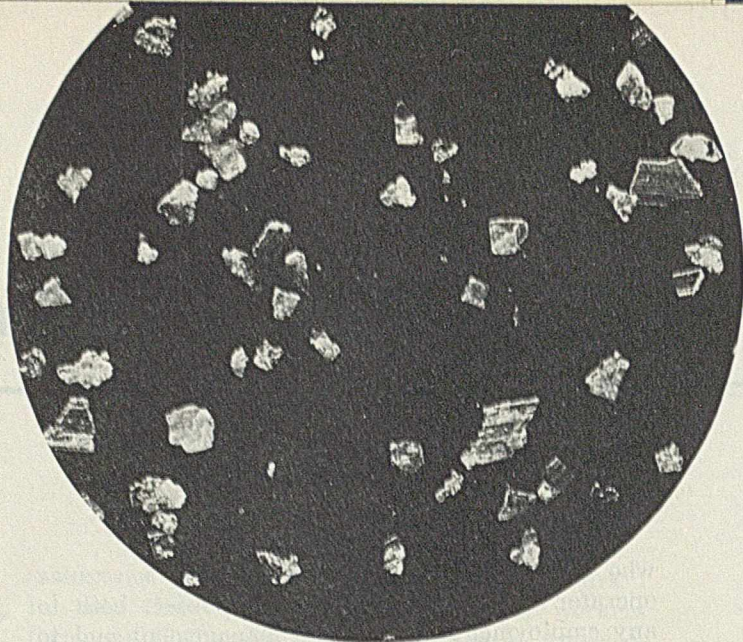
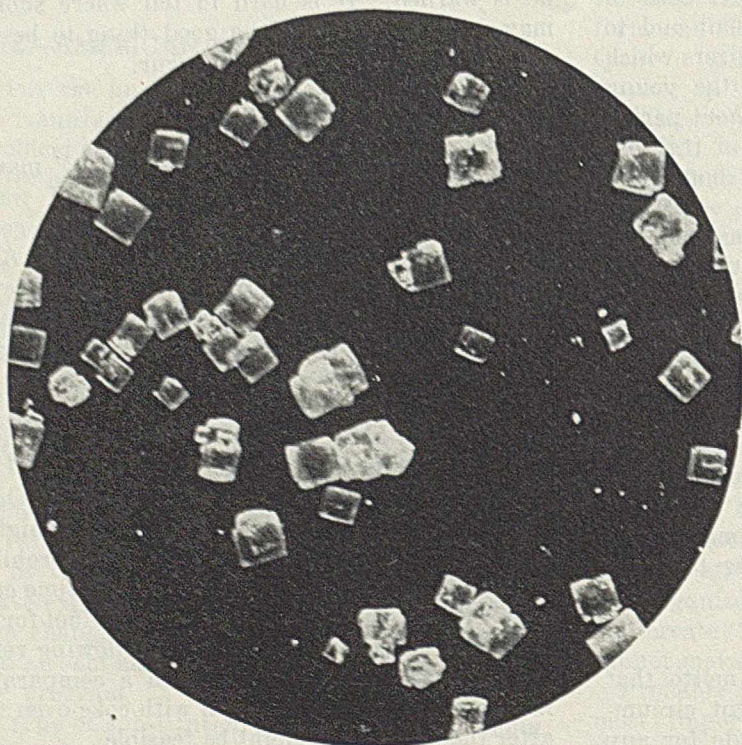
There are three strings attached to this proposition, to wit: (1) Toluol for TNT must be of extremely high purity, thus requiring costly refining; (2) there is no immediate shortage of toluol and government demands will depend on the time of installation and operation of new munitions plants; (3) chances are the government does not intend to pay more than 33-35 cents per gal. (present price 28½ cents) because all demands can probably be met at such a figure by the coke-oven and tar refining industries unless war is actually declared.

Shell Development Co. has evidently found a solution to these technologic and economic problems because it is now building a half million dollar plant at Houston, Texas, to make 2,000,000 gal. of toluol from petroleum yearly. How soon other oil companies will announce the status of their researches in this field is a matter of conjecture.

Our own opinion is merely that the toluol situation will bear watching in the months to come and that the all-important question of price will decide the birthday of the industry.

A Salt for Every Use

JAMES A. LEE, *Managing Editor*



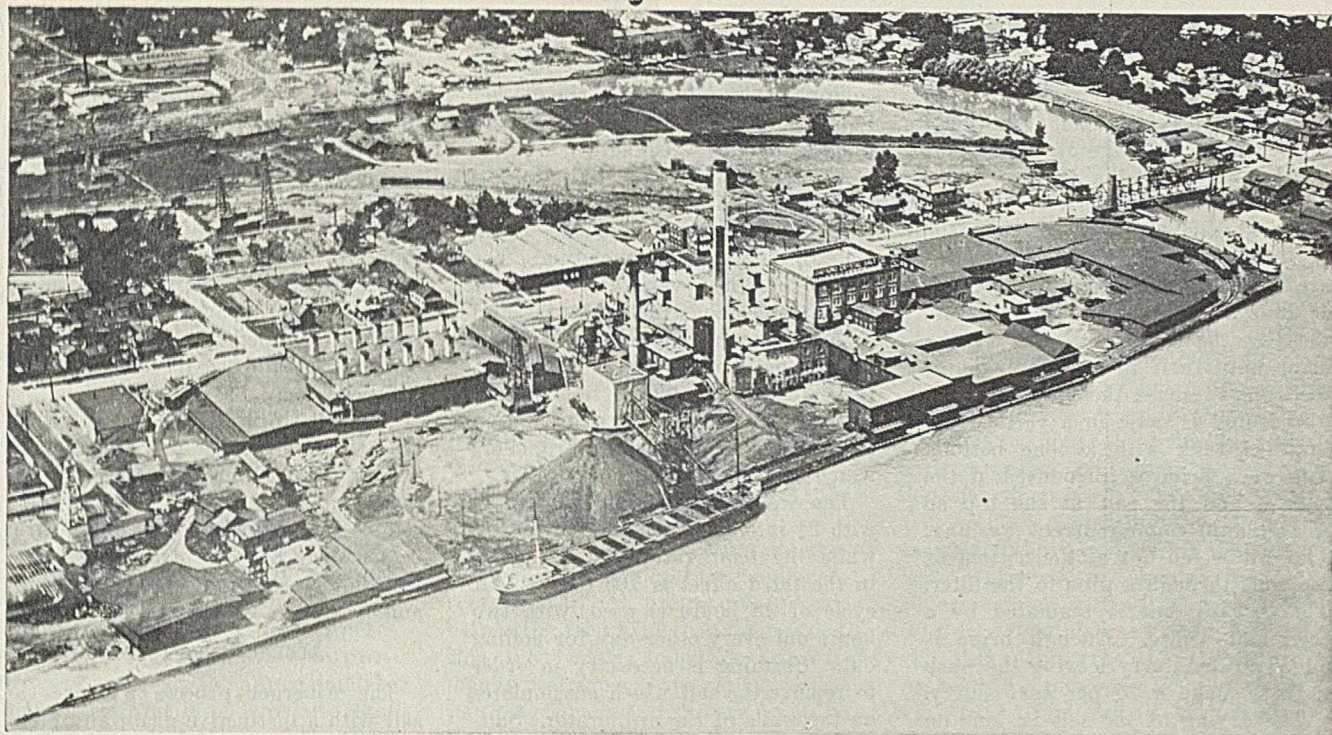
The grain of salt is determined by the method of evaporation. Surface evaporation (grainer) produces a hopper-like crystal; boiling (vacuum pan), a cubical crystal shown at left; and flash (Alberger), an agglomerate crystal shown above. Fragments of hoppers produce what is known to the trade as flake grain

Chem. & Met. INTERPRETATION

Here is a rare opportunity to compare the three processes, grainer, vacuum pan and Alberger, for refining salt by evaporation. There is only one place in the world where the three are operated under one roof, the St. Clair, Mich., plant of the Diamond Crystal Salt Co. This organization long ago recognized the value of chemical engineers and consequently has made great strides in operating technique, developing new equipment and in making this plant one of the most modern in the country. The selection of proper materials of construction has been the subject of much experimentation that has led to the adoption of the newer metals in many instances. It has been demonstrated that welded steel vacuum pan bodies are justified by their much lower first cost over cast iron. Pans of this type construction have been in service for five years and the corrosion has been negligible to date.—*Editors.*

EVAPORATED salt must be produced to meet definite specifications as to purity and crystal grain. These specifications vary according to the use for the product. In order to make salt that will meet different specifications, it is advantageous to produce it by more than one process. The Diamond Crystal Salt Co., St. Clair, Mich., has the unique distinction of being the only organization producing salt by three processes. Each one makes a product with distinctively different characteristics. These processes are distinguished from each other by the manner in which the evaporation of the brine takes place, the method by which the impurities are removed, and the processing equipment required.

The major impurities in the brine from which salt is made are calcium and magnesium chlorides and calcium sulphate. The purity and quality of the salt depend upon how effectively these impurities are removed. This can be accomplished either by washing them from the salt after they have been allowed to accumulate in the mother liquor or by separation from the brine before the crystallization of the salt occurs. The latter can be done either by chemical precipitation or, in the case of calcium sulphate, by direct crystallization at high temperatures. Chemical precipitation with sodium carbonate eliminates the calcium and magnesium as carbonates, but sodium sulphate



St. Clair, Mich., salt refinery of the Diamond Crystal Salt Co.

is formed at the same time and must be washed from the salt as it concentrates in the mother liquor. The disposition of calcium sulphate by crystallization at a high temperature is the basis on which the Alberger process operates.

The grain of salt is determined by the method of evaporation of which there are three being used for brine, namely: surface evaporation, evaporation by boiling, and flash evaporation. Surface evaporation produces a hopper-like crystal; boiling, a cubical crystal; and flash, an agglomerate crystal. Fragments of hoppers produce what is known to the trade as flake grain. For many uses of salt, a high specific surface (surface area per unit weight) is required which the flake and agglomerate grains provide. Usually the coarser grades of Alberger salt are flake grains and the finer grades agglomerate grains. The cubical grain has no desirable characteristics and is produced only for use where the grain of the salt is not important.

The manufacture of salt by any method involves a majority of the unit operations. In each process, corrosion problems are present which must be solved not only to reduce costs but to prevent the contamination of the salt with products of corrosion. Since the salt manufactured by Diamond Crystal is largely used by the food industries, care has to be taken to insure cleanliness.

The three salt manufacturing processes used by the Diamond Crystal Salt Co. are grainer, vacuum pan, and Alberger. These processes are described separately. The equipment, materials of construction, method of evaporation, purification, and other chemical engineering operations of each process are discussed. The flow sheets for the three methods may be found on pages 565 to 568.

GRAINER PROCESS

Grainer salt is made by surface evaporation of brine in long, shallow pans. The salt is washed with brine which removes most of the impurities. The equipment is operated to produce a coarser grain than is made by the other processes. The conveying and drying equipment have been designed so as to reduce grain breakage as far as possible.

This company produces salt in six grainers, the dimensions of which are 18 ft. x 150 ft. x 1½ ft. The daily capacity of the pans is 80 tons. The brine is heated with submerged steam pipes. A scraping conveying system along the bottom of the pans continually removes the salt from the grainers, elevates it to a drainboard, and eventually discharges the salt into a Monel metal launder or trough. The launder carries the salt to a slurry pump which elevates it to a combination washing and supply tank directly over the salt dryer. The

dryer consists of a top feed Oliver filter which both dewater and dries the salt to less than 0.10 per cent moisture. The salt from the dryer falls onto a magnetic, vibrating, cooling conveyor. After cooling, it is passed through rollers to break up the lumps formed on the dryer and cooler. It is then ready for screening and packing.

The grainer feed brine contains impurities of calcium and magnesium chlorides and calcium sulphate totaling 0.75 per cent. Most of the chlorides accumulate in the pan brine and are eventually discharged to the sewer when the grainers are periodically cleaned. Some of these impurities adhere to the salt but by washing the crystals with feed brine they can largely be removed. Less than 10 per cent of the original calcium and magnesium chlorides present in the feed brine appear in the finished salt. The calcium sulphate, however, precipitates with the salt in very fine crystals. Because of its fineness, it can be washed from the salt. The removal of calcium sulphate is 75 per cent effective. The grainer pans are made of steel, and in order to prevent their corrosion with resulting discoloration of the salt, the brine is kept at a pH of 8.5 by the addition of lime.

The crystallization of grainer salt is mostly on the brine surface where the evaporation takes place. The growth of crystals is the result of

additional cubes of salt becoming attached to the original nuclei. As the small cube nucleus grows, it immerses slightly so that additional growth is on the edge of the nucleus which is nearest the surface. The nucleus tends to take a rectangular form at the surface so that the crystal tends to have flat sides which are formed by many cubes. These crystals are supported near the surface by the surface tension of the brine until their increased weight or disturbance cause them to sink.

Washing is done in a vertical cylindrical tank with a cone bottom. The wash brine is introduced at the bottom and the salt at the top so as to obtain countercurrent washing. The salt is fed out of the bottom of the cone through a pipe to the filter. The flow of salt is regulated by a cock and orifice. Enough brine is added to the slurry leaving the wash tank to make a 25 per cent slurry.

The drying of the salt is done on a top feed Oliver filter with air at 700 deg. F. The operation of the drying equipment is automatic but the supervision of an attendant is required.

The salt leaving the filter is at a temperature of 400 deg. F. which is too hot to handle on the dry salt-conveying belt. It is therefore cooled on a magnetic vibrating conveyor, the underside of which is sprayed with water in order to keep the conveying surface cool. The temperature is thus reduced by conduction as well as by radiation and convection.

VACUUM PAN SALT

Vacuum pan salt is made by boiling brine at less than atmospheric pressure. The salt grains produced are cubical. This process was de-

veloped to produce an evaporated salt cheaply. The purity is accomplished by retaining in the mother liquor a large percentage of the impurities and by washing.

The Diamond Crystal Salt Co. has one 10-ft. triple-effect evaporating pan. Each body contains 788—2½ in. o.d. x 5 ft. 16 gage copper tubes. The bodies of the evaporators are of welded steel construction with steel tube sheets and copper tubes. The vapor lines are of steel. The down-take well area is equal to 51.7 per cent of the tube area. Circulation is increased by the use of propellers which are constructed of Ni-Resist.

The evaporator is usually operated with 2½ in. vacuum in the first effect, while the temperature of the brine in the third effect is 108 deg. F. A cycle of 48 hours is used, with two hours out every other day for boiling out. Cleaning is necessary in order to remove the salt which accumulates on the walls of the evaporator. Salting of the tubes is never encountered. A cycle of 72 hours between cleaning operations has been tried, but this practice was discontinued because it was difficult to maintain the purity of the salt during the last 24 hours.

There is no calcium sulphate scale formation on the tubes, and it is therefore possible to operate the evaporators at all times at maximum production. Elimination of the scale is accomplished by controlling the alkalinity of the brine in the pans so that it is slightly alkaline to phenolphthalein. At this alkalinity, a slight deposit of a basic magnesium carbonate forms on the tubes which is largely removed during the boiling out.

The salt is drawn continuously from each evaporator in a 20 per cent slurry through the salt leg. The

feed brine is introduced into the bottom of the leg so that the salt is washed by the incoming brine. The impurities are thus washed back into the pan where they are allowed to accumulate until the boiling-out period. This washing system removes 85 per cent of the impurities that are present in the original feed brine. When the evaporators are to be boiled out, part of the mother liquor is pumped to tanks where impurities are allowed to settle so that the brine may be recovered.

The salt slurry is pumped to a top feed Oliver filter for dewatering and drying. This filter reduces the moisture content of the salt to 0.05 per cent. The drying air temperature is 350 deg. F. The dried salt leaving the filter is ready for screening and packing.

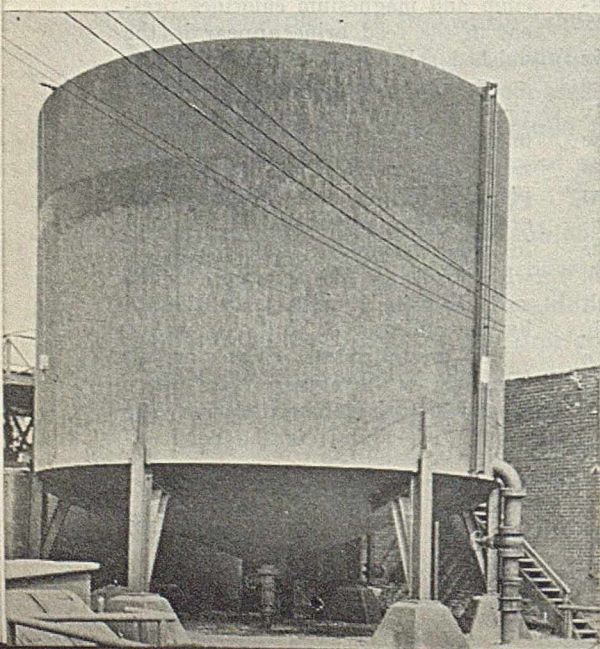
ALBERGER PROCESS

The Alberger process produces a salt with a distinctive grain and high purity, by an unusual method of evaporation. The features of the process can best be understood by following the flow sheet.

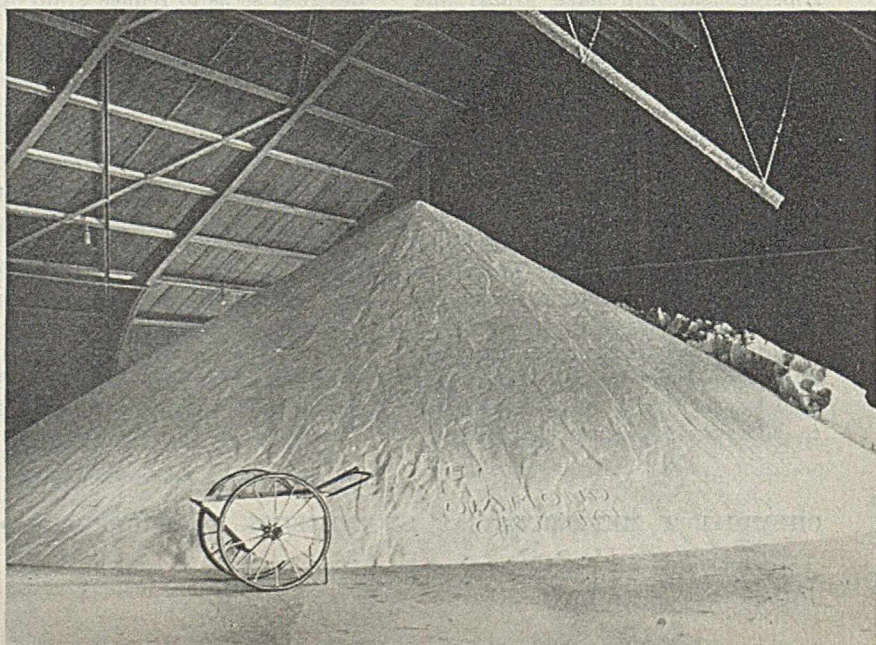
An Alberger unit consists of brine heaters, a calcium sulphate removal system, flashers, and open evaporating pans. The evaporation of brine is carried out in what might be called a "closed" system by circulating brine through the equipment continuously. All of the brine which enters the suction of the circulating pump, except about 7 per cent which is evaporated during the cycle, passes through the entire system of heaters, gravellers, flashers and open pans and finds its way again to the suction of the pump—where feed brine is added to replace that lost by evaporation.

Starting at this point, the first step in the process is that of heating.

Welded steel plate, suspended-bottom brine tank



A mountain of Diamond Crystal salt in a storage bin



As the brine leaves the circulating pump and passes through the series of heaters, its temperature is raised to about 290 deg. F.—considerably above the atmospheric boiling point, but evaporation is prevented by keeping the total pressure on the brine at least equal to the vapor pressure. From the heaters, the brine is passed through a cylindrical vessel filled with stones, which is called the “graveller.” Here, because of its elevated temperature, the brine deposits calcium sulphate. This is the method used for removing this major impurity in the brine.

The brine then passes on into the flashers, where evaporation begins. The pressure on the brine is released in steps in the three flashers in series, and each drop in pressure brings about flash evaporation and an accompanying drop in temperature. In the third flasher the pressure is dropped to approximately atmospheric and it is here also that salt begins to crystallize. The mixture of brine and salt is then discharged from the third flasher, at the boiling point, through a pipe extending beneath the surface of the brine in an open pan. As the brine then passes through the open pan, surface evaporation and further crystallization occur, and finally the brine overflows from the pan and passes again to the suction of the circulating pump. The salt is drawn from the pan to a centrifuge from which it passes to a Monel lined rotary dryer where the drying is completed.

Multiple-effect evaporation is obtained in the Alberger process by using the vapor from the first two flashers to heat the circulating brine in corresponding heaters and by using a portion of the vapor from the

third flasher to heat the feed brine.

The physical-chemical fundamentals involved in the Alberger process can be most clearly presented by means of a “crystallization diagram.” This diagram consists of a plot of sodium chloride concentration against temperatures at different points in the process cycle. This plot is based upon actual determinations of the concentrations, supersaturations, and evaporation rates involved. The concentration unit used is merely a practical one for convenience in calculating production figures and the temperatures are plotted as degrees fahrenheit. The solubility curve for sodium chloride is included in the plot for reference.

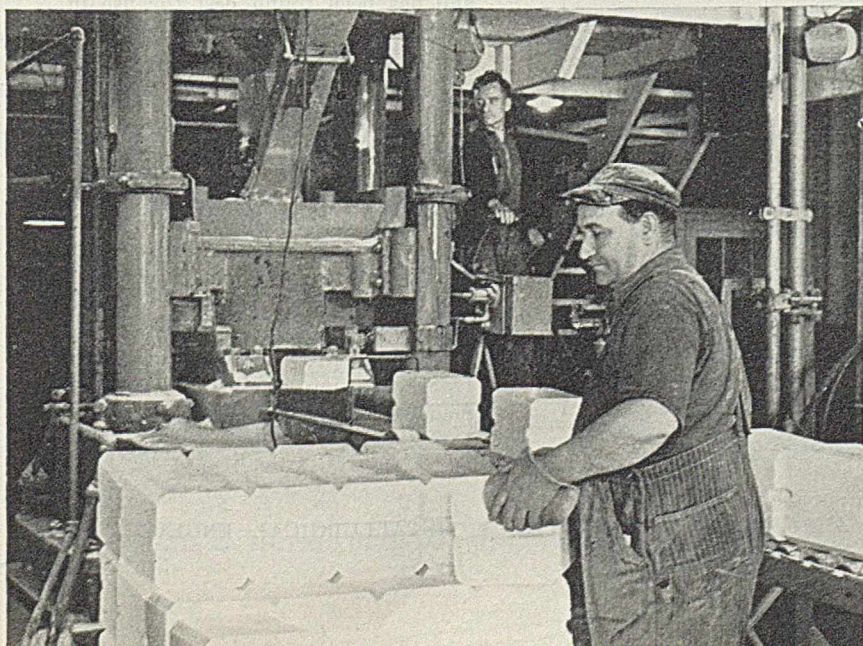
Point “A” on the diagram represents the temperature and concentration of the pan overflow brine before the feed brine has been added. The feed brine added is approximately the same temperature as the pan overflow and, therefore, its addition does not change the temperature as represented by passage on a horizontal line from “A” to “B”. The pan overflow brine is supersaturated with respect to sodium chloride, whereas the feed brine is unsaturated. The addition of feed brine, therefore, decreases the concentration of sodium chloride, but the resultant mixture is still slightly supersaturated. During the heating part of the cycle, no change in concentration occurs and the only change is an increase in temperature from “B” to “C” in the first heater, “C” to “D” in the second heater, and from “D” to “E” in the live steam heater. On passing through the graveller the brine does not change in either temperature or concentration. Consequently, the brine leaving the graveller and entering the first flasher

is still represented by point “E”. In passing through the first flasher, the change represented by the line from “E” to “F” occurs. In other words, concentration increases due to evaporation and the temperature drops at the same time. The line from “F” to “G” represents the changes which occur in the second flasher, which are similar to those in the first flasher and the brine leaving the second flasher is approximately just saturated. The change from “G” to “H” represents that occurring in the third flasher. Here, as a result of evaporation and cooling, the brine becomes supersaturated and then begins to deposit salt crystals. The line from “G” to “h” represents the changes that would have occurred if the brine had continued to become further supersaturated instead of depositing crystals. The distance from “H” to “h” then represents the amount of flasher salt produced. The line from “H” to “A” represents the changes occurring in the open pan and the line from “h” to “a” represents the further changes that would have occurred had no salt been deposited. The distance from “A” to “a” then represents the total salt produced by the system.

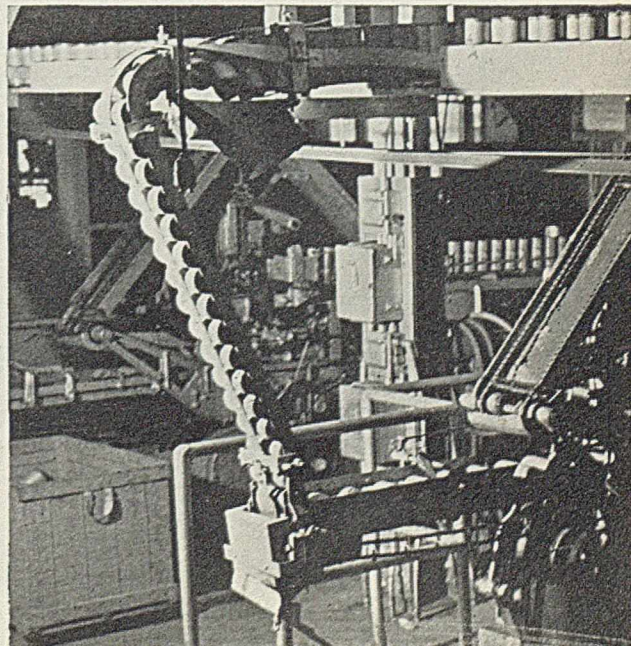
The salt produced in the third flasher is composed of microscopic cubes and needles aggregated in the most irregular shapes to form resultant salt particles of high specific surface. The salt produced in the open pan is composed of hopper-shaped grains, which are typical of surface evaporation. The flake grain is actually the result of fracture of these hopper-type crystals in the drying process.

The Alberger feed brine contains normally 0.45 per cent calcium sulphate and negligible amounts of cal-

Block press where salt for livestock is prepared



A view in the packaging department at St. Clair



cium chloride. The continuous removal of calcium sulphate from the brine by the gravellers prevents the precipitation of any calcium sulphate in the salt crystals. The Alberger system is unique because a condition is set up in the gravellers where salt cannot crystallize, but calcium sulphate is precipitated almost completely. In another part of the cycle (the third flasher and the pan), a diametrically-opposite condition is set up where calcium sulphate cannot precipitate because the brine is not saturated with calcium sulphate; but, at the same time, salt crystallizes because the brine is super-saturated with salt. Thus, calcium sulphate is removed in one part of the system, and salt is removed in an entirely different part of the system. As a result, the amount of calcium sulphate which appears in the finished salt is limited to the amount which is dissolved in the mother liquor clinging to the crystallized salt entering the dryer. Thus a salt of 99.95 per cent purity is produced. The efficiency of the calcium-sulphate removal system is therefore greater than 98 per cent. Since the removal of calcium sulphate is accomplished by a physical process, salt of high purity can be produced with positive regularity.

The use of the Alberger system cannot be justified on the basis of economy. The Diamond Crystal Salt Co., Inc. continues to operate this process because a salt of very desirable grain and extremely high purity is produced, which enjoys a ready market and wide distribution, often

competing against salt of lower price. Alberger salt meets every requirement of the U. S. Pharmacopoeia. In fact, it is very much purer than is required by U.S.P. specifications. Thus the Alberger system is justified on the basis of quality of product rather than on economy.

No discussion of salt manufacture would be complete without stressing the need for adequate screening. Each application of salt requires a definite grain size, and consumers are realizing this fact more than ever before. It is not sufficient to make rough separations, for many of the difficulties encountered in the usage of salt may be laid to improper screening. In the manufacture of cheese, for example, a definite granulation is absolutely essential.

In order to produce "a salt for every purpose" a system of hummer screens is used at the Diamond Crystal plant. The complexity of this salt-screening system resembles that of a well developed flour-milling system. In order to check up on the efficiency of the screening operation, periodic samples are taken at frequent intervals and checked for granulation. As a result, each grade of salt has a definite and uniform character which results in uniformity in blending characteristics, solubility and other important characteristics.

Progress is constantly being made by the Diamond Crystal Salt Co. in the manufacture of salt of better quality. The grainer-salt equipment which dries the salt continuously on an Oliver filter, was first used by

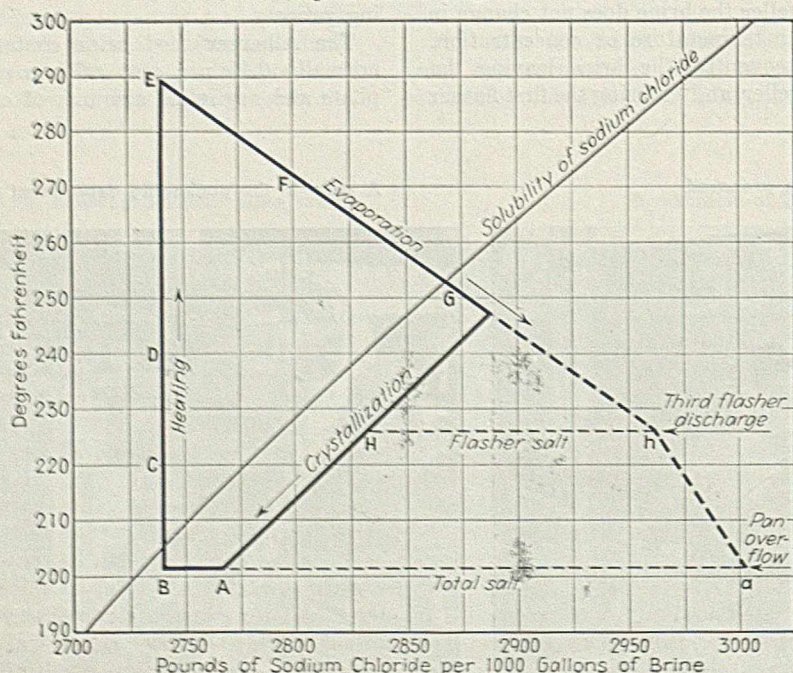
this company. The use of a vibrating conveyor as a salt cooler was developed by the company's engineering staff. The use of these two pieces of equipment has largely eliminated salt breakage. The vacuum pan plant is operated according to modern practices. The limitation of scale on the tubes and salting of the tubes has been a distinct improvement. The use of welded steel bodies is justified by their much lower first cost over cast iron bodies. Previous to the installation of the present triple-effect pan, the company operated a steel single-effect pan for over 30 years. There is no reason to believe that the present pans will not have the same life. The pans are now five years old and the corrosion to date has been negligible. The original propellers which were made of bronze became badly eroded and have been replaced with Ni-Resist propellers.

The Alberger process has been subjected to considerable research work. A new design of the last flasher that eliminates salt crystallization on the walls has been an outstanding development in increasing the efficiency of the system. Several important developments have been made in the use of automatic control instruments.

In a recent article (*Chem. & Met. Eng.*, Vol. 46, p. 142) Diamond & Berry have described salt dryer controls, a vacuum pan condensate recovery system, and Alberger brine circulation controls which have made possible greater efficiency.

The selection of the proper material of construction has been the subject of much experimentation and progress has been made. Monel metal is usually satisfactory and is the standard material for such equipment as dryer linings and wet salt elevator housings. One dryer was tried of nickel-clad steel, but was discarded as unsatisfactory, due to pitting. Stainless steel is used to a limited extent and has been found best for use in Oliver filter screens. Brass is generally unsatisfactory as it rapidly dezincs unless protected most of the time from brine by scale. Excellent results have been obtained from Ni-Resist castings in pumps and filters. Aluminum has been used successfully in lining the underside of the wooden hoods over the evaporating pans. Fortunately much of the equipment that is in contact with brine becomes coated with a calcium sulphate scale. The scale protects the equipment from corrosion so it can often be made of the most economical material.

Crystallization diagram



Petroleum Toluol

For National Defense

Chem. & Met. INTERPRETATION

PROUREMENT OF TOLUOL for American TNT was the No. 1 ordnance problem when Uncle Sam prepared for battle in 1917. But such is not the case in the present program. Big strides in research and experience gained in the previous conflict have placed the petroleum industry in a position effectively to fill the gap in toluol production.

High grade toluol, it will be remembered, is the basic raw material for trinitrotoluol (TNT), important military high explosive. TNT was used by the U. S. in 1917 and 1918 as the bursting charge in medium caliber artillery projectiles—up to the 10-in. size. In the smaller shells it was used alone; in larger shells it was mixed with ammonium nitrate and called Amatol. This was done because of the shortage of TNT. TNT is not suitable for use as a propellant. In the present war larger amounts of TNT are being used in airplane bombs than in artillery shells. The bombs carry up to 60 per cent of their weight in TNT, which is a lot of high explosive in bombs weighing a ton or more. Artillery projectiles on the other hand, carry only 15 to 20 per cent of their weight in TNT which amounts to about 14½ lb. in a 155 mm. shell.

Before the first World War the by-product coke oven was the sole source of toluol. Capacity of the ovens in 1914 was only about 100,000 gal. monthly. By April 1917 this capacity had been stepped up to more than 800,000 gal. At a cost of \$30,000,000 additional coke oven capacity was provided by eight large steel companies. And new ovens at five more mills had been contracted for by the time the Armistice was signed.

Still the capacity was insufficient. In November 1917, construction work began on plants for stripping toluol from domestic heating and illuminating gas. By April, 1918, the first plants of the \$7,500,000 project went into production. Thirteen large cities used gas with 6 per cent less heating value for the duration of the war.

Finally, to complete the picture, a

In accordance with an announcement by E. R. Stettinius, member of the National Defense Advisory Commission in charge of raw materials, Government action is now being taken to stimulate increases in production of toluol. Indeed, procurement of this TNT ingredient is considered so important that steps are being taken by the Commission to assure added supplies, particularly by the petroleum industry. Consequently, Chem. & Met. editors have undertaken a review of the literature with the purpose of comparing certain of the petroleum processes. Since our work was started Shell Development Co. announced plans for building a toluol plant at Houston, Texas, a fact which makes this process study even more timely.—Editors.

third source of toluol was tapped—the abundant hydrocarbons of petroleum. Large plants at refineries of General Petroleum Corp., Los Angeles, and Standard Oil Co. of California, Richmond, were erected at a cost of approximately \$5,000,000. They had a monthly capacity of 3,000,000 lb. (about 400,000 gal.) of toluol and erased all doubt about adequacy of supply. However, the Armistice terminated operation of these plants after a very short period.

A plant for cracking petroleum by the Rittman process (low-pressure high-temperature cracking) was started on Neville Island, Pittsburgh, Pa. but was never completed. A small-scale plant was built and operated in 1918, however, for cracking solvent naphtha under high pressure and temperature by the Hall process at Standard Oil's Bayonne, N. J. works.

Such was the scramble for toluol in 1917 and 1918. It was so successful that the Army's requirements were filled, 11,000,000 lb. was shipped to the Allies and 17,000,000 lb. was left over after the Armistice.

DIFFERENT SITUATION TODAY

Today the situation is vastly different. The problem is again large but the solutions are obvious and

easy. The only important questions to decide are those which relate to minimum cost and maximum industrial convenience. An analysis of the economic factors involved in this decision is presented on page 573 of this issue. From this analysis it is obvious that Uncle Sam must again provide a secondary source of supply.

PETROLEUM A SECONDARY SOURCE

Undoubtedly this secondary source will be the petroleum industry. Thanks to many years of research on old and new methods, the industry is ready with several processes. Investigations since the war were more often aimed at producing aromatics for blending in high-octane motor fuels, but the results are applicable in the present demand for toluol. As pointed out by Cooke, Wagner and Swanson¹, aromatic solvents (with toluol content of as much as 50 per cent) are now produced from high-aromatic crudes. But TNT requires a toluol of 99 per cent purity.

The oldest method of obtaining toluol from petroleum consists of fractionation—generally followed by chemical or physical extraction—of certain crudes. A cut of relatively narrow boiling range containing the toluol (b.p., 231 deg. F.) is taken from the crude. Subsequently, a

high degree of fractionation or extraction with some such solvent as liquid SO_2 , or a combination of fractionation and extraction, yields toluol of the required purity. This process is of limited application. The production of crudes containing appreciable quantities of toluol is quite limited. No comprehensive study of American crudes with respect to toluol content is available. However, it is probable that some of the crudes of California and those of the Smaack-over district of Arkansas are the best of the domestic supplies. Tongberg, Fenske and Sweeney² published in 1938 the results of a study of the composition of 20 virgin naphthas fractionated from unnamed crudes collected in various parts of the world. The naphthas had an average 90 per cent temperature (A.S. T.M. distillation) of 365 deg. F. The investigators designated as the "toluene fraction" of the naphthas that portion having a boiling range between 223 and 230 deg. F. and reported the volume percentages of the fraction in the materials studied. Eighty-five per cent of the naphthas contained no more than 4 per cent, and the remaining 15 per cent contained between 4 and 6 per cent of this "toluene fraction." The actual content of toluol in the fraction was not disclosed. However, even if the fraction were entirely toluol, and if a naphtha containing 6 per cent toluol had constituted as much as 30 per cent of the crude oil, the toluol content of the crude would have been only 1.8 per cent.

RITTMAN CRACKING PROCESS

It is obvious that means are needed for securing toluol in greater amount than that present in a few high-aromatic crudes. One promising method is that for which the groundwork was laid during World War I—low-pressure, high-temperature cracking of petroleum oils. There is some evidence that the characteristics of the oils do not play as vital a part in the yields of toluene as do the conditions under which cracking is carried out. Rittman and his collaborators³ reached this conclusion after choosing three oils as being representative of paraffine, mixed-base and asphaltic crudes. These were cracked at temperatures from 932 to 1,562 deg. F. and pressures from subatmospheric to 24 atm. Results of these experiments showed that for commercial work temperatures from 1,150 to 1,300 deg. F. and pressures upward of 8 atm. were most suitable. A plant was built in 1915 by the Aetna Explosives Co. at

Pittsburgh to make toluol by the Rittman process. However, considerable difficulty was encountered—principally with the condensers, which permitted large quantities of toluol to escape with the gases. Cracking was done in the vapor state in vertical steel tubes, which were inclined to coke up and become troublesome.

More recently Saehanen⁴, writing of low pressure, high-temperature cracking, declared, "The formation of aromatic hydrocarbons in this process at 650 deg. C. and higher, is mostly due to the secondary reactions of cyclization and condensation of olefines. It explains why the yields of benzene hydrocarbons under these conditions are almost independent of the nature of charging stocks, in contradistinction to the customary practice at more moderate temperatures." Not all researchers, however, share this viewpoint, some contending that yields are dependent on the nature of the charging stock.

Groll⁵ reported from the laboratories of the Shell Development Co. in 1933 the results of cracking a paraffinic gas oil of 38 deg. A.P.I. gravity and 530-790 deg. F. boiling range. In a single-pass operation (laboratory scale) using a non-catalytic cracking tube at atmospheric pressure and heated to 1,382 deg. and 1,472 deg. F. the respective yields of toluol were 1.73 and 1.49 gal. per bbl. of charge. The Sarmiza process produces aromatics by vaporization of a petroleum oil and aromatization of the vapors by subsequent heating in three stages, during which olefines produced in the cracking reaction are polymerized to cyclic compounds which are then dehydrogenated to aromatics. When a light oil of 43.4 deg. A.P.I. gravity and 311-535 deg. F. boiling range was vaporized and heated at atmospheric pressure successively at 932, 1,110 and 1,332 deg. F. a yield of toluol amounting to 8.4 weight per cent of the charge was obtained. Precisely what amount of this product was actually made in the process is uncertain since the charge itself contained 13.99 per cent total aromatics.

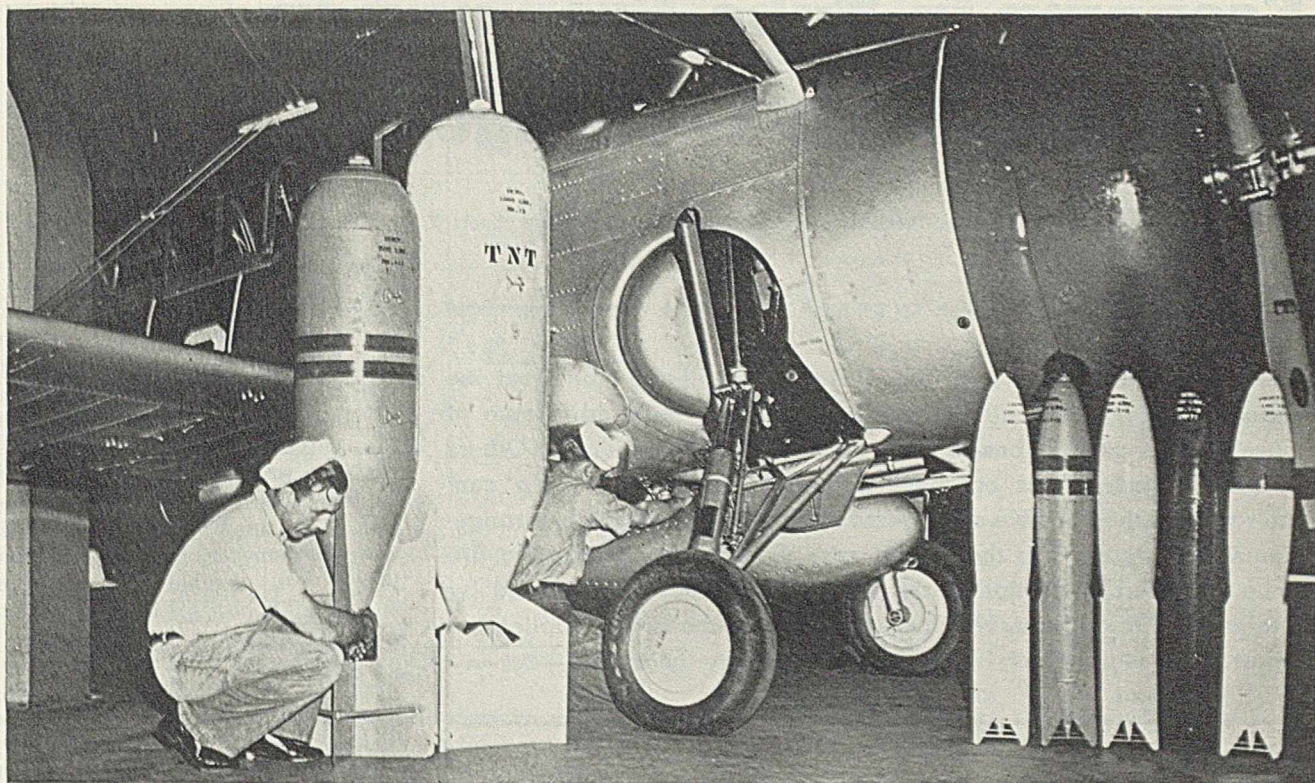
PYROLYSIS OF GASES

A third means of producing toluol exists in the thermal pyrolysis of hydrocarbon gases from petroleum such as natural gas and the cracked gases made in refineries as byproducts. As in the cracking of liquid feed stocks, the reactions of the process are complex and result in considerable amounts of olefines and aromatics. Ridgway, Wagner and Swan-

son⁷ (Pure Oil and Aleo) reported in 1936 in an account of some semi-commercial operations that when a refinery gas mixture containing 35.1 volume per cent unsaturates was pyrolyzed at a pressure of 61 lb. per sq.in. and a temperature of 1,154 deg. F. a yield of 2.07 gal. of 400 deg. F. end point aromatic distillate per 1,000 cu.ft. of gas was secured. The toluol found in this distillate and in a heavier liquid product amounted to over 0.26 gal. per 1,000 cu.ft. of gas charged. The previously mentioned report of Groll⁵ also contained results of some laboratory work on the pyrolysis of individual hydrocarbon gases ranging from ethylene to butane. Under the conditions employed the highest yield of toluol was from propylene. At atmospheric pressure and a temperature of 1,472 deg. F., propylene gave a yield on 0.46 gal. per 1,000 cu.ft. The lowest yield, obtained under the same conditions, was from ethylene, which gave 0.23 gal. of toluol per 1,000 cu.ft.

SYNTHETIC PROCESS

The production of toluol by the catalytic aromatization of *n*-heptane is another process which is receiving consideration. Normal heptane occurs in many crudes and may be separated therefrom by fractionation. Toluol is then made by cyclization with dehydrogenation. Von Grosse, Morrell and Mattox⁸ recently described some results from this process obtained in the laboratories of the Universal Oil Products Co. When *n*-heptane was passed at atmospheric pressure through a tube containing chromic oxide and alumina catalyst and heated to 1,022 deg. F. at a space velocity of 0.385 vol. per vol. per hr., a single-pass yield of about 66.0 weight per cent of toluol was obtained. The mechanism of the reaction was explained as one of successive dehydrogenation. The loss of one atom of hydrogen from each end of a molecule of heptane resulted in the formation of a molecule of methylcyclohexane, and the loss of six atoms of hydrogen from this molecule produced a molecule of toluene. Goldwasser and Taylor⁹ have also produced toluol by the catalytic aromatization of *n*-heptane in the laboratory. Using chromic oxide gel as a catalyst, and employing a temperature of 876 deg. F. they passed *n*-heptane over the catalyst at various feed rates. The conversion of this material to toluol varied from 60 to 100 per cent in a single pass operation, they stated. Unfortunately but little informa-



Uncle Sam's Navy has been credited with having pioneered the technique of dive bombing. Here is its standard Curtiss SBC-4 dive bomber made by Curtiss-Wright. The 100, 500 and 1,000-lb. types of bombs shown require large quantities of TNT. Toluol for defense TNT requirements will probably come from one or another of the petroleum processes described below

tion on the production of aromatics by catalytic reforming (cracking) of petroleum naphthas is available, this process being relatively new. However, it is probable that the total aromatic content of the reformed products is high, perhaps from 30 to 45 per cent depending on conditions of operation and the nature of the feed materials. If the total aromatic fraction contains 10-20 per cent of toluol, it would mean that in this process there is a large potential source of toluol capable of early exploitation. Some large catalytic reforming units are now in operation in American refineries and others are being built.

Another process that is believed to yield large quantities of aromatics, though there has been no published account of it, is the so-called hydroforming process. It was developed jointly by Standard Oil Development Co., M. W. Kellogg Co. and Standard Oil Co. of Indiana (see *Chem. & Met.*, Nov. 1939, p.677). The first commercial installation of this process was made last year at Bayway, N. J. and additional plants have since been built. The principal function of the process is, however, the production of high-octane motor and aviation fuels.

It remains to be seen what process or processes will prove commercially

suitable for manufacturing toluol from petroleum sources. It is a safe bet that no toluol is made by any of these processes in commercial quantities at the present time. However, the following announcement by Shell Development Co. indicates that the time is not far off when petroleum toluol will be a reality:

NEW SHELL PLANT

"It has long been known that concentrates containing 60 per cent toluene are obtainable from selected gasolines, chiefly Borneo gasolines. Such toluene-rich gasolines are not available in the U. S. Though TNT can be made from such concentrates, its manufacture is made more complicated by accompanying hydrocarbons; hence such toluene is only a makeshift during an emergency or grave shortage. Shell has now perfected processes for manufacturing from petroleum toluene of exceptional commercial purity passing the most rigid specifications for TNT manufacture. The product from Shell's semi-commercial plant indeed shows greater purity than samples used in many research laboratories in the past for measurement of the physical constants of this compound. Shell is building at Houston, Texas, a plant to produce 2,000,000 gal. per year and is ready further to increase production to 7,000,000-gal. when necessary."

It is understood that the new Shell plant at Houston will cost \$500,000 and that construction will begin immediately. Certainly these plans are only another indication that the petroleum industry will be able to meet any probable demands for toluol in a national emergency. The *National Petroleum News*¹⁰ reported from Washington in July that the national defense program may require from the petroleum industry between 2,000 and 3,000 bbl. per day of toluol. Whether this quantity is made from gas oil, from combined natural and refinery gases, or from any other petroleum source, only a negligible part of the United States annual production of these raw materials would be required.

REFERENCES

1. Cooke, Swanson and Wagner, *The Refiner*, Sept. 1937, 426. See also A. Lazar, *Ind. Eng. Chem.*, June, 1936, 658-661.
2. C. O. Tongberg, M. R. Fenske and W. J. Sweeney, *Ind. Eng. Chem.*, Feb. 1938, 166-169.
3. W. F. Rittman, C. B. Dutton and E. W. Dean, U. S. Bur. Mines Bull. No. 114 (1916)
4. "Conversion of Petroleum," A. N. Sachanen, Reinhold Pub. Co., New York (1940)
5. H. P. A. Groll, *Ind. Eng. Chem.*, July, 1933, 784-797.
6. M. Nitzesco, *Revue Petrolifere*, 797, 1001-1004 (1938)
7. C. M. Ridgway, C. R. Wagner and H. R. Swanson, *Nat. Petr. News*, 31-4-36, 47-55.
8. Von Grosse, Morrell and Mattox, *Ind. Eng. Chem.*, April 1940, 528-531
9. S. Goldwasser and H. Taylor, *J. Am. Chem. Soc.*, July 1939, 1766-1769.
10. *Nat. Petr. News*, July 17, 1940, 13.
11. F. E. Frey and H. J. Hepp, "The Science of Petroleum," Oxford University Press (1938).

Economy in Tube Grouping in Round-Shell Exchangers

Z. G. DEUTSCH *Consulting Chemical and Mechanical Engineer, New York, N. Y.*

Chem. & Met. INTERPRETATION

There are many factors in the design of shell-and-tube heat exchangers other than calculation of the surface required. Some of these factors can be based only on operating experience. Others as Mr. Deutsch points out here may be understood from a consideration of the possible arrangements of tubes. Four such arrangements are discussed in the article, with the conclusion that two are to be preferred. Selection of the best arrangement is facilitated by a tabulation and charts which avoid need for the user's duplicating a part of the work which has been performed by the author.—*Editors.*

DESIGNERS of shell-and-tube exchangers have introduced a number of expedients for making the fluid paths best suit the requirements of their problem. These all strive toward the ultimate goal of "design for operation," that is, the highest economy in materials consistent with low maintenance costs and low attendance costs. For example, closer tube spacing reduces material cost: partly by direct weight elimination but usually more by reduction in extent of surface needed at the resulting higher fluid velocity. However, since all heat transfer surfaces become fouled during operation, spacing which is too close definitely increases the number of cleanings required per operating period. This not only increases operating and maintenance costs. It also introduces a serious hazard of accidental complete plugging before the impaired performance has had time to register its warning to the operating staff.

Likewise a baffle arrangement from which the highest heat transfer rates can be obtained may introduce just that last straw of extra pressure drop which will prevent use of an existing gravity flow reservoir and piping arrangement. Even though the direct power and maintenance cost of a pump may appear (on paper) to have a somewhat lower annual cost than a gravity installation, experienced operators and engineers know differently.

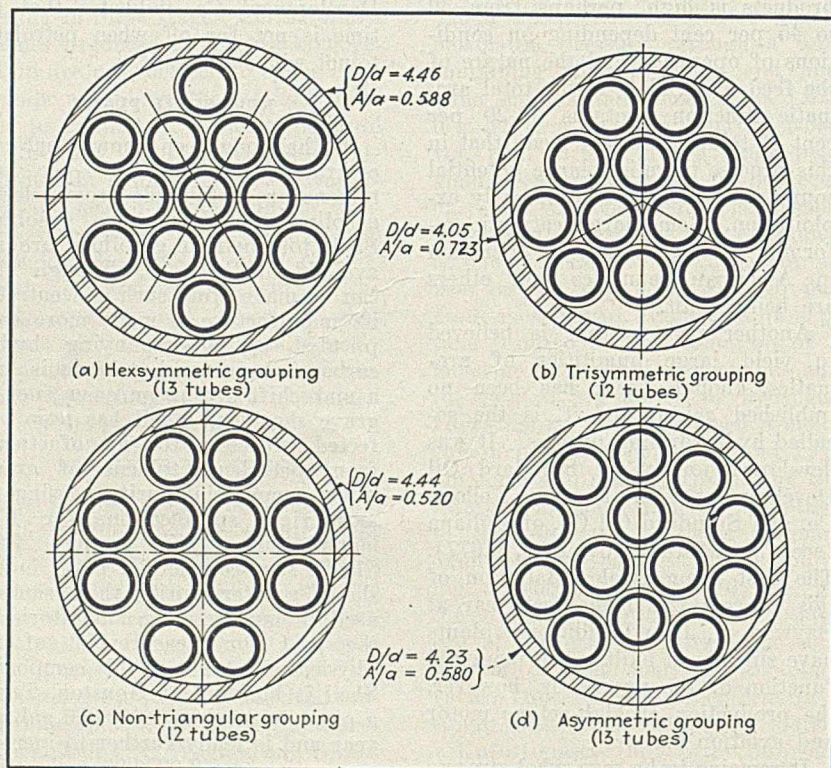
The general requirement of the

tube sheet itself, outside of the elementary one of strength to resist bursting pressure or vacuum collapse, is to support the tubes with a tight, maintenance-free joint. When the fluids separated by the tube surfaces of a heat exchanger have nearly

the same density and nearly the same specific heat, the cross-sectional areas should be as nearly alike as possible. This statement is not invariably true, but frequently so in the author's practical experience. For such problems the best approach to "theoretical" economy of materials is obtained by using the smallest tube diameter, the longest tubes, the closest possible tube spacing, and thinnest possible tube walls that can be justified.

However, for these criteria, certain practical limitations introduce diminishing returns long before the "mill availability" of the usual materials of construction is reached. For example, $\frac{1}{4}$ -in. diameter tubing is readily obtainable, but is extremely limited in application to practical heat exchanger apparatus. Even such a pure liquid as turbine-generator lubricating oil gradually becomes contaminated with an accumu-

Fig. 1—Four possible arrangements of tubes in a shell-and-tube heat exchanger; triangular groupings such as the "hexsymmetric" at (a) and the "trisymeric" at (b) are preferred to the non-triangular groupings shown



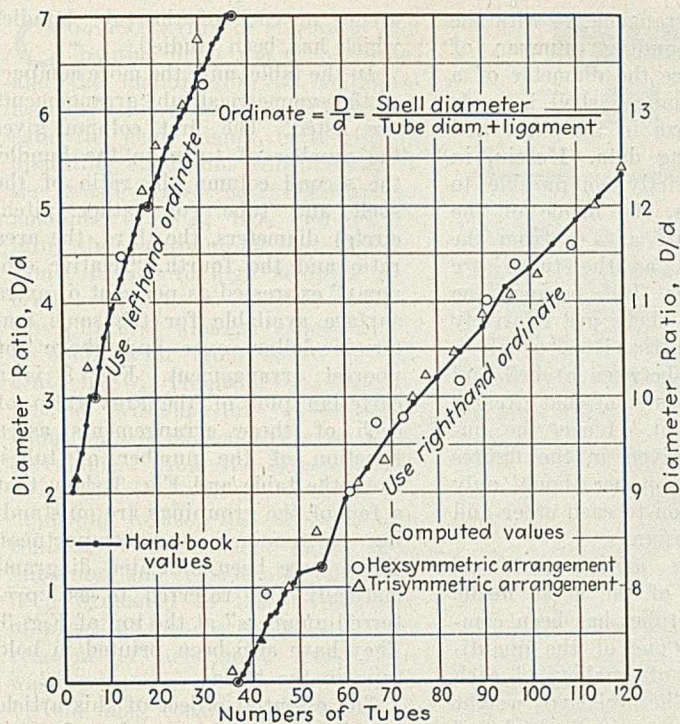


Fig. 2—Relationship of exchanger shell diameter and number of tubes contained therein, based on handbook values (curve) and calculation (triangular and circular symbols)

Diameter and Area Ratios and Relative Economy For Varying Numbers of Exchanger Tubes

Number of Tubes		Diameter Ratio, D/d		Area Ratio, A/a		Relative Economy Per Cent Extra Surface for Same Materials Cost	
Hex	Tri	Hex	Tri	Hex	Tri	Hex	Tri
	3	2.15	0.578				5.5
	6	3.31	0.438				Base
7	12	3.00	4.05	0.823	0.723	10.1	8.4
13	18	4.46	5.16	0.598	0.625	5.2	6.2
19	27	5.00	6.03	0.790	0.749	9.4	8.9
	30		6.77		0.590		6.6
31	36	6.28	7.11	0.838	0.690	10.3	7.6
37	42	7.00	7.43	0.777	0.787	8.3	9.6
43	48	7.93	8.02	0.640	0.754	6.5	9.0
	54		8.57		0.734		8.5
55		8.21		0.914		11.5	
61		9.00		0.772		9.4	
67	63	9.72	9.09	0.683	0.792	7.7	9.7
	69		9.33		0.857		10.6
73	78	9.77	10.23	0.793	0.749	9.7	8.9
	84		10.46		0.802		9.9
85	90	10.16	10.86	0.932	0.788	11.6	9.5
91	96	11.00	11.06	0.769	0.833	9.0	10.4
97	102	11.39	11.26	0.762	0.882	9.2	11.1
109	114	11.58	12.01	0.904	0.850	11.1	10.6
	120		12.37		0.834		10.4
121		12.14		0.923		11.5	

lation of lint and semi-solid products of its own decomposition which plug smaller tubes but never give trouble with tubes above some minimum diameter. In the writer's industrial experience $\frac{3}{8}$ -in. diameter tubes are somewhat troublesome, $\frac{1}{2}$ -in. are quite troublesome and $\frac{3}{4}$ -in. are more or less trouble-free in regard to plugging with occasional foreign bodies. For any one plant, a few diameters are very justly given preference, in order to minimize the number of items stocked.

In heat exchanger design, an engineer first determines in a preliminary way, an approximate number of square feet of heat transfer surface, corresponding to reasonable fluid velocities. This also fixes, at least roughly, the cross-sectional area of the path for both fluid streams. Then, when a small, yet practical tube diameter has been chosen, the number of tubes per pass is fixed. If that number of tubes in a single-pass design requires no excessively long tubes the design is already quite satisfactory. Multipass construction is avoided as much as possible in order to minimize "parasite" pressure drop, complicated head designs and the operating grief of extra "joints." The question then is: what is an excessively long tube? A general median answer might be: 20 ft. for tubes of less than 1 in. diameter supported vertically, and perhaps

40 ft. for tubes of 2 in. diameter supported vertically. About half these lengths should be considered maximum for horizontally placed tubes when there is no intermediate support. Tubes should be located as close to each other as possible, particularly where the flow of a fairly dense liquid around the tubes is to be lengthwise. In qualification, however, a ligament much less than one-quarter of the tube diameter is as a general thing (except in high-strength materials) insufficiently strong to stand the mechanical stresses of expanding the tube. Where bursting stresses in the tube sheet itself are involved, ligaments may have to be much larger and for those cases their design is clearly defined by the boiler codes. Another mechanical limitation of closeness of tubes is that of commercial straightness. Other limitations include fouling, possible plugging and accessibility for cleaning. The last is generally the deciding factor in most practical designing. Through experience, operators learn the rates at which their slimes, cokes or scales build up. They also learn the rates at which they can be removed with this, that or the other solvent or mechanical technique. Such data are obtainable only from experience.

The thinnest tube walls, from strength and mill-limit availability considerations, are frequently not

practical because they will fail under occasional stresses, such as imposed during handling in the storehouse. The stresses of regular operation are usually almost negligible, but if a tube is so thin that it will require absurdly careful handling to avoid all denting, it is, in the writer's opinion, not practical. The use of such thin tubing generally does not reduce the cost of the apparatus enough to warrant its lack of practicability.

A circumstance about tube-sheet layouts which may seem paradoxical is that the "best" arrangements in small circular shells are not necessarily those wherein the center tube is concentric with the shell. Figs. 1(a) and (b) show two possible symmetrical ways of arranging tubes in a circular shell. All other symmetrical arrangements (such as Fig. 1(c) are less compact, and not so satisfactory.

In the usual problem where the cross-sectional area around and within the tubes should be equal, the limitations outlined above make such equality unattainable. One ingenious design uses tubes which have one end swaged down to a smaller diameter, so that the tube-sheet holes are alternately large and small. A very strong tube-sheet ligament is thus obtained, together with a very compact tube bundle. Another expedient is to construct hexagonal rather than

cylindrical shells. All other devices consist of methods of baffling the shell-side of the exchanger. Baffling is theoretically advantageous because heat transfer is improved not only through the higher velocity induced by the smaller cross-sectional area, but also because cross flow reduces film thicknesses. It has, however, so many mechanical and maintenance drawbacks, that the unbaffled round-shell exchanger finds wide and frequent application. The following is confined to such shells.

For the arrangement shown in Fig. 1(a), which has six axes of symmetry, the writer has coined the name "hexsymmetric." That of Fig. 1(b) has been given the name "trisymeric" because there are only three axes of symmetry. Asymmetrical arrangements, or those with only bilateral symmetry (such as in Fig. 1(d)) are frequently quite compact. They have, however, two practical disadvantages. The exact relationship of the holes for best compactness is never obvious and makes difficult the securing of correct layout and shop assembly. Also this grouping leaves a small number of larger empty spaces which, being eccentrically spaced and having low hydraulic radii, aggravate channeling or short circuiting tendencies. Even the best of such asymmetric layouts are no better, and generally not as good as the best hexsymmetric or trisymeric ones for nearly the same number of tubes.

Several engineering handbooks have for many years published tables (with approximate formulae in some of them) stating the number of small circles that can be inscribed in one large circle. In Fig. 2 is plotted a curve drawn through such values as are tabulated in the handbooks. The ordinate is the ratio of the diameter of the circumscribed circle to that of the smaller circles within it, while the number of inscribed circles (number of tubes) is the abscissa. Actual values, accurately computed for the possible finite number of 60-degree symmetrical layouts are plotted on the chart as little circles and triangles for the hexsymmetric and trisymeric arrangements, respectively. It will be noted that the trisymeric arrangement is rather uncompact for the smaller numbers of tubes, but that its most compact points (so far as computed) often occur where the hexsymmetric layout is less compact. Fig. 2 clearly shows that the three best trisymeric groupings (12, 69 and 102 tubes) can be fitted into considerably smaller shells than the

hexsymmetric arrangements with the nearest corresponding number of tubes. In practice the diameter of a round heat exchanger shell is made larger than shown in the chart and the accompanying data. Herein, in order to be strictly comparable to handbook values, the inside of the shell wall is half as far from the outermost tubes as the tubes are from each other. But because the most economical shells are relatively rough and eccentric, it is usual to make the space between a shell and the adjacent tubes somewhat greater than the ligament. Hence, the numerical values given in the figures and table of this paper should only be used in relation to each other and as a guide in design.

In comparing arrangements of tubes, the ratio of the areas inside and outside the tubes has been computed to obtain one of the quantitative measures of quality of each arrangement. The relative weight of materials for a simple style of shell-and-tube exchanger with each arrangement has been estimated for a second measure. These have all been entered into the accompanying tabulation. The "relative economy" column was based on the most usual costs of tube and shell material. For designs that must meet extremes of mechanical stresses or extremes of corrosion resistance, the "relative economy" factors may be grossly in error. They have been added as a guide in indicating the relative pref-

erence of each of the tube bundles which has been studied.

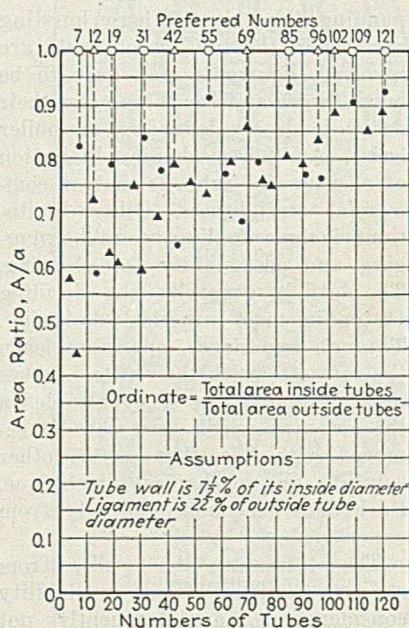
In the table, only the more compact of the symmetrical tube arrangements are listed. The first column gives the number of tubes in the bundle, the second column the ratio of the shell and tube (or rather pitch-circle) diameters, the third, the area ratio and the fourth, "relative economy" expressed as per cent of extra surface available for the same materials dollar, over and above the poorest arrangement. Fig. 3 is a cartesian plot of the area ratio of each of these arrangements as a function of the number of tubes. Both the table and Fig. 3 show that a few of the groupings are outstanding in economy and compactness. These have been indicated diagrammatically and referred to as "preferred numbers" at the top of Fig. 3. They have also been printed in bold type in the table.

The essential object of this article is to publicize these preferred numbers of tubes, so that the labor involved in these computations need not be duplicated. An example of their use: in the design for a heat exchanger an engineer has tentatively arrived at a requirement of 72 tubes. From the data given in the table and Fig. 3, it is obvious that the 85-tube hexsymmetric arrangement would be preferable, whereas (with a slightly larger tube or a somewhat higher velocity) the 69-tube trisymeric arrangement might better be chosen. Any number of tubes between these two preferred numbers would be less advantageous insofar as area ratio and material economy are affected by this one circumstance.

The data in this paper have been computed only up to about 120 tubes. With larger numbers of tubes there is relatively less difference in area ratio. Also in working with larger tube bundles, the designer is generally faced with circumstances which makes the use of a perfectly symmetrical bundle less and less likely. That is, it is necessary to accommodate certain nozzles, connections, circulating pipes, etc., which interfere with the uniform placement of tubes across the entire cross-sectional area of the shell.

The writer acknowledges the assistance of Mr. Andrew Melnychuk in the computations for this work and of Miss Martha Craft for the preparation of the sketches. He is also indebted to Mr. Kenneth Millett of the Griscom-Russell Co., for valuable suggestions.

Fig. 3—Relationship of path areas inside and outside tubes, to number of tubes when arranged in "hexsymmetric" and "trisymeric" groupings



CONCENTRATION of sulphuric acid by the direct use of hot gases and the manufacture of sulphuric acid by the absorption of SO_2 in catalytic acid plants both require operating conditions which result in the waste gases carrying varying amounts of SO_2 , SO_3 and H_2SO_4 into the surrounding atmosphere. Concentration to high acidities generally requires the use of Cottrell precipitators, whereas concentration to acidities of from 60 to 70 per cent H_2SO_4 frequently is accomplished without this protection—using only a packed tower to scrub entrainment from the effluent gases. From the viewpoint of nuisance, it is important to keep the sulphuric acid content of the effluent gases at a minimum, and considerable effort has been expended in the development of practical low-cost methods for the removal of acid mist from these waste products.

Acid mist, consisting of non-volatile droplets may maintain a characteristic fog formation over considerable distances. Sulphuric acid fog consists of very stable H_2SO_4 aerosols, which stability has been shown to be due to the small particle size of H_2SO_4 droplets and the fact that they are surrounded by adsorbed-gas films which prevent coalescence.

Various methods for the removal of H_2SO_4 droplets from the stack gases of sulphuric acid concentrating plants have been evaluated, the various known methods having been divided into two categories, effective and ineffective, according to the practicability of the method from both the viewpoint of acid removal and from the economic picture.

Classed as ineffective were: direct absorption in packed towers in various absorptive solutions; injection of steam into an air stream bearing H_2SO_4 mist with subsequent condensation of the steam, and the use of high stacks for dispersion above local ground currents.

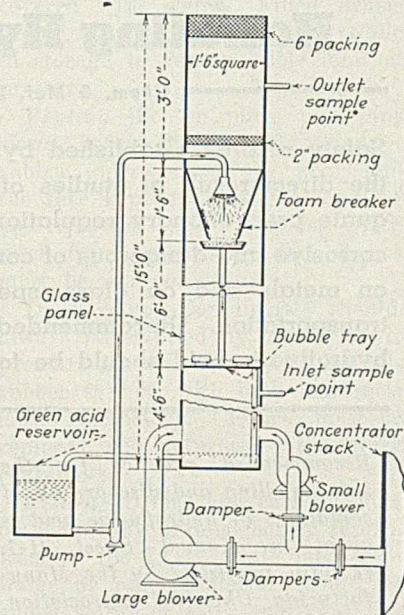
Effective methods with high investment or high operating costs are: gas filtration through various wetted media; decomposition of the mist by heating to 1,000 deg. F. or more under controlled conditions of combustion; use of Cottrell precipitators; use of steam ejectors with subsequent steam condensation; and the use of turbine-type mixers.

"Practical Removal of Sulfuric Acid Fog by Bubble-Phase Absorption" by D. W. Bransky and F. F. Diwocky, the paper from which this article was abstracted, was presented to the Division of Refining at the Fort Worth, Tex., meeting of the American Petroleum Institute, May 29, 1940.

Bubble Phase Absorption Of Sulphuric Acid Fog

Chem. & Met. INTERPRETATION

Tackling the nuisance problem of sulphuric acid fog, D. W. Bransky and F. F. Diwocky of the Standard Oil Co. (Indiana) have evolved a bubble phase absorption system using the petroleum industry's "green acid" as a foam forming agent. The process appears to be effective and to have moderate installation, operating and repair costs.—Editors.



Pilot plant equipment for bubble-phase absorption of sulphuric acid fog

Direct absorption in a foam phase which is produced by bubbling the H_2SO_4 mist through an aqueous solution of a foam-producing substance has been found to reduce the H_2SO_4 content of entering gases 90 to 98 per cent. The most effective bubble-forming agent found was a sulphonated acid mixture commonly referred to as "green acid" which is obtained upon the hydrolysis of the acid sludge derived from the treatment of petroleum. Although insoluble in H_2SO_4 , these petroleum sulphonic acids are readily soluble in water, and sufficiently soluble in aqueous solutions of H_2SO_4 containing up to about 10 per cent acidity to perform satisfactorily as foam-forming agents. The acid sludge itself may be used as a bubble-forming agent, but its efficiency is inversely proportional to the amount of free H_2SO_4 present. Both the sulphonated acid and the acid sludge

lose their foam-forming properties when the acidity of the total solution reaches approximately 10 per cent; but in continuous operation, as the acid concentration builds up above 10 per cent and the green acid becomes insoluble, it may be separated and recycled with the addition of fresh make-up water.

Production of synthetic H_2SO_4 fog and the quantitative measurements of the absorption of the fog in the bubble layer produced from green acid solutions were carried out in specially designed apparatus.

Bubble sizes, time of contact, acid concentration of incoming fog, and temperature were the variables studied in the preliminary investigations. Comparison of effectiveness of absorption by green acid and two commercial wetting agents revealed the superiority of the green acid.

Ferrie salts in solution destroyed the foam-forming ability. Thus, the use of acid-resistant operating equipment is essential.

On the basis of the laboratory data, a 15-ft. wooden pilot-plant scrubber was constructed adjacent to the effluent stack of a commercial hot-gas concentrator. The concentrator operated over the range 50 to 55 per cent inlet acid to 65 to 70 per cent outlet acid, and was provided with a packed tower containing ceramic rings for the reduction of H_2SO_4 entrainment. The normal operation of this unit produced effluent gases of from 40 mg. to 80 mg. of H_2SO_4 per cubic foot of dry gas. As shown in the accompanying illustration, H_2SO_4 -bearing gases were drawn from the concentrator stack by means of one or both blowers, and forced into the bottom of the tower. Dampers were installed at the positions indicated for regulating the volume of gas introduced to the system. Saw-toothed bubble caps insured an adequate formation of

bubbles, which completely filled the section between the bubble tray and the foam breaker. The green-acid solution was circulated by a pump from the green-acid reservoir to the foam-breaker section, and was effective in destroying all bubbles entering the section. The green acid then passed to the bubble tray through a liquid-sealed downspout. Excess green acid was conducted from the bubble tray through a liquid sealed overflow pipe and was withdrawn from the bottom of the tower. The bubble caps and the overflow pipes were constructed to permit a head of about 0.25 in. of green-acid solution on the bubble tray. The tower was insulated with 2 in. of hair felt; and a glass panel extended 3 ft. above the bubble plate, which permitted observation of the bubble formation stability, size, and other operations. Provisions were made for the introduction of a second bubble plate between the lower plate and the bubble breaker, and gas-sampling tubes were provided near the base and near the top of the tower. The upper sampler was located above the foam breaker, and was protected from entrained green acid in the effluent gas by a 2-in. layer of carbon raschig rings. Protection from atmospheric eddy currents was afforded by a 6-in. layer of 3-in. spiral ceramic rings. After equilibrium had been established during the test periods, samples were taken by drawing gas from the lower and upper sample points. Sampling was continuous over the duration of test runs, which usually were from one to two hours.

The contact time between the H_2SO_4 mist and the bubble phase was calculated from gas velocities and the volume of the tower occupied by the bubble phase. The gas velocities were measured experimentally by determining the time required for an H_2S injection at the bottom of the tower to darken lead-acetate-saturated paper at the top of the sampling section. Velocities were adjusted at the beginning of each run by the proper selection of orifices or by varying the operation of the blowers, and were checked at the completion of each run. Very little variation was found during any given run. The maximum velocity rates which permitted stable bubble formation were found to be approximately 2.9 ft. per second in this tower. At higher rates, the liquid seal was destroyed around the bubble caps, and the formation of a continuous bubble phase was impossible.

The data obtained show that the time of contact between the acid mist and the bubble phase, and the gas velocity, are controlling factors in the acid-absorption efficiency of this type of equipment.

No increase in the effectiveness of absorption can be attributed to the use of two bubble plates, despite the fact that smaller diameter bubbles were formed in the passage of the foam from the lower tray through the upper tray. The use of two trays doubled the pressure drop through the absorption system, but in prac-

tical usage might prove to be advantageous by insuring bubble formation throughout the absorption system, and by aiding in the support of the bubble structure.

With 10 to 11 seconds of time of contact, 93 to 95 per cent of the total H_2SO_4 may be removed in equipment having a pressure drop of only approximately 2 in. of water. Economic calculations have indicated installation, operating and repair costs to be approximately 50 per cent of those of equivalent electrical precipitation equipment.

Handling Hydrofluoric Acid

Chem. & Met. INTERPRETATION

Safety records established by the chemical process industries are the direct result of studies of hazards and establishment of adequate precautionary regulations. Hydrofluoric is one of the most corrosive and dangerous of commercial acids. Because of its action on metals and on glass, special containers are required for its transportation. Recommended practice in handling and shipping hydrofluoric acid should be followed at all times.—Editors.

Recommended practice for the safe handling and discharging of containers of hydrofluoric acid is given in Manual Sheet H-1, recently published by the Manufacturing Chemists' Association. The information contained in this pamphlet is presented here in abstract form. Priced at 15 cents, it is obtainable from the M.C.A., 608 Woodward Bldg., Washington, D. C., and it should be consulted for details and more complete information.—Editor.

HYDROFLUORIC ACID is a colorless, corrosive liquid which fumes at concentrations above 48 per cent HF. The acid has a corrosive effect upon the skin which may result in burns that are painful and difficult to heal unless properly cared for. Action of the higher strengths of this acid upon the skin is rapid and severe. The action with weaker acid is delayed and it may be several hours after contact before the burn becomes apparent. When handling any strength of this acid, any suspicious moisture on the skin should be immediately removed by washing and the area treated in order to prevent a possible burn. Fumes are very irritating to the eyes and the mucous membrane and should be avoided. The acid will attack glass

and rapidly corrode most metals. The containers described in this article are safe and entirely adequate when they are properly handled.

Precautions—Protection to workmen handling hydrofluoric acid should include the wearing of long gauntlet rubber gloves, long aprons made of rubberized fabric, rubber shoes or their equivalent, and proper goggles. It is essential that this equipment be maintained in good condition. Rubber gloves should be inspected frequently to insure against defects.

Adequate exhaust ventilation should be provided for enclosed working rooms. If such ventilation is not available, a respirator of an approved type should be used, avoiding, however, the possible collection of condensate from fumes which might result in burns on the wearer's face. It is further recommended that an employee who may be exposed to fumes or acid spillage be provided with a regulation acid hood with respirator and goggles. When such a hood is used, it is advisable that it be equipped for fresh air supply so that the fumes will be kept away from the face and not pocketed under the hood. Whenever an employee is exposed to diluted or concentrated fumes to the extent

that cough or distress in breathing develops, he should report at once to the plant physician or hospital.

In case acid contacts any part of the body, the clothing should be stripped from the affected parts and first aid treatment given immediately. This should consist essentially of washing the affected parts liberally with cold water, preferably under a safety shower, until all traces of acid are removed. The use of greases or salves for first aid or emergency treatment should be avoided. The employee should immediately receive medical attention. For eye injuries, the eye should be thoroughly washed with running water from a faucet or drinking fountain, and prompt treatment given by a physician. The plant physician should become familiar with the treatment of hydrofluoric acid burns. Contact of the acid or its fumes with goggles or glass spectacle lenses will etch the lenses. When this occurs they should be immediately replaced. Application of a thin film of vaseline to both inside and outside surfaces of the glass will retard such etching.

Porous materials, gaskets, etc., that have been in contact with this acid should not be handled until they have been thoroughly neutralized with a soda ash solution. Even after neutralizing, it is advisable to wear rubber gloves when handling such materials.

Of the containers available for hydrofluoric acid, the type is governed by the strength of the acid and the size of container required. Types

General Rubber drum for transporting HF. Also note protective apparel



Courtesy Maurice A. Knight

and sizes authorized are summarized in the accompanying table.

Handling—All containers should be handled with reasonable care and should not be dropped. Before moving, the closure should be examined to insure security of seal. Lead carboys must be handled with particular care to avoid cracking and subsequent leakage.

Storing—A cool location, away from exposure to the sun, should be selected for storage of drums, barrels and carboys containing HF. Grease contamination should be avoided. Drum bungs should be up; wood barrel heads should be kept covered with water. Filled drums should have closures loosened while in storage to vent possible internal pressure.

Venting—Loosen plugs and caps slowly before disengaging. Gauntlet rubber gloves should be worn and the face kept away when loosening or removing any closures. With steel drums, sparks or open flames must be guarded against.

Discharging—Containers should always be emptied by gravity. Air pressure must not be used. An all-rubber syphon with bulb starter is most satisfactory. Closures must be replaced and returned with empty containers.

Return—Drums and carboys must be completely drained before return. Remove the I.C.C. white label. No water or other material should be added before or after emptying; insides must not be washed.

The anhydrous acid is a liquid at relatively cool temperatures, but is shipped in unbrazed steel cylinders, I.C.C.-4B (or other cylinders of superior specification), because its boiling point (66.7°F.) is often exceeded by the temperatures at which it is transported and used. The presence of appreciable pressure within cylinders under ordinary conditions is therefore improbable but should be guarded against. The temperature-pressure chart shows gage pressures of 0, 17 and 44.5 lb. per sq.in. at 68, 108 and 149 deg. F. Special equipment should be provided by the customer for either the direct use or dilution of the acid.

Tank cars, I.C.C.-104A, 105A, or A.R.A. IV-A are also authorized for the transportation of anhydrous hydrofluoric acid.

Equipment—Steel cylinders for anhydrous acid are equipped with a special valve for discharge, which should not be used as a control valve. Pipe connections from the valve to the point of use should be of steel

(seamless tubing preferred, of 16 gage, minimum) and welded wherever possible. Cast iron piping and fittings are not recommended. Where gaskets are necessary they should be of Vistanex impregnated asbestos, or of neoprene. The discharge line should include a steel adapter for connecting the discharge line to the cylinder valve, and an all-steel needle valve for regulating the flow of acid from the cylinder.

Emptying the Cylinder—This may be accomplished by pouring the acid directly from the cylinder or by distillation.

Pouring should never be attempted when the temperature of the surrounding air is equal to or greater than the boiling point of the acid. Where temperature conditions are such that the pouring method can be used, the operator must be provided with adequate safety equipment.

If the distillation method of discharge is used, the cylinder should be placed in a water bath and heated to a temperature of approximately 140 deg. F., which should result in a gas discharge sufficiently rapid for most requirements. Higher distillation temperatures with correspondingly greater rates of discharge may be used provided the proper precautions are observed. Anhydrous acid at 212 deg. F. has a gage pressure of 120 lb. per sq.in. Never apply direct heat or a flame of any kind against the cylinder. The gas from the cylinder may be piped direct to the point of use by means of seamless steel tubing.

In no case should the acid gas be passed directly below the surface of water during a diluting operation, unless a vacuum break is provided between the liquid container and the acid cylinder.

Authorized Containers for Shipping Hydrofluoric Acid

Type	I.C.C. spec. No.	Capacities, gal.	Acid strength, per cent
Rubber drums	43 A	5, 13, 30	65 or less ¹
Steel drums			
unlined ^{2,4}	5 A	20, 55, 110	60 or more
rubber lined	5 D	110 max.	40 or less
lead lined		55 max.	65 or less
Lead carboys	1 B, 2S	5 to 15	65 or less
Wood barrels, asphaltum lined	10 A	55 max.	30 or less
Tank cars			
rubber lined ³	103 B	8,000 max.	40 or less
wood tanks	108, 108 A	8,000 max.	30 or less
unlined ⁴	103 A, 104 A 105 A; (ARA-IV A)	8,000 max.	60 to 80

¹ Neoprene lining advisable for concentrations greater than 48 per cent.

² Fill to 90 per cent of capacity. For I.C.I. use drums not over 55-gal. capacity, fill to 80 per cent of capacity, drums 2 gages heavier than I.C.C.-5 A.

³ See also M.C.A. Manual TC 2.

⁴ Passified.

Leather Cloth

MELVIN E. CLARK *Assistant Editor, Chemical & Metallurgical Engineering*

EACH YEAR the layman has greater difficulty in distinguishing between real and artificial leather in the products he buys. Men's pocketbooks and billfolds, ladies' handbags, notebook covers, brief cases, overnight bags, women's shoes, automobile upholstery and many other products are now made from coated fabric at the lowest prices ever. Simulated cowhide, calfskin, doeskin, pigskin, alligator hide and even artificial suede, actually *feel* as well as *look* like the genuine leather.

The beginning of the artificial leather industry in this country dates back to 1850 (see *Chemical Engineering in the Production of Coated Fabrics, Chem. & Met., June 11, 1923*). Technical progress in the industry has been steady—not many spectacular developments and yet a good many process improvements and refinements. Basic steps in the manufacturing process remain the same: a sheet of cloth is dyed, coated with rubber or pyroxylin; vulcanized or dried, embossed, inspected and packaged for shipping. Some of the new developments have been in more efficient pigment grinding, one-step dope mixing, larger capacity coating machines, and solvent recovery.

At the Stamford Works of its Zapon Division, Atlas Powder Co. has three plants in one. They were acquired in 1917 when Atlas purchased Richards & Co., Inc., Celluloid Zapon Co., and the Zapon Leather Cloth Co., and were com-

Chem. & Met. INTERPRETATION

Out of the technology of the textile, leather and chemical industries, the artificial leather industry has built a technology of its own. Since 1923, the dollar volume of the pyroxylin coated fabrics business has not grown much — only from \$22,000,000 to \$24,000,000 in 1937. Quantity of production, however, tells another story. Yardage has grown steadily from 41 million sq.yd. in 1923 to 80 million in 1937. Twenty-five manufacturing establishments are operating instead of 17. Surely these data indicate an advance in technology, economies in process and improvement in product. To find the specific answers we sought out one of the largest leather cloth manufacturers and arranged to describe a modern plant by word and picture.—*Editors.*

bined to form the Zapon Division. One department of the division makes rubberized cloth of various kinds, a second makes industrial lacquers and finishes and the third makes pyroxlin coated fabric. This article will describe only the coated fabric department. The work of this department is divided by areas and functions into six sections: dye-house, dope room, coating room, embossing room, solvent recovery, inspection and packaging.

DYEHOUSE

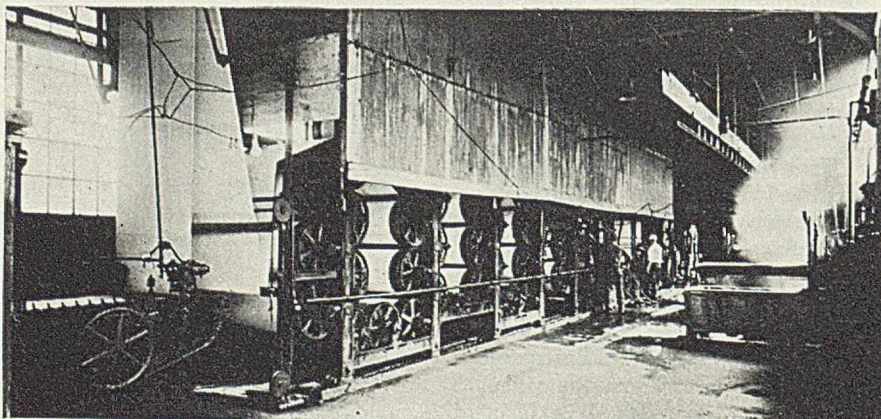
Cotton cloth of various grades (broken twills, ducks, sheetings, drills, sateens) is taken first to an

upper floor in the dyehouse for inspection. Loose threads, knots, bumps and other imperfections that might produce a flaw in the coating are removed. Next the sheet may be singed and/or napped, according to the customer's order. Dyeing is not an absolutely essential step for many coated fabrics, but it is usually done because the finished product looks better if the back of the sheet is nearly the same color as the coating. For this reason, dyeing is not done as critically as in commercial dye-houses. Approximate color matching and surface dyeing only are usually satisfactory.

Speed is the main consideration

Cotton cloth base for artificial leather is dyed "to match face" on continuous machine (left) or on small jig dyers at right

Close-up of vats on the continuous machine which dyes 80 yards a minute



From Chemicals

Ethyl acetate, ethyl alcohol and naphtha solvents are stored in these tanks



Nitrocellulose dope is made in mixers at left. Pigment is dispersed in castor oil with the colloid mill (right)

and two kinds of dyeing machines are used at Stamford. Small jig dyers are most satisfactory for small orders. But a large continuous machine handles all quantity stock. It runs at speeds up to 80 yd. per minute and cannot be used on a run of less than 4,000 yd. J-boxes are used before the vats and before the finishing rolls to accumulate cloth in case of interruption in dyeing or finishing. Drying is done in two stages: (1) on a can or roll dryer of the type used in the paper industry and (2) in a tunnel while the cloth is stretched by tenting frames.

The last operation in the dyehouse is that of finishing, where the cloth is metered, rewound and cut to length.

DOPE ROOM

While the cloth is being prepared for coating in the dyehouse, the coating material is being mixed in the dope room. The term "dope" has long been used in the industry to describe a heavy syrup-like mixture of nitrocellulose, pigment, oil and solvents. The first operation in its preparation is the dispersion of the pigment in the oil, which is done in a unique manner at the Zapon plant.

Pigment and castor oil receive a preliminary mixing in a small tank with a propeller-type portable mixer. The grinding is done in a colloid

mill specially designed by Zapon engineers. This mill consists essentially of two circular plates placed parallel to each other with very little clearance, and rotated in opposite directions by small steam turbines at 8,000 r.p.m. The mixture is charged from above through a hollow shaft and discharged through the bottom of the plate housing. It took years to develop this type of grinding unit, which has proved to be extremely efficient. A large saving over the 3- and 5-roll mills formerly used has been effected as evidenced by the fact that only two colloid mills are used to disperse all the pigment for the coated fabrics plant at Stamford.

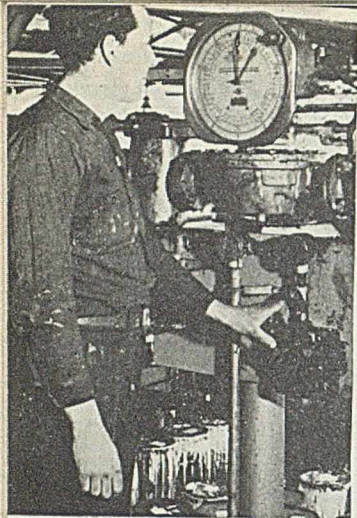
Dope is prepared by mixing this pigment, some additional castor oil, solvents and nitrocellulose, in large Turbo-Mixers. The solvent (a standard mixture of ethyl acetate, naphtha and denatured alcohol) is charged to the mixer through a Neptune signaling positive displacement meter, after which the nitrocellulose is shoveled from a drum to the mixer. When the "cotton" is completely dissolved, the oil and pigment are added. This installation is unique, in that the mixing is started and finished all in the one Turbo-Mixer.

Composition of the solid pyroxylin in round numbers is approximately as follows: 25 per cent nitrocellulose, 25 per cent pigment and 50 per cent castor oil. To make dope, about 40

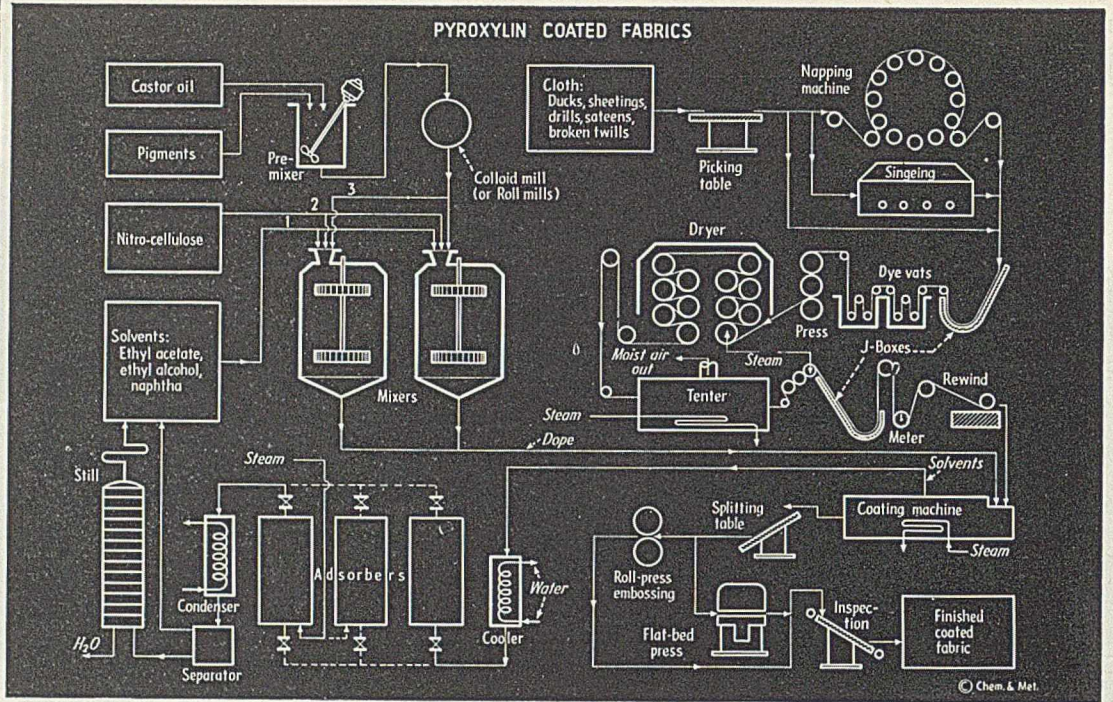
per cent of this mixture is added to 60 per cent of solvent, which in turn contains 30 per cent ethyl acetate, 30 per cent naphtha and 40 per cent denatured alcohol (SD-1). These percentages are by weight and are, of course, varied from time to time, depending on the type of product desired.

Because of the potential hazard in the dope room, every precaution is taken for safety. Louis-Allis explosion-proof motors are used to drive agitators on the mixers. All electrical wiring is encased in vapor-proof conduits. Solvent pipelines are painted red, castor oil lines are green so as to be easily distinguishable. Precautions are taken to avoid static electricity. Batches are figured to use only full drums of nitrocellulose so that no open half-filled drums will invite a fire. This procedure also insures accurate measurement. Although Zapon nitrated its own cotton at one time, the division now purchases all its requirements in small metal drums.

Color matching is an important job in the dope room. The color of each batch mixed must be regulated carefully to comply with specifications. The eye of the color matcher is the colorimeter and a special type of daylight bulb his only aid. Changing colors in the mixers is not difficult, providing they are changed gradually, e.g., red to orange, etc.



Dope solvents and castor oil are metered into 1,000 gal. mixers with this semi-automatic equipment. Pigments, dispersed in oil, are poured into the mix by hand after the nitrocellulose has been thoroughly dissolved in solvents. See flow sheet at right



It is rarely necessary to clean the tank completely with solvent when changing color.

COATING ROOM

A coating machine is a long low table on which the cloth is moved by an endless conveyor while being spread with dope. Most of the machines at Stamford are 60 ft. in length and, by overlapping, can accommodate about 1,000 ft. of cloth in continuous strip.

Dope is usually applied to the machine by hand (see cut) by means of a spatula (some machines are equipped for semi-automatic feed). Thickness of coat is regulated by a doctor knife. A minimum of three and sometimes as many as 20 coats

are applied to each sheet of cloth.

Each machine is completely enclosed and connected to a solvent recovery system through a duct. Solvent is driven off by a unit heater of the radiator type placed at the front of the machine and by a number of steam coils beneath the conveyor at intervals. Each conveyor is equipped with a Reeves variable-speed drive to regulate the speed of the cloth through the machine.

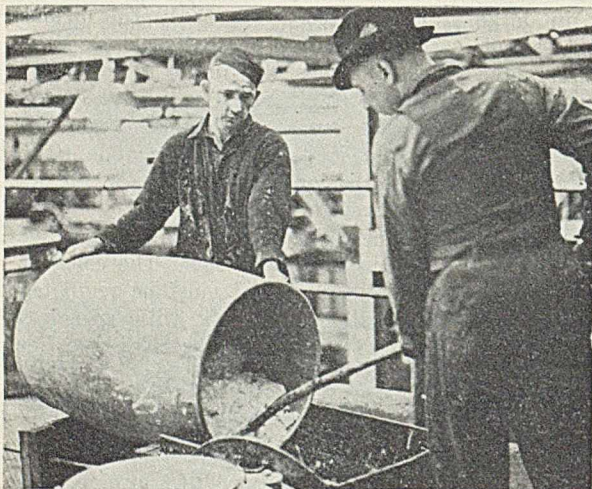
Some coating machines are built to give special effects. For example, Spanish leather effects are made by coating a cloth with red dope, embossing, then coating again with black dope on a special machine. The black fills only the troughs of the pattern leaving the ridges red.

Thus by contrast the impression of depth is created.

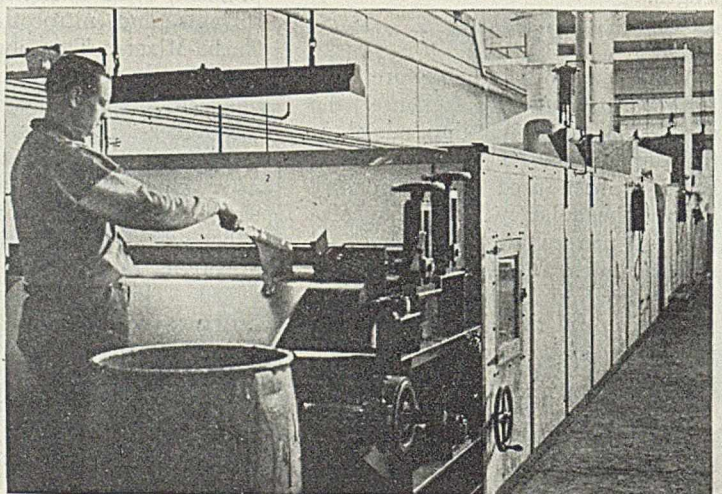
Several new-type coating machines with capacities three times that of the small machines are being constructed by Zapon. Instead of providing for the sheet to go straight through and back again, the new machines provide an extra lap. That is, the sheet travels the length of the machine once, returns more than half way, goes back to the end again, and finally returns to the starting point. On the return trip the sheet is laid on the conveyor in laps, thus allowing several feet of fabric to be carried per foot of conveyor space.

In the above paragraphs the coating operation has been discussed as though all machines were in a single

Nitrocotton is shoveled from drums into the top of one of the large mixers already charged with solvent



Cloth and dope finally come together on this coating machine. Oven is steam heated and equipped for solvent recovery



room. However, such is not the case. There are several rooms at Stamford devoted to coating—some for large quantity items of standard design, others for small quantity stock items, and still others for special fabrics made to order. One room contains a number of hand-finishing tables where cloth effects may be printed.

From the coating machines the rolls of fabric go first to an intermediate inspection called the split table. Here the sheet is examined for flaws, measured and cut to proper length for individual orders. Then it is ready for embossing. Two kinds of embossing machines are used, the flat bed press and the roll press. The former, a Sheridan press, uses a steel engraving 26 x 54 in. for the upper platen. The female die is made for each engraving by inserting a heavy sheet of paper and pressing until the design is firmly imprinted. Zapon has a stock of engravings containing 350 different designs. Embossing is accomplished by intermittently closing the press and moving the fabric. Steam is used for heating to a temperature of 280 deg. F.

Large quantity orders are handled on the roll presses where the engraving is a cylinder and the sheet moves at a rapid, steady pace. These cylinders, however, are very expensive and interchangeable only with difficulty; so they are not practical for short or specialized orders. They do have the advantage that they print a continuous pattern, whereas a sheet embossed on a flat bed press exhibits, to the expert's eye, a break every 26 in.

Every yard of coated fabric is inspected by an expert as it moves

down across an inclined table. The inspector controls the speed of the sheet, which is rewound simultaneously, by a foot treadle. Flaws are cut out, sometimes making it necessary to sell the remainder of the roll as a remnant for some specialized use.

SOLVENT RECOVERY

As mentioned previously, all coating machines are equipped with hoods and ducts for solvent recovery. The air drawn off contains from 0.7 to 0.9 per cent of solvent vapor, which is about 40 to 45 per cent of the lower explosive limit. It is carried to a separate building for recovery by means of three 75-hp. blowers handling 40,000 c.f.m. The air is cooled by salt water (water pumped from Long Island Sound) and introduced into three horizontal activated carbon adsorbers in series.

When the activated carbon in the adsorbers is 75-80 per cent saturated, it is reactivated by the introduction of live steam at the rate of 9,000 lb. per hour. The steam-solvent mixture containing about 35 per cent solvent is condensed and separated in a gravity separator. All the naphtha and some ethyl acetate is removed (about 35 per cent of the recovered solvent is separated this way). The water solution containing the remainder of the ethyl acetate and the ethyl alcohol is distilled in a Badger continuous copper still using 1,200 lb. of steam per hour. The two fractions of recovered solvent are mixed, butted-up and returned to the dope room for reuse. About 85-90 per cent overall recovery is effected.

Copper construction is necessary in many parts of the unit because of

small amounts of acetic acid formed in distillation.

Zapon executives are proud of their power plant, and it is, indeed one of the most modern and efficient power plants of its kind. There are three boilers, two Heine straight tube rated at 500 hp., and one new Edge Moor bent tube rated at 720 hp. The new boiler has an output of 70,000 lb. of steam per hr. at 200 lb. pressure and 100 deg. superheat, whereas the two small boilers have a combined capacity of only 66,000 lb. of steam per hour.

With the exception of the small steam turbines driving the colloid mills and the embossing machines, all of the plant's 80,000 lb. per hr. (maximum) steam requirements are for low pressure steam. Therefore, most of the steam is reduced from 200 lb. to 28 lb. pressure through 2 Westinghouse turbines—one a 937-kva. condensing, the other a 1,250-kva. non-condensing turbine. Two large Ingersoll-Rand compressors provide for compressed air requirements. High pressure and low pressure steam requirements are thus balanced and all electricity generated is a byproduct.

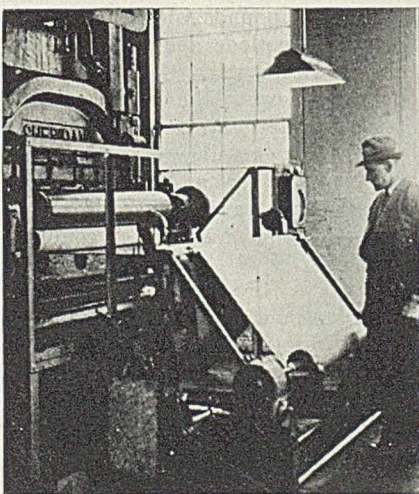
ARTIFICIAL SUEDE

Artificial suede (tradenamed Izarine) is an interesting product made at Stamford but not included in the class of leather cloth described in this article. Nevertheless, its manufacture is so intriguing that the author should like to outline it briefly as an appendix.

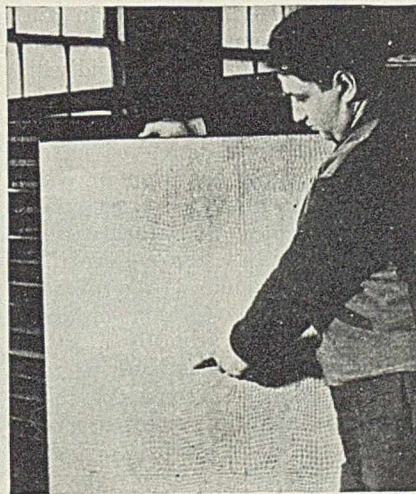
The base material for Izarine is a rubberized cloth which is threaded into a coating machine similar in appearance to those described above. A thin coating of rubber cement is applied. Then the cloth is sprinkled with finely divided cotton fibers which have been dyed to the proper color. Beaters in the form of ropes tightened by spring action beat the sheet from the bottom, making the fibers stand on end until the rubber cement hardens. The sheet is then vulcanized and the product looks and feels like a fine suede. It is used for ladies suede shoes, suede jackets and the like.

In conclusion, the author wishes to acknowledge *Chem & Met's* indebtedness to M. J. Creighton, general manager of the Zapon Division, and G. C. Bacon, superintendent of the coated fabric department, for permission to visit the plant, for illustrative material and for checking details in the manuscript.

Pigskin, buckskin and other designs are added by this embossing machine



Steel embossing plate 26 x 54 in. with popular alligator hide design

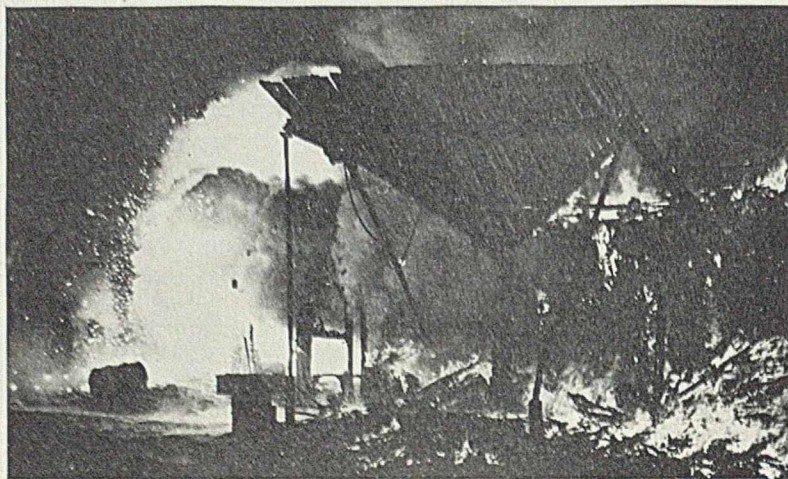


Extinguishing Fires in the Chemical Industry

TWO CONDITIONS must be satisfied if there is to be combustion, namely ample concentration of gas, liquid-vapor or dust, and ample air or oxygen in which they can burn, the elimination of either condition, will effect extinguishment. The former can be accomplished by cooling the liquid surface directly or through the mass, and the latter by cutting off the required supply of air or oxygen. This can be done either by artificial means such as smothering by automatic self-closing covers on containers of solvents, waste cans, excelsior bins, or by use of inert materials such as powdered asbestos, tale, rock dust, sand, graphite, and soda-ash; even saw-dust and fire-blankets have their uses. Application of chemical foam and mechanical foam accomplishes this well, except in that class of liquids which dissolve the foam or in which the water content of the foam is in itself a hazard. Physically, this air or oxygen supply can be cut off or at least can be diluted to less than that required for combustion either by application of inert gases such as carbon dioxide and nitrogen or by steam flooding. This is also the function of carbon tetrachloride, the most commonly used vaporizing liquid, the gas from which is an effective diluent in fire extinguishment.

Water is the most abundant of the fire extinguishing mediums, it is the cheapest and is most universal. However in the chemical industry it is effective, useful and safe only so long as its use does not involve reaction hazards on chemicals which are liable to overheat, burst into flame violently or explode. Since electrical equipment is so universally used, the accident hazard from the use of water is ever present. Water still holds predominance in the art of fire-fighting and in the water spray method of discharge it is commanding prominence in protecting oil filled electrical equipment.

Abstracted from "Extinguishing Fires in the Chemical Industry," by R. M. L. Russell, Engineer, Factory Insurance Association, Hartford, Conn. The paper was presented at the Western New York Safety Conference held at Niagara Falls, N. Y., June 5, 1940.



Courtesy The Hartford Times

Chemical fires require careful use of extinguishing agents. The above illustration shows what happened when water was sprayed onto burning magnesium

Chem. & Met. INTERPRETATION

Chemical industry in general necessarily operates with a thin margin of safety because of the fire and explosion hazards involved in the storage, handling and processing of many materials which in themselves are susceptible to ignition in one form or another. To minimize the danger to both life and property, it is essential that fires be anticipated and that proper methods of fighting them be available for instant use wherever and whenever needed.—Editors.

"Caution" is the single word that should identify its use about chemical plants, in general.

Certain elements and compounds which will burst into flame in air at normal temperatures include white or yellow phosphorus. So rapid will this material oxidize in contact with an oxidizing chemical that it will explode. It should be stored under water in underground iron or concrete tanks well isolated from other chemicals. In event of fire it should be deluged with water until extinguished, the solidified phosphorus then covered with wet sand or dirt. There are other chemicals a little less violent in this class such as red phosphorus, which is explosive when mixed with oxidizing materials such as nitrates, chlorates, persulphates and certain acids. Red phosphorus

should be flooded with water and then blanketed with wet sand or dirt.

There is that class of chemicals such as sodium, potassium and some of their compounds which burst into flame and explode spontaneously on contact with water. Obviously anyone not knowing the characteristics of these materials not only risks his life from a possible explosion but also will render a bad fire even worse by the careless use of water or any extinguishing agency containing water. For the extinguishment of fires in these chemicals, absolutely dry sand, tale, asbestos powder, dry salt, or graphite should be carefully spread over the burning mass.

Magnesium is being used extensively in the aircraft industry in order to give certain desirable characteristics to the aluminum alloys

used and for that reason magnesium production has been greatly increased in recent years. Because it weighs about $\frac{2}{3}$ as much as aluminum its advantages can be appreciated, nevertheless it has introduced fire and explosion hazards where considerable quantities of materials are being handled in dust form in which there is magnesium present. Shavings, thin sheets and dust are ignited very readily. Inasmuch as water thrown upon burning magnesium liberates hydrogen gas which only adds to the intensity of the fire, it is obvious that extinguishers employing water, foam or carbon tetrachloride or soda should never be used. Aircraft plants use dry asbestos cement, such as is used for boiler insulation, for smothering burning magnesium. Dry sand and tale are also effective.

Aluminum powder is equally dangerous. Careful use of dry sand, ashes or rock dust is considered proper extinguishing procedure for aluminum dust fires.

There is also the familiar calcium carbide which liberates acetylene gas on contact with water or moisture. Obviously water cannot be used for fire extinguishment. Probably the best and quickest means is by use of dry sand, dry ashes, rock dust and soda ash.

Similar inert materials should be used for extinguishing fires in such other chemicals as barium peroxide, camphene, camphor, potassium peroxide, sodium peroxide and so forth.

There is an abundance of other chemicals such as sodium nitrate, potassium nitrate, magnesium nitrate, barium nitrate, barium chlorate, potassium chlorate, sodium chlorate, sodium perchlorate, strontium nitrate, thorium nitrate, glacial acetic acid, etc., which can effectively be extinguished by use of water. Such ma-

terials may also be smothered by use of carbon dioxide.

Cellulose nitrate or pyroxylin base materials decompose when exposed to temperatures in the neighborhood of 300 deg. F. The heat of combustion of nitrocellulose is about the same as that of wood, but the rate of combustion of nitrocellulose is from 12 to 18 times that of wood. Through the decomposition of cellulose nitrate there becomes available oxygen in sufficient quantities to maintain combustion. If the decomposition takes place under pressure, such as in a vault not properly vented, hydrogen gas may be evolved in considerable quantities; if the supply of air is insufficient to cause the immediate combustion of these gases, a potential explosion hazard exists, since these combustible gases may later be ignited when fresh air is admitted. The generation of hydrogen and oxygen may be so rapid in a hot cellulose nitrate fire that even though the material is cooled or an attempt is made to smother such a fire or to dilute the atmosphere with an inert gas, the material may still continue to burn due to the presence of the combustible gases of its own decomposition in the absence of air. Therefore this material must be treated by special means of fire extinguishment, either by an absolute deluging with an abundant supply of water in order to check the spread of such a fire or by an attempt to maintain a very high concentration of inert gas such as carbon dioxide or nitrogen. Cellulose nitrate burning in large quantities also liberates certain toxic gases, which in a confined space may impair fire-fighting procedure. Extreme care therefore should be exercised also from a life hazard angle.

Since the decomposition of burn-

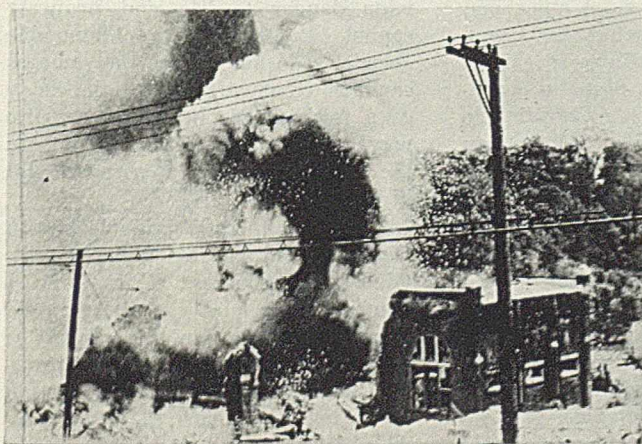
ing cellulose acetate is not exothermic, if once started it does not continue except under conditions where there is an external source of heat. Combustion therefore of cellulose acetates ceases in the absence of a fresh air or oxygen supply and will quickly respond to extinguishment by water, foam or carbon dioxide.

Another commonly used chemical is sulphur. This material can readily be extinguished by smothering with carbon dioxide, nitrogen, sand, foam and will also respond to the cooling effect of water in form of a spray. However, like aluminum dust, it must not be scattered into the air by pressure from a hose or other disturbing mediums, for when mixed with air and ignited it produces a violent explosion.

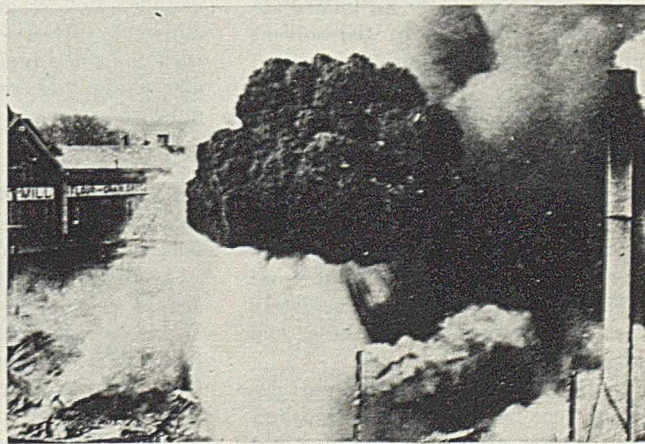
There are several hundreds of liquids constituted by the various combinations of chemicals which are either intentionally produced for industry or are the biproducts of such operations, uses for which have either been found or created. For instance there are the multitudinous combinations of carbon, hydrogen and oxygen constituting the classification known as synthetic hydrocarbons such as ketones, esters, ether and ethyl, methyl, amyl and butyl alcohols. These aggregate a very great percentage of the solvents, vehicles, thinners, cleaning agents, anti-freezes, anesthetics, etc. used today. Practically all of these liquids have flash-points above 0 deg. F. with the exception of acetone which may run from 0 to a few degrees below 0 deg. F. Those solvent chemicals which have a flashpoint in excess of 100 deg. F. are classed as safety solvents. It can be said that usually the synthetic hydrocarbons can be extinguished by means of smothering or diluting the atmosphere above the sur-

Aluminum bronze dust explosion at a fire in Painesville, Ohio

Photographs courtesy National Fire Protection Association



Explosion of a tank of turpentine during a fire in a paint shop



face of the burning liquid with carbon dioxide or nitrogen down to a point that combustion ceases. The majority of these liquids also responds to extinguishment under a blanket of foam except for the alcohols and mixtures containing alcohol, as this particular classification of liquids will dissolve foam. Inasmuch as the common alcohols are miscible in water, such fires can be extinguished by the use of water either as a result of cooling or of dilution of the liquid itself.

There is also that classification of liquids arising from the distillation of coal tar such as benzol, toluol, solvent naphtha, heavy naphtha, naphthalene, phenols and oils. Extinguishing fires in these liquids can be quickly accomplished by use of carbon dioxide, nitrogen gas, or by the blanketing effect of foam. Because of the fact that they are not miscible with water, the use of water only serves to spread the burning liquid which will float and burn on the surface of the water itself, unless the fire is caught in a stage where through the abundance of water the fire can be extinguished by dispersion.

Hydrocarbons may also be classified as being obtained from the distillation of crude petroleum. In this class are the gasolines, benzines, naphthas, petroleum spirits, fuel oils and the lubricating oils. Carbon dioxide, nitrogen gas, carbon tetrachloride and foam are considered the proper extinguishing agencies. Because of the fact that these materials are not miscible with water, a fire is only spread by use of water unless, as above, it is used in spray form. This is being done today with very excellent results.

RE-IGNITION HAZARDS

Because of the high volatility of all low flash solvents, unless there is absolute and positive fire extinguishment there will be an immediate re-ignition or reflash of the solvent vapors liberated from the heated mass of liquid. Because of the fact that this gas accumulates and does not ignite until the mixture has reached the lower explosive limit, it is usual, particularly if the vapors are confined, for this secondary ignition to produce an explosion. Therefore the necessity for absolute and complete extinguishment immediately must be impressed upon those who are exposed to this hazard.

In the chemical industry, particularly where byproduct gases are bottled, refrigeration is an important

factor. While some refrigerants are noncombustible or only weakly flammable, there are some such as butane, dichlorethylene, ethane, ethyl bromide, ethyl chloride, methyl chloride, methyl formate and propane which are flammable and explosive. As a matter of fact, while the lower explosive limit of ammonia itself is very high, it does have a wide range of from 16 to 25 per cent by volume in air.

Without a doubt the most effective method of extinguishing fires in these refrigerants is by dilution with an inert gas such as carbon dioxide or nitrogen. Because of the fact that these materials are commonly used under pressure, it is necessary to use a gas under pressure for extinguishment in order to cut off the source of ignition and the use of carbon dioxide seems to be particularly well adapted for this purpose.

CARBON DISULPHIDE

There are other chemicals which are extremely violent and must be treated with very special care. One of them is carbon disulphide, extensively used in the manufacture of explosives, in the rubber industry, and in the viscose process in the rayon manufacturing plants. It is highly volatile with an extremely low flashpoint of minus 22 deg. F. and an ignition temperature of 212 deg. F. It is classed as more hazardous than gasoline. The best extinguishing agents are carbon dioxide, nitrogen gas, sand or other inert materials. Its hazard justifies the total flooding of storage rooms by an automatic carbon dioxide system. Foam is not considered effective. Neither should carbon tetrachloride be used. Water discharged at very low pressure but in large volume beneath the surface is highly effective, in that the water rises to blanket the liquid surface.

Other highly flammable chemicals include ethyl ether, vinyl ether and ethylene. These should be stored with the same precautions as carbon disulphide and can best be extinguished by the use of carbon dioxide and sand. Very small amounts can be extinguished with carbon tetrachloride. Where large amounts are stored, automatic carbon dioxide flooding is justified.

Acetone is another chemical that should be treated with special care. It is very volatile and highly flammable. Extinguishment should be by water, particularly in the spray form, or by carbon dioxide.

Since the chemical industry is tied

up very closely with an abundant use of electricity, fires in electrical equipment such as oil switches, oil filled transformers and d.e. generators must not be overlooked.

One of the best methods for extinguishing fires is by the use of carbon dioxide. Vaults in which there are banks of large transformers, automatic carbon dioxide flooding is urgently recommended. Another excellent method of handling this oil hazard is by the use of a built-in system of water spray. Handling an oil fire from the escaped contents of a transformer can be extinguished either with carbon dioxide, water spray or with a blanket of foam. In handling oil fires, when a stream of foam is used, extreme care should be taken not to direct the stream of foam into the burning oil but to throw it against a vertical surface on the far side of the liquid allowing it to gently flow back across the oil surface until complete extinguishment is effected.

The use of carbon dioxide in extinguishing fires in converter stations where motors and generators are revolving at high speed, is extremely effective and with it experience has been excellent.

In the power houses of chemical plants, the use of gas, fuel oil and pulverized coal is ever increasing. Automatic flame failure protection is being recognized as a safeguard against explosions which might tie up the operations of a plant for weeks. There should be quickly accessible carbon dioxide, carbon tetrachloride or foam extinguishers to cope with the fuel oil and electrical hazards.

CONCLUSIONS

In conclusion it must be said that in the event of a fire, unless there is ample distribution of first aid fire apparatus at hand, prompt and complete extinguishment with minimum danger to life and property cannot be expected. Flammable chemicals do not behave the same as common combustibles and the delay of a few seconds in checking a fire may result in total destruction to the property as well as a severe loss in life.

First of all, every possible human means should be regimented to eliminate the sources of ignition of flammable chemicals and secondly, if a fire does occur there must be enough extinguishing agencies, properly distributed, so that the fire can be extinguished with the least possible delay.

Timesaving Ideas for Engineers

SIMPLE PLOT FOR PARTIAL PRESSURE AND VAPOR COMPOSITION DATA FOR AQUEOUS AMMONIA

DONALD F. OTHMER Polytechnic Institute of Brooklyn, Brooklyn, N. Y.

A NEW METHOD of plotting vapor pressure data was disclosed at the recent Buffalo meeting of the American Institute of Chemical Engineers; and the theory was outlined in the June 1940 issue of *Industrial & Engineering Chemistry*. One application, in relation to psychrometric charts, was presented in the May 1940 issue of *Chem. & Met.*, p. 296.

Partial pressure and vapor composition relationships involved in aqueous ammonia solutions may also be correlated by this type of plot. Perry ("Chemical Engineers' Handbook," pp. 352, 353, 354, 357) gives data. Briefly, this method consists in laying out on the horizontal axis of logarithmic paper a scale of temperatures corresponding to a number of vapor pressures of a suitable reference liquid in whatever units may be desired, drawing in ordinates representing these temperatures, and then

plotting vertically the vapor pressures of the material or materials in question on these ordinates. The vapor pressure lines so drawn are straight. Thus, Fig. 1 is the plot for the partial pressure of ammonia in pounds per square inch absolute for solutions of different concentrations using water as the reference substance.

It will be seen that straight lines represent the data accurately and that these straight lines, each for a solution of different molar concentration, tend to converge. The lower half of Fig. 2 is a similar plot of the partial pressure of water from aqueous ammonia solutions for the solutions of the same molar per cents. Here again a family of straight lines represents the data very well; but these lines are all parallel to each other and to the line for the vapor pressure of pure water.

The upper part of Fig. 2 is a plot of the total pressures of these solutions



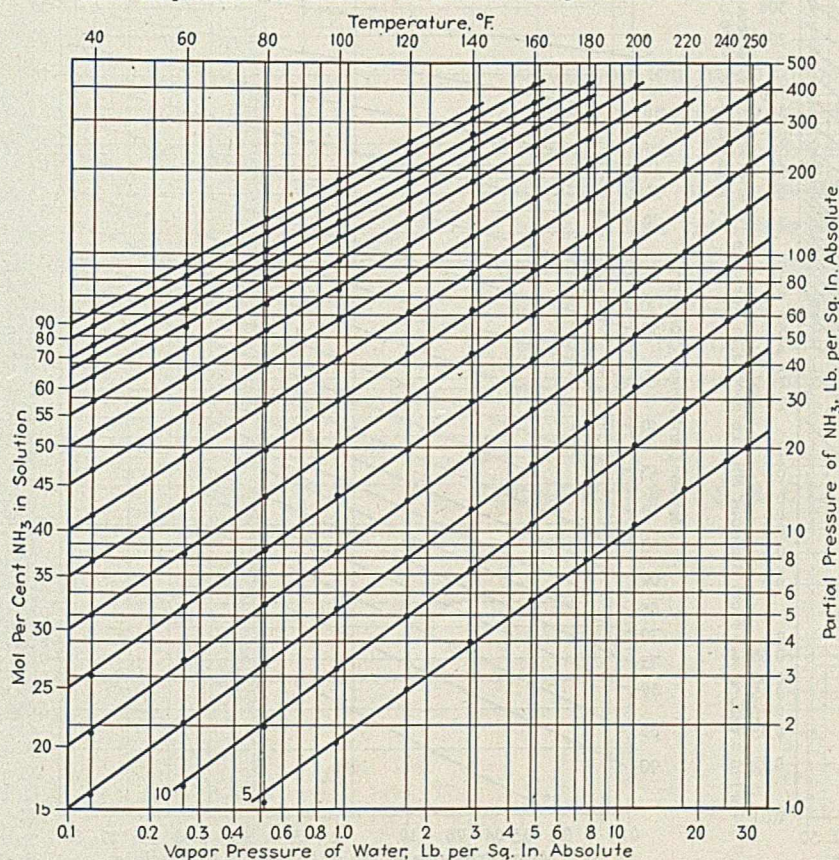
(that of ammonia in Fig. 1 plus that of water in the lower part of Fig. 2). Again there is obtained a family of straight lines representing the absolute pressures which would be read as existing over the respective solutions at the different temperatures.

A corollary of this method of plotting is that the value of the slope of any one of the straight lines of such a plot times the molar latent heat of the reference substance, at any temperature, gives the molar latent heat of the material in question at the same temperature. The latent heat of ammonia separated from any solution may thus be found by measuring the slope of the vapor pressure line (or obtaining the tangent of the measured angle) for this solution and multiplying this value of the slope by the latent heat of water at the same temperature. Since the slopes of the lines representing vapor pressure of water from solutions of different compositions are all the same as that for water itself, (the slope is unity which is the value of the tangent of an angle of 45 deg.) it follows that the latent heat of water out of any ammonia solution is the same as the latent heat of pure water. (Although the data indicate this, it seems reasonable to believe that there may be some minor errors in these data for strong ammonia solutions to modify this last conclusion). Similarly, the heat required to evaporate a molar weight of the entire solution could be found from the slope of the appropriate line in the upper part of Fig. 2 and the latent heat of water at the same temperature.

Fig. 3 represents probably the simplest method of correlating the data of the vapor phase compositions, which vary at different pressures and temperatures. Using the same calibrations of the horizontal axis and plotting mol per cent water in the vapor on the vertical logarithmic axis, a straight line results for each solution of different strength, and shows the relation of the composition of the vapor in equilibrium with this solution as it changes with changes in temperature and pressure.

This third graph and the relation it

Fig. 1—Partial pressures of ammonia solutions versus vapor pressure of water at same temperatures for solutions of different mol per cents of ammonia



represents follow directly from the first two. The mol per cent water in the vapor phase may be indicated by N_w , the partial pressure of the water by P_w , the total pressure by P_T , and the vapor pressure of pure water at the given temperature by p .

Since

$$N_w = P_w/P_T$$

Then

$$\log N_w = \log P_w - \log P_T$$

and

$$d \log N_w = d \log P_w - d \log P_T$$

This equation may be divided by $(d \log p)$ and there is obtained at any constant liquid composition the following equation:

$$\frac{d \log N_w}{d \log p} = \frac{d \log P_w}{d \log p} - \frac{d \log P_T}{d \log p}$$

The plot of the partial vapor pressure of water (lower half of Fig. 2) shows that the slope of a plot of $\log P_w$ against $\log p$ is constant; and thus the first term on the right hand side of the above equation is constant. Similarly, the slope of a plot of $\log P_T$

against $\log p$ is constant from the upper half of Fig. 2; and thus the second term on the right must be constant. The left term in this equation, must also be constant, which means that the log of the mol per cent of water in the vapor when plotted against the log of the vapor pressure of pure water gives a straight line, which is shown in Fig. 3.

Tank Car Collapse

ALTHOUGH accidents are generally considered as unusual happenings, the July issue of *Chemical Safety*, the bulletin of the Chemical Section of the National Safety Council, points out that most accidents are the logical result of a series of events which should never have taken place, and that the result should have been capable of being foreseen. As an example, the following is related:

In one plant empty tank cars are returned and filled partially full of hot water and the water then boiled with steam to soften a caustic sediment in the tank bottom. The solution is drained and the tank washed with cold water; the car is refilled and is

then sent on its way. This procedure has been followed for years and has probably been used thousands of times by other plants shipping chemicals. However, in one case the procedure outlined was not followed exactly. Since the car was not going to be refilled immediately, after steaming the dome was swung into place and the nuts turned down by hand so that more cars could be switched. That night the weather turned unusually cold and the internal vacuum resulting toward morning collapsed the tank completely. Rivets were sheared off and side walls crumpled like paper. Every step in what had been done to the tank was aimed inevitably toward producing a high vacuum—and with predictable results.

Fig. 2, Left—Lower half: Partial pressure of water from ammonia solutions plotted against the vapor pressure of pure water at the same temperatures. Upper half: Total pressure of ammonia plus water from ammonia solutions plotted against the vapor pressure of water at the same temperatures

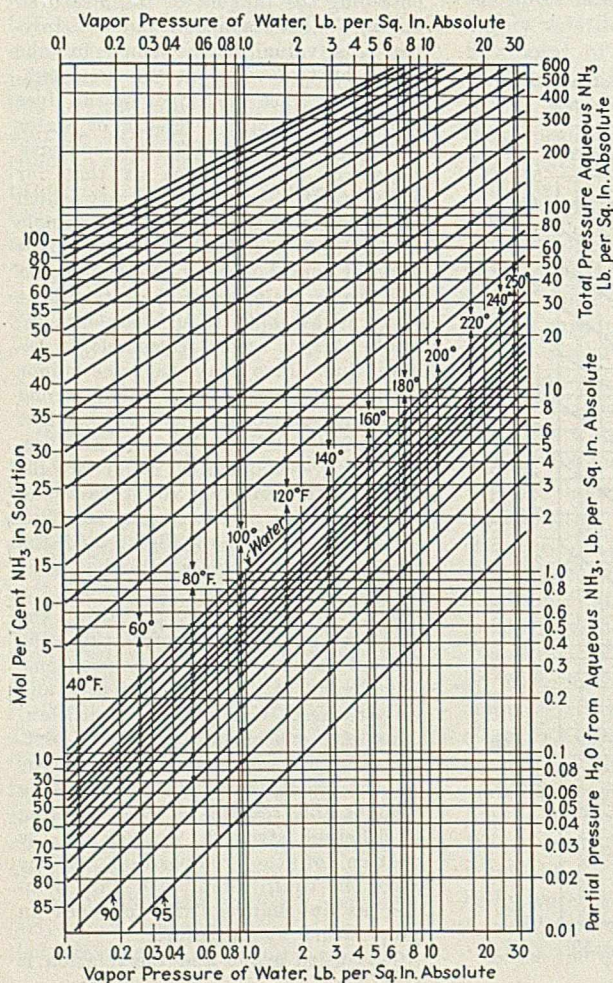
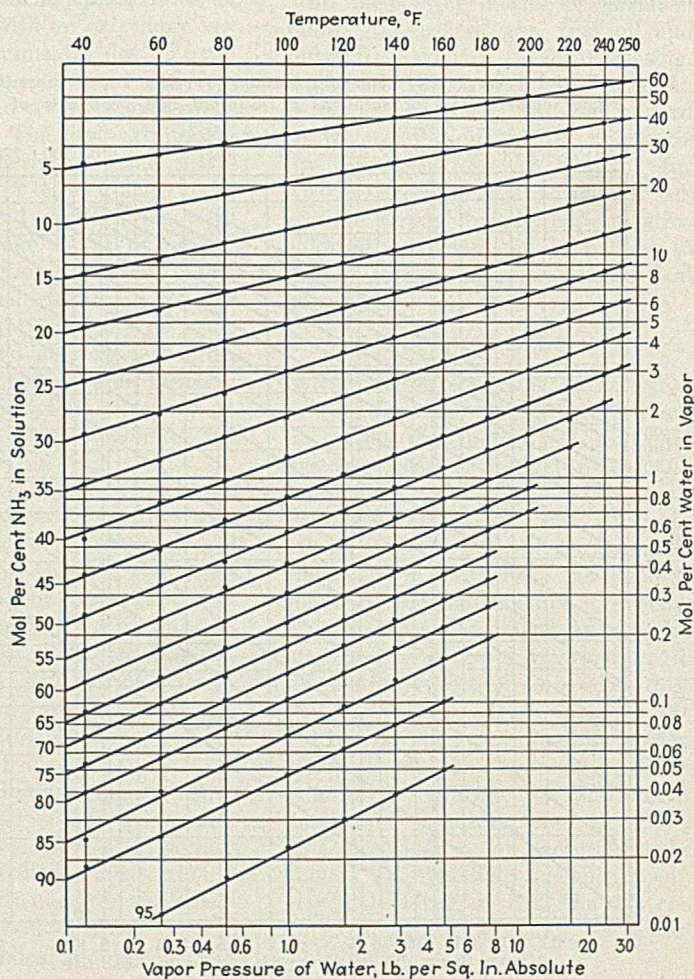


Fig. 3, Right—Mol per cents of water in vapor in equilibrium with ammonia solutions of different concentrations plotted against the vapor pressure of water at the same temperatures



CHEM. & MET. REPORT ON

Measurement and

Control of pH

**TO PLANT MANAGERS, SUPERINTENDENTS
AND CHEMICAL ENGINEERS**



Hydrogen ion measurement and control have progressed so rapidly in recent years that much of the literature is now out of date. Nevertheless, applications of this method of determining and regulating effective acidity or alkalinity have grown by leaps and bounds. To an ever increasing extent process industries are finding pH control to be essential in securing optimum conditions for settling, coagulation, precipitation, reaction rate, particle size, filtration and other factors, and in preventing corrosion. Evidently pH pays!

CHEMICAL & METALLURGICAL ENGINEERING

August 1940

Series A, No. 5

TITLE OF REPORT Measurement and Control of pH
TO Plant Managers, Superintendents and Chemical Engineers
FROM Chem. & Met. Editors

DATE August 1940

CONCLUSIONS

Lower production costs, improvements in uniformity and quality, greater yields and reduction in waste and spoilage are all consequences which many process industries have been discovering in the measurement and control of the hydrogen ion concentration. Particularly in such industries as leather, paper, sugar, fermentation, water purification, sewage disposal and pharmaceuticals has this been true.

However, only in the last few years has pH regulation truly come of age. New developments have appeared at a rapid rate. In bringing to its readers this last-minute report on the situation, *Chem. & Met.* has solicited and received the help of many people. Particularly, however, we acknowledge the work of Douglas M. Considine, chemical engineer of Cleveland, from whose pen most of the report has come.

Principles and Significance of pH Measurement

IN 1887, the Swedish scientist, Arrhenius, in attempting to account for the abnormal osmotic activity of solutions of acids, bases and salts proposed that the aqueous solutions of such substances be considered as dissociated into positively and negatively charged particles, or ions. That hypothesis led subsequently to the realization that the hydrogen ion plays a major role in its effect upon many biological and chemical processes in which it is present. The concentration of hydrogen ions was found not only of significance in itself, but found to serve as an index of reactions in which the hydrogen ion is not an actual participant. Today, the importance of the hydrogen ion and its control are taken for granted in many industrial processes.

When pure water dissociates, there are equal numbers of hydrogen and hydroxyl ions formed and it is termed neutral. The concentration of H^+ and OH^- ions in pure water and neutral solutions are each equal to 10^{-7} , 0.0000001, or 1/10,000,000 gram equivalents per liter at 22 deg. C. The use

of a negative exponent, decimal or fractional expression of such concentrations is cumbersome and inconvenient for hydrogen ion calculations. The pH scale was devised and utilizes the negative exponent as a means of expressing the hydrogen ion concentration. Thus, a neutral solution is termed as having a pH of 7 instead of a hydrogen ion concentration of 10^{-7} gram equivalents per liter. Mathematically, pH is defined as the logarithm of the reciprocal of the hydrogen ion concentration, shown by

$$pH = -\log [H^+]; [H^+] = 10^{-pH}$$

When an acid such as HCl dissociates, H^+ and Cl^- ions are formed and the pH of the solution is dependent upon the degree of dissociation. From Fig. 1 it may be noted that the pH will lie between 0 and 7 for an acid solution. Similarly, a base such as NaOH forms Na^+ and OH^- ions upon dissociation. The figure shows that the pH of an alkaline solution will lie between 7 and 14.

The pH scale not only is of advantage in hydrogen ion calculations, but

one can learn to use it intelligently without knowing the derivation of the term, just as one may learn to use the Fahrenheit scale of temperature without knowing the derivation of degrees F. This enables the operator or foreman of a process to make intelligent use of instruments for determining pH and apply a practical interpretation of the data thus obtained. It should be remembered that the hydrogen ion concentration of a solution increases by a power of ten while the pH term decreases by one unit. Practically speaking, a solution of pH 5 is ten times as acidic as one of pH 6.

The normality of a solution should not be confused with the pH. Normality represents the total acidity of a solution, namely the hydrogen ions present as ions, plus the ionizable hydrogen still present in molecular combination. All acid solutions are not dissociated completely. In an HCl solution, part of the hydrogen may be present as ions and the remainder in combination with chlorine in the undissociated molecule, but available for ionization under favorable conditions.

[H ⁺]	10 ⁰	10 ⁻¹	10 ⁻²	10 ⁻³	10 ⁻⁴	10 ⁻⁵	10 ⁻⁶	10 ⁻⁷	10 ⁻⁸	10 ⁻⁹	10 ⁻¹⁰	10 ⁻¹¹	10 ⁻¹²	10 ⁻¹³	10 ⁻¹⁴
pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
pOH	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
[OH ⁻]	10 ⁻¹⁴	10 ⁻¹³	10 ⁻¹²	10 ⁻¹¹	10 ⁻¹⁰	10 ⁻⁹	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³	10 ⁻²	10 ⁻¹	10 ⁰
	Strong Acid			Neutral solution						Strong base					

Fig. 1—Correspondence of pH, pOH and ion concentration at 22 deg. C.

pH represents the concentration of hydrogen ions and may be looked at as the instantaneous or effective acidity of a solution. Hydrogen ion concentration is the intensity of acidity, whereas normality is an expression of the quantity of available acidity.

Temperature greatly affects the ionization of a solution and consequently affects the pH of the solution. At 22 deg. C., the hydrogen ion concentration of pure water is 1×10^{-7} gram equivalents per liter, whereas at 100 deg. C., it is 6.07×10^{-7} gram equivalents per liter. It is most important that one have the correct temperature in mind when making hydrogen ion calculations. The feedwater treatment for a boiler operating under high pressure and temperature based upon raw water at 22 deg. C. may fall considerably short of the required treatment because of a great increase in ionization at the elevated temperature.

Buffer Solutions—An industrial process solution may possess a definite resistance to a change of pH when an acid or base is added to it. That resistance is created by the presence of substances known as buffers and the solution is termed a buffer solution. Buffer action may be caused by the presence of a weak acid and one of its salts, or a weak base and one of its salts.

For example, acetic acid and sodium acetate when present in solution exert buffer action and are capable of neutralizing both acids and bases within

certain limits. A mixture containing equivalent amounts of acetic acid and sodium acetate may be used to illustrate how buffer action occurs when an acid or base is added to it. If an acid, such as HCl, is added to such a mixture, the HCl will not remain as the highly ionizable hydrochloric acid, but will convert some of the sodium acetate to the slightly ionizable acetic acid and the hydrogen thus added is kept in molecular combination and will not ionize to produce a change in pH. Similarly, when a base, such as NaOH, is added to the mixture, the sodium hydroxide will combine with the acetic acid to produce sodium acetate and water and no additional hydroxyl ions will be produced to change the hydrogen ion concentration.

It must be emphasized that such buffer action is limited and dependent upon the amount of buffer substances present and the concentration and volume of acid or base added. The buffer action varies with the type and concentration of the substances, the pH region in which the action occurs, and the character of the acid and base involved. Consequently, a solution may be a strongly or a weakly buffered one. Various compounds, such as acetates, carbonates, borates, phosphates, phthalates, citrates and lactates are responsible for buffer action over certain divisions of the pH scale.

In certain processes, advantage is taken of buffer action to keep a reaction mixture within a definite pH range. For example, calcium carbonate is added to fermenting mashes in the production of alcohol to keep the mash at a definite pH. In many fermentation processes, the pH of the fermenting mash is adjusted by add-

ing high wines distilled from the mash, which contain natural buffer substances, such as lactates, and present a case where fortunately buffer substances are present. When a buffer is added to a reaction mixture for the purpose of maintaining a constant pH, it must be a substance which will not interfere with the main reaction and added in sufficient quantity to neutralize the effect of any acid or alkaline material which may be produced as a part of the reaction.

Significance of pH Control

Production of bromine requires the precise control of hydrogen ion concentration in at least two steps of its recovery from sea water⁹ and illustrates how vital pH control is to many chemical processes. The sea water is acidified to a definite pH with sulphuric acid before chlorine is added and the mixture pumped to the top of the blowing-out towers where bromine is liberated. The bromine thus formed is reacted with soda-ash solution to produce sodium bromide-bromate. This mixture is treated with sulphuric acid and adjusted to a definite pH, producing free, concentrated bromine. The production of bromine from other brines presented one of the earliest cases where pH control was absolutely essential in the chemical industry. Precise control requirements resulted in applying automatic means of pH measurement and control.

Hydrogen ion concentration affects the speed and completeness of many actions and unit processes vital to the chemical engineer. Some of the actions in which hydrogen ion concentration may play a major role are: (1) Completeness of precipitation and uniformity of grain size; (2) coagulation; (3) flocculation; (4) rate of settling; (5) adsorption; (6) absorption; (7) crystallization; (8) speed and completeness of chemical reactions; (9) speed of filtration; and (10) corrosion.

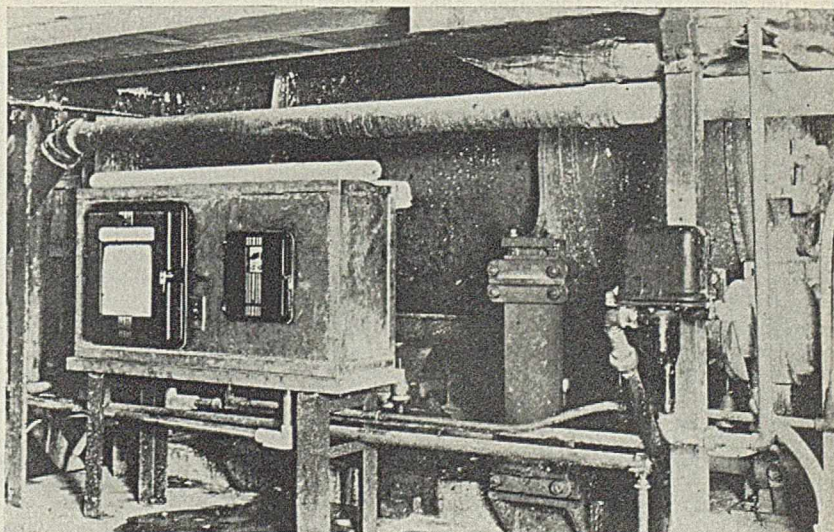
Some of the industries and processes which require precise control of hydrogen ion concentration, and the optimum values of pH for those actions, are given in Table I. Not only does pH control spell the material success

Table I—pH Ranges for Various Processes*

Industry	Process	Optimum Value or Range of pH
Metal plating	Nickel plating baths	5.2 to 6.8
	Zinc plating baths	4.0 to 5.0
Textile	Scouring of cotton	11.0 to 13.0
	Bleaching of cotton	8.0 to 10.0
	Wool bleaching	6.5 to 11.5
Paper	Degumming of silk	8.5 to 9.5
	Sizing	4.0 to 6.5
	Coagulation of white water	4.0 to 5.0
Leather	Putrification action on hides	5.5 to 6.0
	Chrome tanning	3.0 to 4.0
Brewing	Beer mash fermentation	4.5
Sugar	Refining processes (to prevent inversion of sugar)	above 6.8
Laundry	Soap baths	9.0 to 12.0
	Rinsing operations	7.0 to 8.5
Baking	Preparation of cracker doughs	7.1
Pharmaceutical	Preparation of ergot and cocaine extracts	4.0
Sewage disposal	Activation of sludge	7.4
	Filtration with ferric chloride	3.4
Water purification	Alum coagulation	4.5 to 7.5
	Copperas coagulation	8.8 to 9.4

* From various sources, especially reference (6) below.

Fig. 2—Leeds & Northrup antimony electrode installation for recording and controlling hydrogen ion concentration in a chemical plant



of many processes, but it has tremendous economic values. In many processes, a careful control of pH will result in economic gains because of (1) improvement of quality; (2) greater production and yield; (3) uniformity of product; (4) lower labor cost; (5) prevention of waste and spoilage; (6) prevention of corrosion; and (7) prevention of stream pollution.

It is estimated from instrument sales that in 1937 there were approximately 350 automatic pH recording or controlling installations in the Americas. The cane sugar industry accounted for approximately 125 antimony electrode installations while the beet sugar industry accounted for about 100 of that same type installation. The remainder were in use in paper mills, water treating plants and various miscellaneous applications. These figures pertain only to automatic recording or controlling instruments and do not include any laboratory and solely indicating set-ups. Since that time, there have been a large number of additional installations made of each electrode system, including many employing the glass electrode.

Colorimetric Determination of pH

It need not be emphasized that the colorimetric method of hydrogen ion determination has contributed much to our present knowledge of the effects of hydrogen ions and to our present realization of the value of pH control.

The colorimetric method is especially adaptable to certain fields where precise control is not absolutely essential and where the original investment must be relatively small. Colorimetric determinations have been found of value where frequent check-ups are desired on the process liquor and where the average and practical accuracy of measuring need not exceed 0.2 pH.

No definite line can be drawn between the colorimetric and electrometric fields as all applications present different problems and requirements. Of course, if automatic indicating, recording, or controlling of processes is desired, the electrometric remains the only method which has thus far proven successfully adaptable.

Principles of Method—As indicated from the word colorimetric, the method depends upon the change of color of indicators in various ranges of hydrogen ion concentration. Indicators, the basis of this method, are organic dye-stuffs of a weakly acidic or basic nature which undergo a color change when contained in a solution undergoing transition from one pH range to another. Each indicator has a definite pH range in which both colors are exhibited and the most suitable and accurate indicators for hydrogen ion work exhibit a narrow range of transition from one color to another. The average pH range of a good indicator is 1.5 pH units, meaning that the indicator changes completely from one color to the other within this range.

Colorimetric methods of pH determination in use today are generally based upon a comparison of the colors produced when a definite quantity of an indicator is added to a definite volume of the unknown solution, and to one of a group of standardized buffer solutions. Commonly these color standards are prepared and sealed in glass

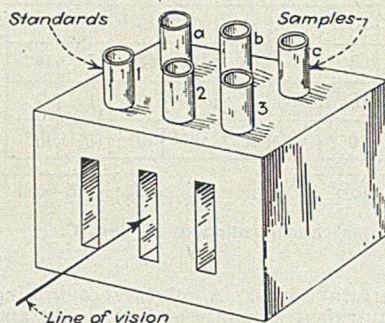


Fig. 3—Simple block comparator showing samples and color standards

(a) Sample; (b) sample plus indicator; (c) sample; (1) color standard; (2) distilled water; (3) color standard

tubes for repeated use. Instead of liquid standards, however, sometimes colored glass disks or plates are used.

Colorimetric Equipment—Most colorimetric determinations are made by means of some form of block comparator which in its simplest form consists of a wooden block in which are three pairs of compartments to hold the specimen tubes and the color standards. Openings through the block perpendicular to the first set of holes permit light to pass through the adjoining pairs of tubes for color comparison. As indicated in Fig. 3, identical samples of the unknown are placed in the three rear tubes with the proper quantity of the appropriate indicator added to the center tube. Then adjacent pairs of color standards from a sequence procured from the manufacturer are placed in the outer openings of the front line until the light transmitted through the center viewing opening is found to have the same color as one of the standards, or to lie between two of them.

Several modifications of this fundamental form of comparator have been developed for greater convenience. The La Motte Roulette comparator places the three sample tubes in holders which align with color standard tubes, alternating with tubes of distilled water and supported around the periphery of a drum, in the center of which is a standard type of day-light incandescent lamp. Rotating the drum successively brings all of the color standards in line with the sample tubes, permitting rapid selection of the corresponding standard to identify the proper pH. The Taylor slide comparator is similar in principal, substituting for the drum carrying the standards a long block containing a sequence of standards alternating with tubes of distilled water, which may be slid past the three specimen tubes for comparison. The Hellige comparator employs colored glass permanent standards but otherwise operates in substantially the same manner.

Errors of Method—Colorimetric pH determinations are subject to several types of error including those due to use of indicators at temperatures other than were used in preparing the color standards; errors due to the presence of salts (salt error) which suppress the solubility of certain indicators; errors due to different color effects (dichromatism) on account of observ-

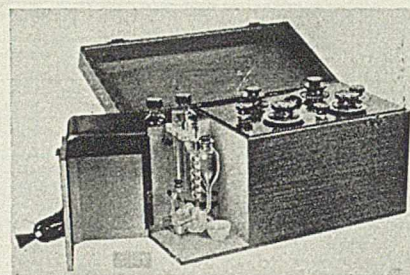


Fig. 4—Industrial model glass electrode pH indicator made by Cambridge Instrument Co.

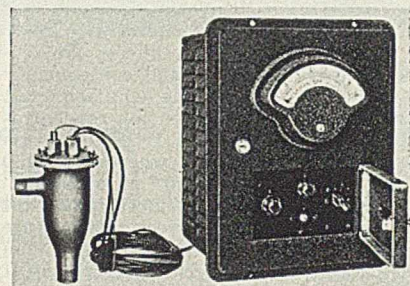


Fig. 5—Beckman Model R automatic pH indicator with flow type glass electrode

ing varying depths of solutions; errors due to the acid effect (acid error) of the indicators themselves in unbuffered solutions; and errors introduced by colloids or proteins which may affect the color by selective adsorption of the indicator. Needless to say, personal errors may also arise owing to deficiencies in color judgment. Many photoelectric colorimeters now available avoid such difficulties.

Electrometric Determination of pH

Electrometric measurement of pH is made possible by measuring the e.m.f. developed by an electrolytic cell, one electrode of which is immersed in the solution of unknown pH and the other a standard reference electrode, such as the calomel electrode.

The single-electrode potential produced when a metal is immersed in a solution of its ions is the algebraic sum of two forces, electrolytic solution pressure and osmotic pressure. It is, however, impossible to measure the single-electrode potential produced between a single electrode and the solution, and hence it is necessary to dip another electrode into the solution to complete the circuit. Therefore, the potential measured is the algebraic sum of the two electrodes. A combination of two electrodes dipping into the same solution and causing a difference of potential and a current to flow when the circuit is completed is known as a cell and each electrode dipping into the solution is known as a half-cell, or simply as an electrode. Since the single electrode potential of one half-cell cannot be measured directly, it is necessary to employ a half-cell of known electrode potential in combination with the first.

A voltmeter cannot be used to measure the potential produced by such a cell, as current must flow to actuate such an instrument and when an appreciable current flows the voltage

changes because of polarization effects at the electrodes. Use of a potentiometer makes it possible to measure the voltage with no current flowing from the source.

Potentiometer Systems—Instruments intended only for the measurement and indication of pH in most cases employ manually balanced potentiometers, most of which at present have been constructed to simplify use in the extreme. For example, in the industrial glass electrode indicator made by the Cambridge Instrument Co. (Fig. 4), a cathode ray "eye" has been substituted for the galvanometer to indicate the balance point. Most indicators also incorporate simplified means for standardizing. Instruments of this type are made in laboratory models, with non-integral electrode systems. In the industrial type of indicator the instrument is generally fully self-contained, the electrodes occupying a compartment in the case.

For recording, or recording and controlling, it is necessary to use a self balancing potentiometer (Figs. 2, 6, 7) which may be either of the battery operated or of the a.c. type. At least one concern also supplies self balancing indicating instruments (Fig. 5) which may simply indicate the pH continuously, or may be hooked up to recording or controlling equipment. Such automatic instruments do not differ materially from those used for temperature except in the detecting element (electrodes) and so do not need detailed description here. Suffice it to say that in addition to the detector the instrument requires some means of amplifying the primary impulse, and also means for actuating the indicator, recorder or control valve.

Reference Electrodes—The fact that it is impossible to measure the absolute potential of a single electrode created the necessity of assigning an arbitrary value of zero to one electrode to be used thereafter as a standard. The normal hydrogen electrode, with its arbitrary value of zero, has been accepted as the standard reference electrode. Although the hydrogen electrode is not as adaptable to certain applications as are other reference electrodes, it remains the prime standard of reference and comparison for all pH work.

A reference electrode for use in industrial instruments must be rugged and so constructed that contamination is eliminated. It must maintain a constant potential and have a low temperature coefficient. The calomel electrode is used for this purpose.

Hydrogen Electrode—Hydrogen gas is not an electrical conductor and, therefore, it is necessary to employ some means to establish good electrical contact with the solution and to allow the hydrogen atoms to ionize and enter solution. When hydrogen is adsorbed on the surface of platinum black, it takes on the characteristics of a metallic electrode, as the hydrogen ions are capable of breaking away from the hydrogen atoms adsorbed on the platinum, the latter acting as an electrical conductor.

There are several forms of the hydrogen electrode available, but essentially it consists of a platinum foil coated with platinum black and saturated with hydrogen. A common type

is shown in Fig. 8 (a). The hydrogen is bubbled around the platinum foil and should be at a pressure of 740-780 mm. of mercury and the solution should be at a temperature near 22 deg. C. Within this pressure range and from 20 to 30 deg. C., the error due to departure from 22 deg. C. and 760 mm. is less than 0.02 pH units. For conditions farther from standard, corrections can be applied.

The advantages of the hydrogen electrode include its use over the entire pH range, from 0 to 14, the fact that it is not affected by the presence of salts, that it may be used in colored and turbid solutions, and that the electrode system is of low resistance.

There are a number of limitations to the hydrogen electrode relegating it more or less strictly to the laboratory as a reference electrode and eliminating it from use industrially in pH recording and controlling equipment. Platinized surfaces are susceptible to the action of poisons which many industrial liquors contain, such as

arsenic trioxide and hydrogen sulphide. These substances destroy the effectiveness of the platinized surface within a short time. The hydrogen electrode cannot be used in highly oxidizing or reducing solutions, nor in the presence of metals immediately above or below it in the electromotive series. It is not recommended for use in unbuffered solutions, especially within the pH range of 5.0 to 8.5, and cannot be used in solutions containing dissolved gases, as the dissolved gases adjacent to the electrode tend to escape because of the bubbling action and hence alter the true pH of the solution. Although not applicable to continuous measurement and control of pH in industrial processes, the hydrogen electrode is nevertheless used widely for research purposes and standardizing.

Calomel Electrodes—There are three standard forms of calomel electrode in general use as reference electrodes, the normal, deci-normal and saturated forms, these terms referring to the concentration of the potassium chloride solution used. This electrode, of which typical forms are shown schematically in Fig. 8 (b), consists of mercury, calomel (mercurous chloride) and an aqueous solution of potassium chloride. The mercury is contained in the bottom of the electrode vessel over which is a paste containing the mercury and calomel. The remainder of the vessel is filled with potassium chloride solution, the strength of which determines the type of calomel half-cell, as explained previously. The saturated calomel half-cell is used more widely than the normal and deci-normal types.

Measuring Electrodes

The quinhydrone, antimony and glass electrodes are the primary industrial means of detection and measurement of pH. Each electrode has its suitable working range and field of application. Despite popular belief, the glass electrode is not a cure-all; advantageous use of other types is still being made.

Quinhydrone Electrode—Quinhydrone is an equimolecular compound of quinone, $C_6H_4O_2$, and hydroquinone, $C_6H_4(OH)_2$, and is soluble in water to the extent of 3.94 grams per 1,000 cc. It dissociates at such concentrations

Fig. 7—Coleman glass electrode pH recorder-controller built for acidification control in Ridgewood, N. J., activated sludge sewage disposal plant

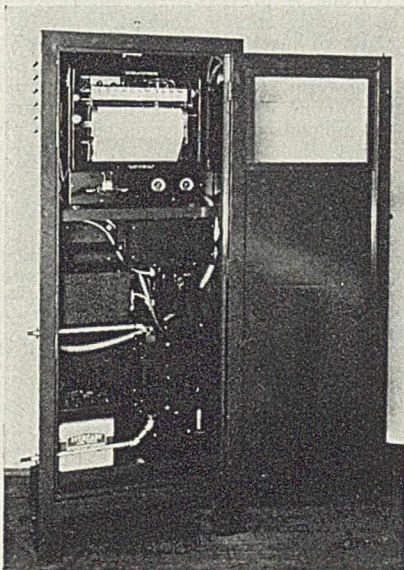
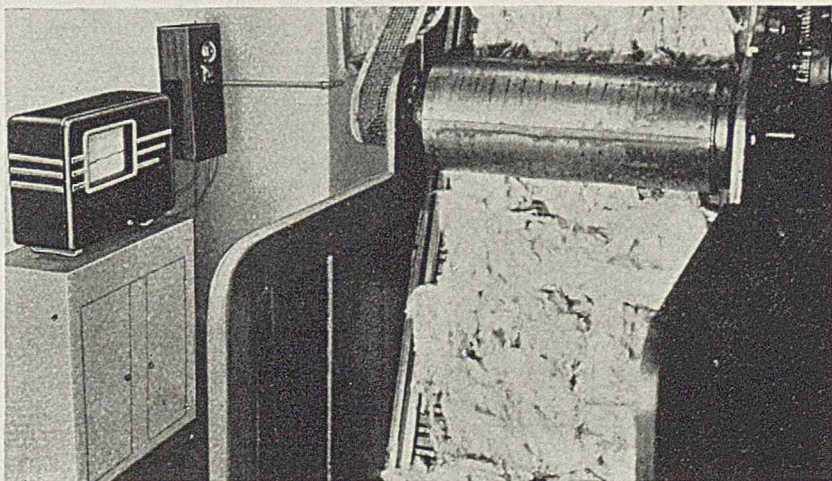


Fig. 6—Cameron pH recorder employed in a wool scouring plant



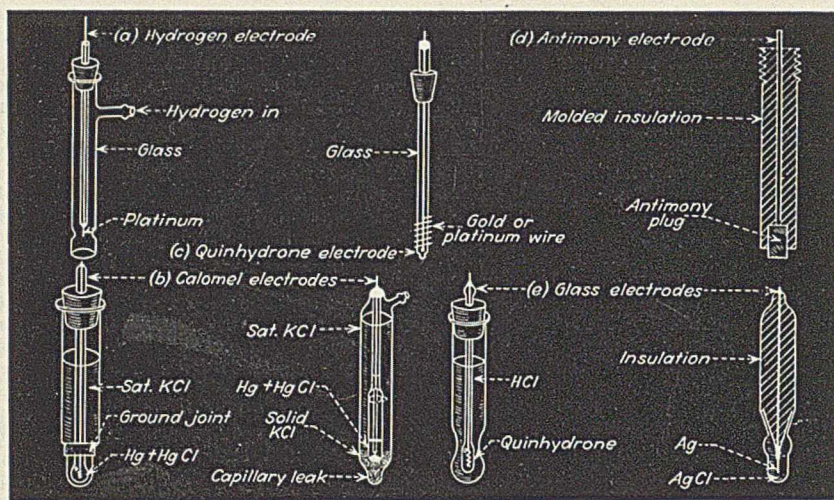
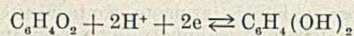


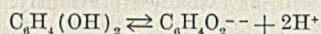
Fig. 8—Hydrogen, calomel, quinhydrone, antimony and glass electrodes shown in typical diagrammatic forms

into quinone and hydroquinone to the extent of 93 per cent, maintaining constant and equivalent concentrations of quinone and hydroquinone.

The relation between the two compounds when equilibrium is established is



where e symbolizes the release of one electron, Hydroquinone is weakly acidic and ionizes as



The hydrogen ions of this latter reaction are the measure of the pH of the solution in which the quinhydrone is contained. The ratio of hydroquinone to that of quinone must be constant and equivalent and will be so, if the solution is acid and undissolved quinhydrone is present. The substance is so slightly soluble that it is not difficult to meet the latter requirement. If the solution is alkaline over a pH of 9, however, the ratio of hydroquinone to quinone will be altered and it must be emphasized that the measure of pH

Table II—Electrode Comparisons

Electrode	pH Range	Advantages	Limitations	Applications
Hydrogen	0-14	Basis and standard of pH measurement. Covers entire pH range. Not subject to salt error. Can be used in colored and turbid solutions. Has low electrical resistance.	Requires Pt catalytic surface and pure supply of hydrogen gas. Pt surface susceptible to poisons. Cannot be used in solutions containing dissolved gases. Not good for use in unbuffered solution especially between 5 and 8.5 pH.	Research laboratory. Calibration of buffer and colorimetric standards. Biochemical investigating. Absolute standard of pH measurements.
Quinhydrone	0-9	Does not require a catalytic surface or gas. May be used in solutions containing dissolved gases. Simple in operation and relatively economical.	Cannot be used in presence of most oxidizing and reducing substances. Cannot be used in presence of sulphites, chromic acid and ferric salts. Samples become contaminated with quinhydrone.	Research laboratory. Nickel plating. Fermentation processes. Water purification. Biological investigations. Dairy industry.
Antimony	4-11.0	Rugged and durable. Can be used in semi-solids, sludges and viscous solutions. Has low resistance. May be used in presence of acetates, sugar, soap, suspensions, clay, alum, lime, etc.	Calibration not same in static and flowing liquid. Subject to poisoning by even traces of Cu and Ag. Slightly soluble in acid solutions. Subject to error in oxidizing and reducing solutions.	Sugar refineries. Paper mills. Water purification. Coagulation, neutralization and recarbonation processes. Corrosion prevention.
Glass	0-14	No contamination of sample. Can be used in presence of oxidizing and reducing substances. Can be used in unbuffered solutions. Not subject to poisoning. Can be used in presence of dissolved gases.	Subject to alkaline salt error over 9 pH. Subject to salt errors above 2N. High resistance system requiring amplification. Some types subject to breakage. Due to solubility of 015 Corning glass in highly alkaline solution, electrode should not be continuously immersed.	Research laboratory. General industrial applications. Tanning industry. Water treatment. Sewage treatment.

is based upon the second equation given above.

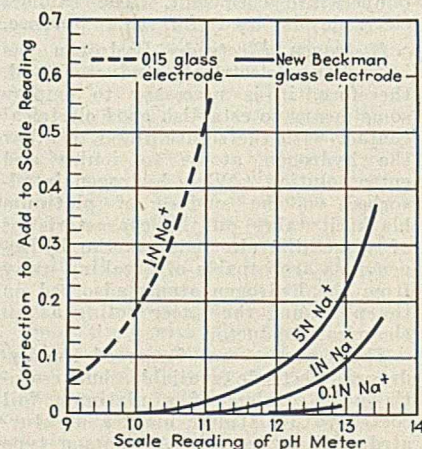
When an inert electrode, such as a piece of platinum or gold is placed in a solution containing quinhydrone, the electrode acquires a potential which is dependent upon the ionization of the hydroquinone, as shown above. It has been explained that the extent of this ionization is dependent upon the hydrogen ion concentration of the solution and hence the potential produced is a measure of the hydrogen ion concentration. A typical quinhydrone electrode for general laboratory and plant use is shown in Fig. 8 (c).

Over a pH of 9.0, the quinhydrone is more soluble and it is difficult to keep it in excess. It is excellent over the range from 0 to 9, but for highest precision between 7 and 9 it should be used in strongly buffered solutions only. When it is used over a range of 7, a continued drift in voltage takes place, especially in a poorly buffered solution. The voltage will return to its original value when more hydroquinone is added and, if a laboratory determination, the reading obtained just prior to the beginning of the drift is the most reliable one. Voltage drifts may be caused by the reaction of quinhydrone with other constituents of the solution and in such cases the readings are not to be relied upon.

The quinhydrone electrode can be used in a few mild oxidizing solutions in which the hydrogen electrode cannot be applied. However, in most cases of oxidizing and reducing solutions, the quinhydrone electrode cannot be used with success. Strong salt solutions may affect the accuracy of this electrode, as the "salting out" effect on the hydroquinone may not equal that effect on the quinone and destroy the ratio between these two substances. The effects of salts in solution are not serious unless in high concentration.

The quinhydrone electrode is adaptable to the measurement of pH in process liquors in the acid range, with a claimed limit of error of 0.1 pH. However, it is seldom used for recording and control. It is applicable for use in solutions containing aluminum, nickel, copper, milk, beer and a wide variety of substances. If used in a continuous system, it should be cleaned once daily.

Fig. 10—Sodium ion corrections of 015 glass and new Type E Beckman high-pH electrodes at 25 deg. C.



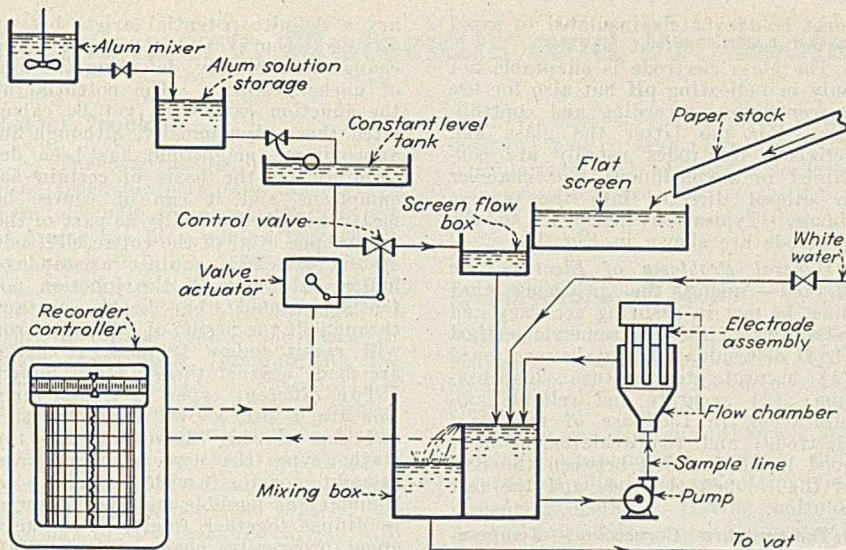
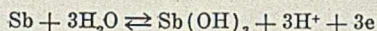


Fig. 9—Schematic hook-up of Leeds & Northrup antimony electrode equipment for automatic control of alum addition to paper board stock

Antimony Electrode—Various metal oxides of low solubility have been considered for use as hydrogen ion indicators and the experimentation in the past both in the laboratory and field has eliminated all metal-metal oxide electrodes from practical consideration except the so-called antimony electrode. Some of the metal-metal oxide combinations which have been considered are the silver-silver oxide, copper-copper oxide, lead-lead oxide, tungsten-tungsten oxide and mercury-mercury oxide.

As shown in Fig. 8 (d), the antimony electrode is simple, consisting merely of an antimony plug, the lead from which is insulated from the solution. The fundamental reaction is



The concentration of the hydroxide is kept constant by the presence of the solid phase. The concentration of the metal ion is dependent upon the concentration of the hydrogen ions, and since it is the concentration of the metal ion which establishes the potential of the electrode, the electrode potential is dependent directly upon the hydrogen ion concentration.

G. A. Perley states⁸ that the relation of e.m.f. to pH for the antimony electrode depends upon (1) the nature of the electrode surface, (2) the concentration of dissolved air or oxygen, (3) the agitation prevailing at the electrode surface, (4) the nature of dissolved salts and their concentration, and (5) temperature of the system.

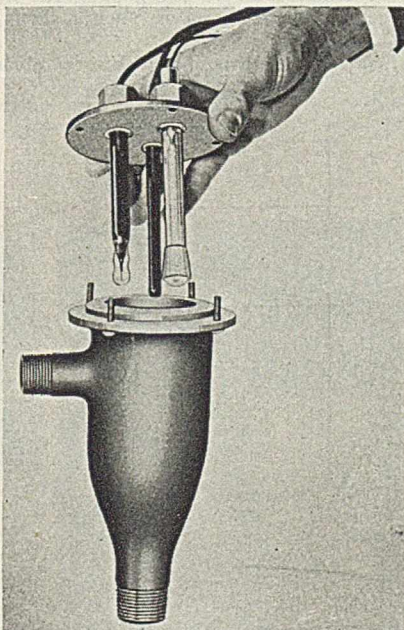
Several concepts of the supposed reaction between the antimony electrode and the solution and surrounding atmosphere have been advanced. In all cases, the electrode must be calibrated for the specific purpose it is serving and it should be added that the calibration for a static liquor is different from the calibration for a flowing liquor. The antimony electrode possesses several advantages over other electrodes, such as its rugged construction, its low resistance system (requiring no amplifier), and the fact that it can be used in turbid and colored solutions. It may be used in the presence of acetates, sugar, soap, sus-

pensions, clay, alum, sulphites, lime and many other substances which affect other electrodes. The electrode can be calibrated for specific solutions within a limit of error of 0.1 pH.

The useful range of an antimony electrode is between a pH of 4 and 11.5. However, under special conditions, the range can be extended from 2 to 12 pH. Because of its rugged construction, it is adaptable for use in sludges, semi-solids and viscous liquids.

Among the disadvantages of the antimony electrode are its susceptibility to poisoning by traces of copper, its unsuitability for use in oxidation-reduction systems and the fact that the calibration for a solution varies with the amount of air and gases dissolved in the system.

Antimony electrodes are in successful operation in sugar refineries, paper board mills, water treating plants and many other industrial plants for continuous, automatic recording and controlling of processes. A typical setup



based on a Leeds & Northrup installation in a paper board mill is diagrammed in Fig. 9. Here it is desired to add alum solution to a mixture of stock and whitewater so as to maintain an optimum pH. This is accomplished by continuously measuring the pH of the mixture and automatically adjusting the alum solution valve in case of a departure from the set point. The equipment includes an antimony measuring electrode, calomel reference electrode and temperature compensator suspended in an open flow channel through which a sample is continuously pumped. A self-balancing potentiometer controller is used.

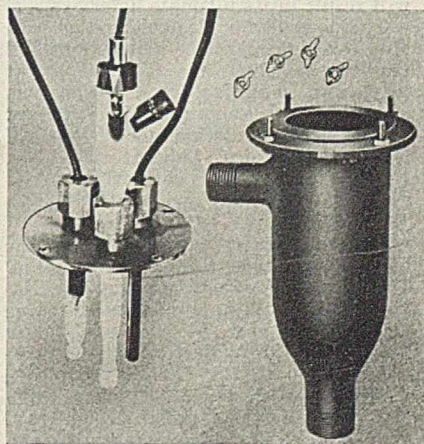
Glass Electrodes

Although the principles of the glass electrode have been known since 1906, its potentialities as a means of pH measurement were not realized until 1922. Since that time, extensive research has been carried on and only within the last five years has the glass electrode assumed general commercial significance. With further study and investigation, the glass electrode will continue to increase in use, as the present trend is definitely away from the quinhydrone and antimony electrodes.

When a thin membrane of soda-lime glass separates two solutions of different hydrogen ion concentrations a potential is established which is a function of those concentrations. If the pH of one solution is maintained constant, that of the other solution can be calculated from the potential.

The early glass electrode consisted of a thin membranous glass bulb of the order of 0.08 mm. in thickness, sealed at the end of a glass tube. The reference solution of known pH was contained inside the bulb and when measurements of pH were made, the exterior of the bulb was immersed in the solution of unknown hydrogen ion concentration. To effect an electrical contact, it was necessary to employ an inner electrode dipping into the internal reference solution. Some investigators used an inner reference solution of 1N HCl saturated with quinhydrone, into which dipped a platinum electrode. The inner electrode accurately reflected the potential differences created as long as the inner reference

Fig. 11—At left, standard Beckman glass electrode flow assembly; and at right, new high-temperature assembly



solution remained constant in composition and concentration.

The inner electrode has been the source of many difficulties since the glass electrode has come into use. The quinhydrone inner electrode has continued to be used in some commercial instruments, but has been replaced in other instruments by a saturated calomel or silver-silver chloride inner electrode. Nearly all glass electrodes, of which Fig. 8 (c) and 11 are typical, are now sealed at the factory and require no further maintenance on the part of the user other than frequent cleaning.

The very thin membranous bulb served well for laboratory use and still is available commercially for certain types of laboratory work. Industrial applications require a rugged and more durable electrode and a much heavier bulb, with accompanying high electrical resistance, has been developed. On account of this high resistance of the heavy bulb the potentials encountered are unable to produce sufficient current through the system to actuate even the most sensitive galvanometer. Therefore electronic devices are usually employed for amplifying the minute currents.

The rapid advance and bright outlook for the glass electrode may be attributed to many of the advantages which it possesses over the other available electrodes. Only the glass electrode approaches the hydrogen electrode in its ability to cover the entire pH range. If sodium, potassium, or lithium salts are not present in solutions and other conditions are favorable, ordinary glass electrodes may be used over the pH range from 0 to 14. Oxidizing and reducing substances, colloidal material, suspended solids and dissolved gases do not affect the action of the electrode. It is applicable in clear, colored, or turbid solutions and is not subject to poisoning.

Over a pH of 9 and in the presence of alkaline salts, such as mentioned above, the usual type electrode which is made of Corning 015 glass is subject to what is called the sodium ion error. If the salt concentrations and other conditions are known, the error caused by their presence may be calculated and applied to give a true pH value. Inasmuch as 015 glass is somewhat soluble in alkaline solutions of high pH, electrodes made from it are not recommended for use in measuring and controlling the pH of highly alkaline substances, as constant immersion of the electrode in such solutions will result in its ultimate deterioration.

The demand for glass electrodes suitable for high alkali concentrations has resulted in much recent work by at least two manufacturers. One such glass already announced is employed in the Type E Beckman electrodes of National Technical Laboratories. Fig. 10 shows sodium ion corrections necessary for 015 glass and the new Type E electrodes.

Another recent development is the high temperature glass electrode (Fig. 11, right). As introduced by the National Technical Laboratories this electrode makes use of a special glass giving long life under continuous operation at 50 to 100 deg. C.

The glass electrode, having a high resistance system, must be shielded against electrostatic potentials and

must be adequately insulated to avoid errors due to current leakage.

The glass electrode is adaptable not only in indicating pH but also for use in continuous recording and controlling. For the latter the glass and reference electrodes usually are contained in a continuous flow chamber or dipped directly into the process liquor. Typical arrangements of the electrode are shown in Fig. 11.

General Problems of Electrometric Method—Among the problems that must be met in assuring accuracy and reliability of the electrometric method of pH determination may be mentioned (1) accurate temperature compensation; (2) accurate and reliable amplification, in the case of the glass electrode; and (3) achievement of a good liquid junction between the KCl of the calomel electrode and the test solution.

Temperature Corrections—Temperature changes of the test solution may be compensated automatically by placing a resistance thermometer in the solution, in series with the potentiometer slide wire. Similar use of an adjustable resistance in the slide wire circuit can sometimes be made to cancel out known constant errors, such as the presence of electrode poisons.

Amplification—The high resistance of the glass electrode presents problems of amplification not encountered with the other electrodes (Fig. 12). The amplifier must be designed for long periods of use without any attention whatsoever and some means for compensating fluctuations in voltage occurring in ordinary feed lines must be made. A drying agent to prevent surface leakage may be used in the amplifier tube chamber. In addition, the input leads to the amplifier should be shielded.

Liquid Junctions—Rather complex problems occur in developing an unchangeable and reproducible liquid junction between the KCl solution of the calomel half cell and the solution being tested. At the boundary between two solutions of electrolytes a potential difference is set up, owing apparently to the differential rate of migration of ions across the boundary. At the instant of forming such a bound-

ary a definite potential exists but as mixing occurs the potential may change considerably, defeating the aim of unchangeability. The potential at the junction cannot as yet be calculated thermodynamically, although its approximate magnitude has been determined on the basis of certain assumptions and it can of course be measured experimentally as part of the overall potential of the entire electrode system by check against a standard buffer. However, if the junction potential cannot be kept constant throughout the period of the test, error will result unless frequent re-checks are made against the standard buffer.

Two different types of liquid junction are in use, known as the "static" and the "flowing" boundary. In the static type the two solutions are brought together with as sharp a boundary as possible and then allowed to diffuse together freely, with consequent progressive change in potential. In a flowing junction a boundary results from the meeting of two slowly flowing streams of the solutions.

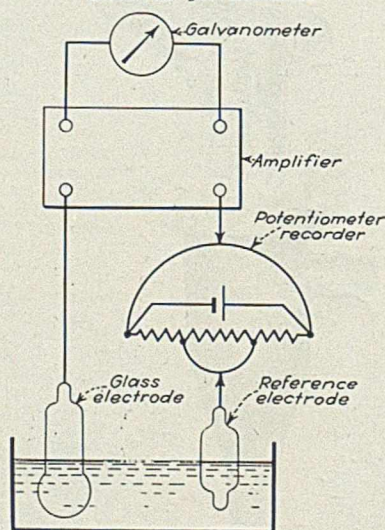
In practice the attempt is made to reduce the variation of junction potential to negligible proportions by using what is called a "salt bridge," consisting of concentrated KCl. Many means have been developed for completing the salt bridge connection between the two different solutions. Wicks, asbestos plugs, agar or parchment membranes, ground glass joints which permit minute leakage, pinched rubber tubes and capillary connections have all been used. Industrial equipment at present relies chiefly on the last three methods. It is highly important that the design of the salt bridge junction permit a moderately reproducible and constant potential over daily operating periods.

In conclusion the editors wish to express their appreciation for valuable assistance rendered by the manufacturers of pH equipment, and particularly that of G. A. Perley of the Leeds & Northrup Co. who reviewed the manuscript and aided in the clarification of numerous points.

Bibliography

1. Koehler, W. A., "Principles and Applications of Electrochemistry," 1935, John Wiley & Sons, New York.
2. Dole, Malcolm, "Principles of Experimental and Theoretical Electrochemistry," 1935, McGraw-Hill Book Co., Inc., New York.
3. Britton, Hubert, F. S., "Hydrogen Ions," 2d Ed. 1932, Chapman & Hall, Ltd., London.
4. Clark, W. Mansfield, "The Determination of Hydrogen Ions," 3d Ed. 1928, The Williams & Wilkins Co., Baltimore.
5. Mac Innes, Duncan A., "The Principles of Electrochemistry," 1933, Reinhold Publishing Corp., New York.
6. LaMotte, F. A., Kenny, W. B., and Reed, A. B., "pH and its Practical Application," 1932, The Williams & Wilkins Co., Baltimore.
7. Perley, G. A., Modern Views of pH Measurement, *Amer. Dyestuff Reporter*, Dec. 27, 1937.
8. Perley, G. A., Characteristics of the Antimony Electrode, *Ind. Eng. Chem., Anal. Ed.*, June 15, 1939.
9. Illust. flow sheet, Bromine From Sea Water, *Chem. & Met.*, Dec. 1939, p. 771ff.

Fig. 12—Diagrammatic hook-up of glass electrode pH indicator



Reprints of this 8-page Report are available at 25 cents per copy. Address the Editorial Department, Chem. & Met., 330 West 42d St., New York, N. Y.

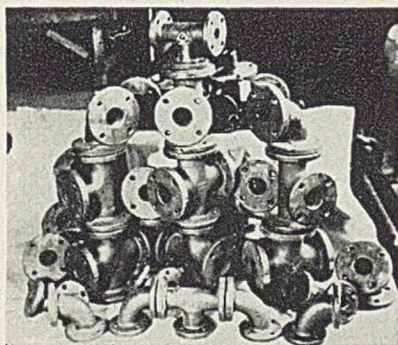
Machinery, Materials and Products

Barrel Truck

AN IMPROVED DESIGN of barrel handling truck for permitting an average man to handle alone even the heaviest of drums has been put on the market by Palmer-Shile Co., 7100 West Jefferson Ave., Detroit, Mich. As shown in the accompanying illustration, the truck is pushed against the barrel or drum and a hook (designed for the type of barrel to be handled) is dropped over the rim. Without rocking or tugging, the truck can be tipped backward, slipping the drum smoothly into place and cradling it in perfect balance on rubber-tired wheels, according to the manufacturer. All-welded, the truck weighs but 85 lb.

Rubber-Lined Pipe

SEAMLESS rubber lining of metal pipe and fittings for the chemical-using industries has been announced by Paramount Rubber Service, Inc., 1430 Rosedale Court, Detroit, Mich. All units up to 1 ft. long are given complete rubber covering, inside and out, including flanges and bolt holes, at no extra cost. Longer lengths are given an application of this company's rubber paint on exterior surfaces and back of the flanges. The rubber used is built up from specially treated



Variety of seamless rubber-lined fittings



Single Kiln Three Freight Cars Long

Two of the largest all-welded, completely assembled kilns ever built for shipment in one piece were recently fabricated and shipped to paper mills in the southeast by Allis-Chalmers Mfg. Co., Milwaukee, Wis. Weighing 175,000 lb. each, the kilns were 140 ft. long and 8 ft. in diameter, requiring three flat cars.

metal surfaces to the required thickness and has no seams or laps. The formulations used are stated to have been given five year service tests under extremely corrosive conditions.

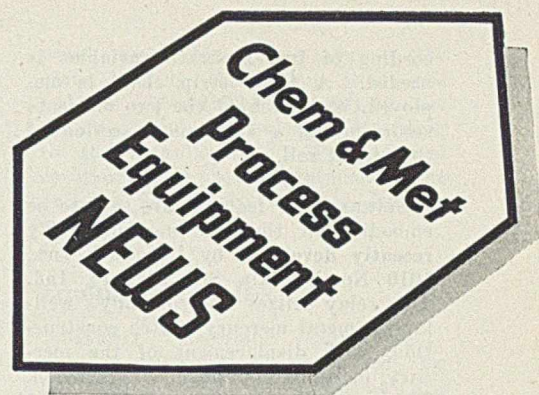
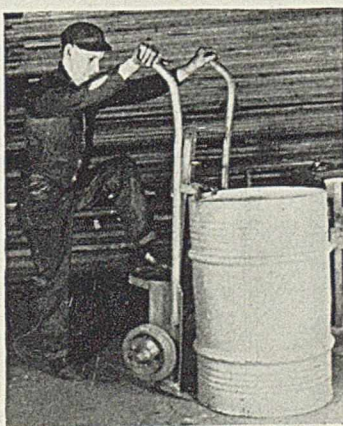
Quinhydrone pH Meter

NATIONAL TECHNICAL LABORATORIES, 820 Mission St., South Pasadena, Cal., manufacturers of the Beckman glass-electrode pH equipment, have announced a new portable pH meter employing a quinhydrone electrode suitable for applications permitting this measuring method. Having a range from 0 to 9 pH the meter automatically corrects for temperature, permitting readings to 0.1 pH through a magnifying lens mounted above the dial. Electrical parts are built into a molded plastic case with the meter in the top. A single flashlight cell is required for operation. Both quinhydrone and calomel electrodes are of molded plastic. The case serves to support the instrument, but if desired the latter can quickly be removed from the case for direct immersion of the electrodes into the solution to be tested.

New Products

CORROSION CONTROL in sub-aqueous systems at extremely low cost is claimed for a new organic chromium inhibitor recently announced by D. W. Haering & Co., 2308 South Winchester Ave., Chicago, Ill. Known as Quachrom glucosate, this material forms a monomolecular oxidation film which protects metal surfaces from corrosive attack of both oxidation and sulphide types. Concentrations from 15 to 50 parts per million are said to be effective in most media. The manufacturer states that this inhibitor has proved itself in a variety of applications: in cooling systems, steam and return systems, air washers and other similar uses, showing cost reductions from 50

New barrel truck in use



to 200 per cent, and is compared with inorganic chromates. The protective film formed is said to be resistant and self-repairing, offering a maximum of corrosion protection with a minimum of control.

LEAD-SODIUM alloys for use as drying agents for flammable materials, as well as for metallurgical work, are now available commercially from the R. & H. Chemicals Dept., E. I. duPont de Nemours & Co., Inc., Niagara Falls, N. Y. One such material, Hydrone, is a solid lead-sodium alloy containing approximately 31 per cent sodium. A smooth evolution of hydrogen is obtained without sparking when small lumps of the material are immersed in water, liberating 2.4 cu.ft. of gas per pound of alloy. Thus the material can be used as a source of hydrogen where it is required in small quantities. It is stated to be safe for drying flammable liquids in place of metallic sodium.

TWO NEW molding compounds have recently been introduced by Durez Plastics & Chemicals, Inc., North Tonawanda, N. Y. A new arc-resistant phenolic compound called Durez 8685 has been formulated specifically to prevent tracking where there is combined electric spark and rubbing action. High resistance to carbonization under an arc is claimed. Its high dielectric strength is held under moderately high temperatures, according to the manufacturer. Durez No. 1905 Black, the second new compound, has been announced for applications requiring high impact strength. The impact strength is 0.6 (A.S.T.M.) and the heat resistance 418 deg. F.

Equipment Briefs

ANNOUNCEMENT of a new duplex recorder for the simultaneous recording of two factors such as volts and amperes, kilowatts and frequency, or speed and temperature, has been made by the General Electric Co., Schenectady, N. Y. Originally designed for cement mills for the recording of kiln speed and temperatures simultaneously on a single chart the CD-37 recorder is expected by the manufacturer to have wide use wherever synchronized re-

ording of two separate variables is needed. A 10-in. strip chart is employed, with each of the two elements recording on a 4-in. ruled section of the record roll.

SEVERAL new features are said to be embodied in the new mercury relay recently developed by Durakool, Inc., 1010 North Main St., Elkhart, Ind. This relay utilizes this company's well-known metal mercury switch construction, with displacement of the mercury obtained by solenoid actuation. The relay may be operated up to 300 times per minute and is available in various capacities up to 200 amp. Without glass in the construction, the relay is said to be unbreakable and to require no maintenance or attendance.

MERCURY CLUTCH CORP., Massillon, Ohio, has announced the development of the Mercury clutch, a starting coupling utilizing mercury to displace friction segments by centrifugal force so as to pick up load gradually as the motor attains full speed. The clutch comprises a driving member or housing, a driven member or inner drum, a number of clutch segments, and mercury. In operation the mercury displaces the clutch segments inward where they engage the drum at the proper time and speed. The standard size now available transmits loads up to 5 hp. Other sizes are available on specification.

ACCURACY within 4/10 of 1 per cent in the measurement and recording of liquid flow is obtained, according to the Foxboro Co., Foxboro, Mass., in a new system of measurement recently developed primarily for juice recording in cane mills. Employing the bubble pipe principle of hydrostatic head measurement, the new system is designed to carry out automatically the filling of two or more tanks to a calibrated level, automatically switching the flow from one measured tank to another at the proper level, emptying the filled tanks and making a chart record of each filling-emptying cycle. Knowing the specific gravity of the juice, it is only necessary to multiply the number of cycles by the standard weight to determine the quantity passing through the system in a given time.

Brush Sifter

A DUST-TIGHT, all-steel case is a feature of a new brush sifter for the handling of lumpy materials which must be broken up and screened before processing or packaging, recently announced by Sprout, Waldron & Co., Muncy, Pa. Material is first broken up by the intermeshing fingers of twin agitator shafts and is then brushed through a wire screen cage under the brush cylinder. This latter is 16 in. in diameter and 42 in. long.

Braided Packing

LATTICE-BRAID is the descriptive name given to a new patented packing recently perfected by the Garlock Packing Co., Palmyra, N. Y. The new packing is distinctive in design and made on specially developed machinery used only for this purpose. Every braiding strand passes diagonally through the body giving a completely unified structure, braided internally as well as externally. The advantages of this construction compared with earlier braided types are said to include longer service without disintegration upon wear; flexibility for formation into rings around small diameter rods without distortion; controlled porosity; and semi-automatic adjustability within the stuffing box. Manufactured from long fiber asbestos yarn, the new packing is made in types for various services, impregnated with special lubricants and available in sizes from $\frac{3}{8}$ to 1 in. Lattice-Braid is recommended by the maker for centrifugal and rotary pump shafts handling water, steam, caustic solutions, acids, gas, high pressure, hot oil and strong chemical solutions.

Automatic Processing Kettles

A NEW LINE of kettles designed for automatic control of time, temperature, pressure, atmosphere, agitation and other factors, for heating by electricity, gas or oil, has been announced by the Drever Co., 748 East Venango St., Philadelphia, Pa. These kettles are made in sizes from 200 to 750 gal. working capacity, the exact design being based upon the requirements of

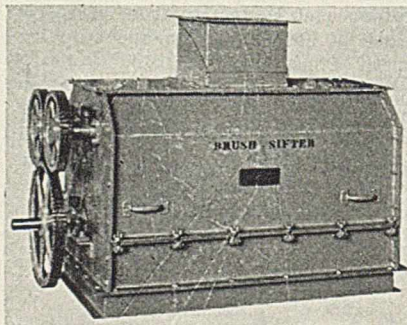
the particular process for which the kettle is intended. Such processes include the manufacture of varnishes, bodied oils, ester gums, phenolic, alkyd and glyptal resins, wax compounds and similar materials.

A typical design of Drever kettle is a vertical insulated shell provided with agitation and a jacket for heating by combustion products or electricity, and cooling by air circulated by a blower which is part of the installation. The kettle may be provided with a condenser for fumes, equipment for producing an inert atmosphere within the kettle, and automatic temperature control instruments.

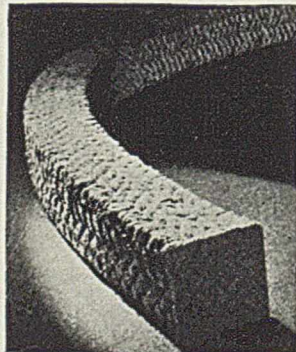
Bulk Handling Plant

FOR THE BULK HANDLING and unloading of liquefied gases such as ammonia, chlorine, carbon dioxide, butane, propane and other hydrocarbons, the Blaw-Knox Division of Blaw-Knox Co., Pittsburgh, Pa., has announced design of a line of bulk unloading and storage plants. The company reports that in most cases the price spread between the cost of gases in cylinders and in tank car lots is sufficient to amortize the cost of a good bulk handling and unloading plant in from six months to five years. To permit taking advantage of such savings, the company is now designing and fabricating such plants particularly for the gas to be handled. Storage tanks are fabricated in accordance with code requirements and stress-relieved in one piece to eliminate fabricating strains.

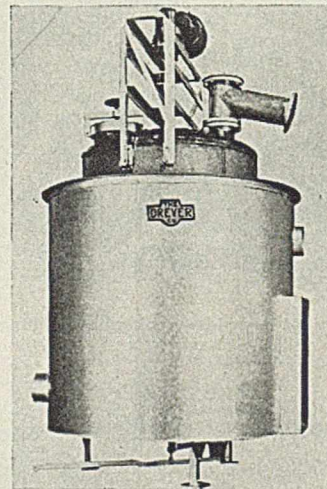
Steel-case brush sifter



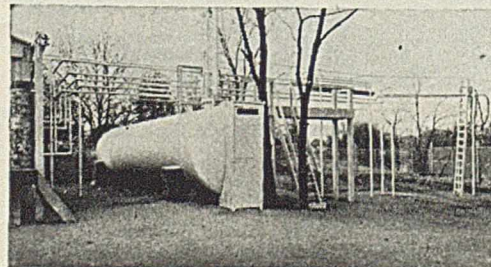
Lattice-Braid packing

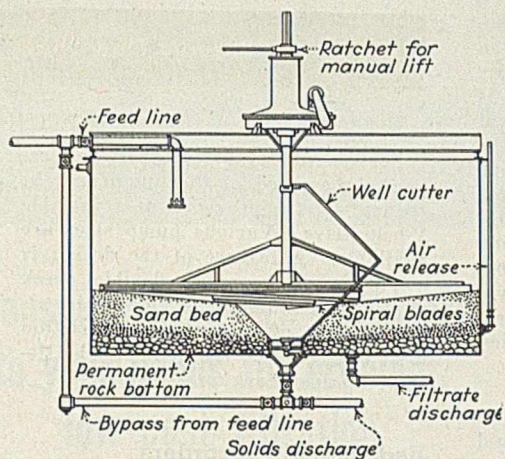


Drever 500-gal. electric kettle

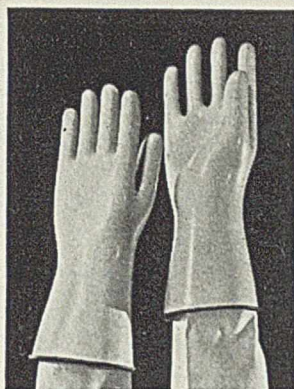


Typical butane handling and unloading plant





Cross section of improved sand clarifier



White Stanzoil neoprene gloves

pedal, and which close against the crate housing the carboy when the pedal is released. The arms lift against the cleats and hold securely, according to the manufacturer. Welded steel construction is used to minimize weight and the floor space required for the unit.

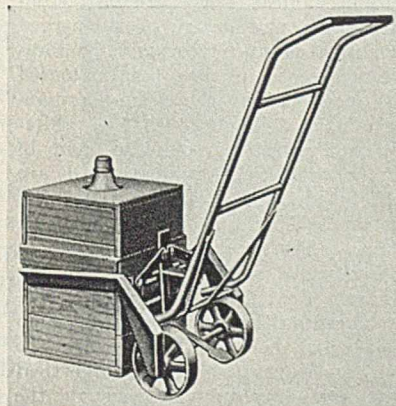
Equipment Briefs

SEVERAL electronic developments have recently been announced by Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass. One of these instruments is an electric-eye smoke alarm designed to indicate smoke density on a dial and to operate a signal light when the density achieves a predetermined value. Another development is a liquid level control operating on electronic principles. This device is activated by a pair of probes which are placed in the liquid at the level to be controlled. When the liquid reaches this level sufficient current passes through the liquid to actuate a pilot relay. The electrical resistance between probes may be as high as 25 megohms. The relay operates valves, pumps, etc., to maintain constant level.

AN OPPOSED-TYPE duplex chemical pump with a capacity of 4 g.p.h. against pressures up to 3,000 lb. is now being offered by Milton Roy Pumps, 3160 Kensington Ave., Philadelphia, Pa. Pumps of this type can also be supplied for pressures up to 20,000 lb. for the handling of alkalis, oil solutions, sulphuric acid and other corrosive chemicals. For 3,000-lb. operation only 1 hp. is required. The explosion-proof geared motor and pump are of integral construction and compact design. The pump may be used for handling two or more chemicals simultaneously or for a single chemical pumped to two or more points of delivery.

A NOVEL IDEA applicable to the gaging of tanks of any depth has been developed by J. A. Campbell Co., Long Beach, Calif. This consists of a new type of gage strip which can be added to foot by foot, to make a gage strip of any length. The units are of 1 ft. each, cast from a zinc base alloy and designed to be locked together by inserts carrying the foot numerals. The alloy used is stated to be stronger than bronze and thoroughly weather-proof.

AERODYNAMIC DESIGN of the fan blade assuring uniform velocity over the entire working face of the fan is claimed for a new power-operated room ventilator currently announced by the De Bothezat Ventilating Equipment Division of the American Machine & Metals, East Moline, Ill. Positive ventilation at all times is independent of weather conditions, it is claimed. Non-overloading power characteristics pro-



Light-weight carboy truck

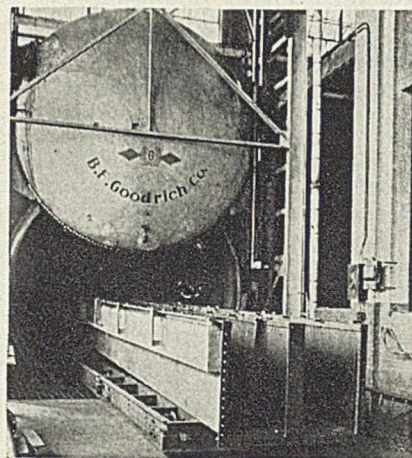
used to scrape the deposited solids to a cone-shaped outlet at the center of the filter bed. Occasional lowering of the spiral by a ratchet mechanism is employed to remove sand which has been plugged by the deposited solids. Back-washing is never required, according to the maker, and renewal of the sand bed is needed only once every two to five years on the average. Operation is said to be extremely economical. Sizes of this filter range from 6 to 100 ft. in diameter and capacities from a few gallons to 5,000 g.p.m.

Neoprene Gloves

AS AN ADDITION to its previously produced line of black neoprene gloves, the Pioneer Rubber Co., Willard, Ohio, has recently introduced a line of white Stanzoil neoprene gloves for use in pharmaceutical, cosmetic and food manufacture. The new gloves are stated to resist deterioration under exposure to oils, greases, fats, acids, cleaning compounds and similar materials. A range of weights and sizes is available.

Carboy Truck

TO FACILITATE the handling of carboys with a minimum of hazard, the Barrett Cravens Co., Chicago, Ill., has announced a new carboy truck of simple design having two arms which are spread open by means of an accessible



Rubber-lined tank constructed for automatic electroplating

The B. F. Goodrich Co., Akron, Ohio, has announced that it has found its new Triflex K rubber tank lining, as developed for bright nickel-plating, equally satisfactory for high-speed bright copper plating. Ordinary rubber or synthetic rubber linings are stated to have a tendency to throw high-speed copper plating baths off balance. The new lining is found to be non-contaminating and completely resistant to corrosion by the bath, according to reports. The view above shows a steel tank lined with this material coming out of the vulcanizer.

In general, the equipment as installed includes car-unloading lines, welded storage tanks with or without inclosure, unloading compressor and filling equipment for small cylinders.

Sand Clarifier

SEVERAL IMPROVEMENTS are stated by the Hardinge Co., York, Pa., to have been made in a new design of heavy duty sand filter recently announced for the clarification of feed water, brine and a variety of other liquids.

The clarifier consists of a circular tank in the bottom of which is a rock support for a sand filter bed. A spiral rake which may be rotated either with standard open type worm gearing or with a completely inclosed drive designed for continuous operation, is

teet against burned-out motors and entrance eddy losses are reduced to a minimum by a new patented "Log Cone" entrance ring, according to reports.

DEVELOPMENT of an exceptionally light and efficient respirator for protection against dust, pollen and certain bacteria is claimed by the American Optical Co., Southbridge, Mass. Weighing only $1\frac{1}{2}$ oz. and excluding particles as fine as one micron, the new respirator has been approved by the U. S. Bureau of Mines for protection against silicosis- and asbestosis-producing dusts as well as nuisance dusts such as metal powders, cement, coal, gypsum, ores and limestone. New facial design, new self-equalizing headband, new exhalation valve and a new method of producing a large surface area are important features.

A NEW INSTRUMENT for determining the refractoriness of sand, clays and refractory materials has been put on the market under the name of Sinter Meter by Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich. A platinum-rodium ribbon which is heated electrically is placed against the sample and the temperature raised until the sample is fused. The temperature of the ribbon at this point is measured with an optical pyrometer. The point of fusion is determined when the ribbon adheres to the sample.

ALLVENT is the name of a new all-purpose ventilating fan recently introduced in sizes ranging from 4,070 to 23,000 c.f.m. by Autovent Fan & Blower Co., 1805 North Kostner Ave., Chicago, Ill. This fan features V-belt drive so as to employ standard 1,750 r.p.m. motors to drive the newly designed three-blade fan wheel.

Swing Joint

UNOBSTRUCTED FLOW through all bends, coupled with ability to operate at pressures up to 500 lb. and temperatures to 700 deg. F., are features of a new high-temperature swing joint recently announced by the Chiksan Tool Co., Brea, Calif. This swing joint is without packing glands or stuffing boxes, a packing chamber being provided which is machined, chrome plated, polished and provided with a packing combination of asbestos and brass rings. Loads are transmitted through double rows of hardened steel balls to assure easy turning. Six styles are available for 360 deg. rotation in one, two or three planes, for the handling of steam or chemicals at pressures up to the specified working conditions.

Illium Thermocouple Tubes

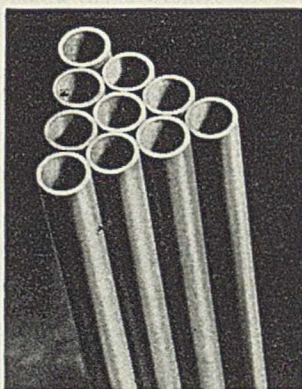
IN ADDITION to the various forms such as rolled strip, welded tubing, rolled rod stock and drawn wire which were recently announced as available in Illium, the Burgess-Parr Co., Free-

port, Ill., now has available thermocouple protection tubes fabricated from this alloy. This material is a complex nickel-chromium base alloy which is said to be unusually resistant to acid corrosion. It is now being used in the form of protection tubes of 5 to 7 ft. in length and 1 in. in diameter for thermocouples measuring the temperature of a highly oxidizing steel pickling solution at 150 deg. F. Such tubes are stated to be resistant to corrosives found in drug, chemical, mining, explosives, paint, and other industries.

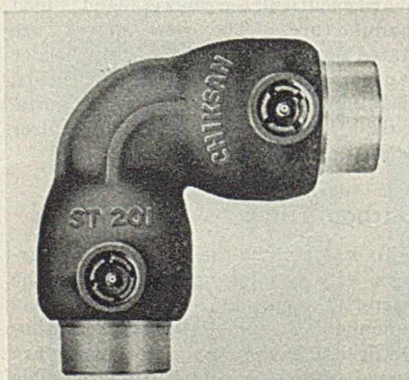
Packless Pump

PACKING, stuffing boxes, glands, liquid and mechanical seals are all eliminated in a new design of submerged centrifugal pump for corrosive or abrasive service which has been patented and introduced by the Allen-Sherman-Hoff Co., 225 South 15th St., Philadelphia, Pa. All parts of the pump in contact with the liquid handled are either made of or covered with this company's Maximix rubber or with neoprene. The pump consists primarily of two parts, a lined feed tank containing a float for maintaining a constant head on the pump; and the pump itself which is supported beneath the tank and operated with a vertical shaft extending upward through the tank to the motor above. As are the feed chamber, float and pump itself, the shaft also is protected up to the bearings above the tank body with rubber or neoprene.

Illium thermocouple tubes



High temperature swing joint

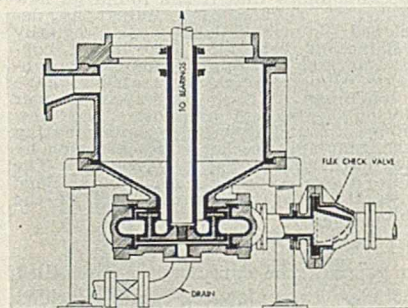


For operation at less than full capacity the speed of the pump may be reduced by the provision of a variable V-belt drive. Various pump sizes are available. A feature of the design is a rubber or neoprene flexible check valve in the discharge line which is claimed to offer almost no friction loss when open, yet to hold bottle-tight against back pressure.

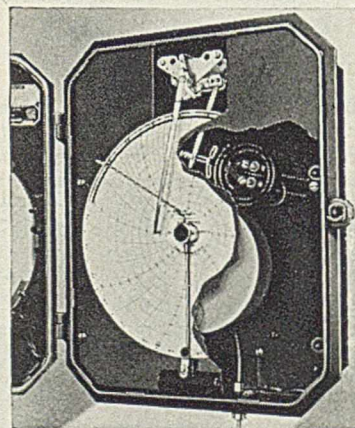
Redesigned Recorders

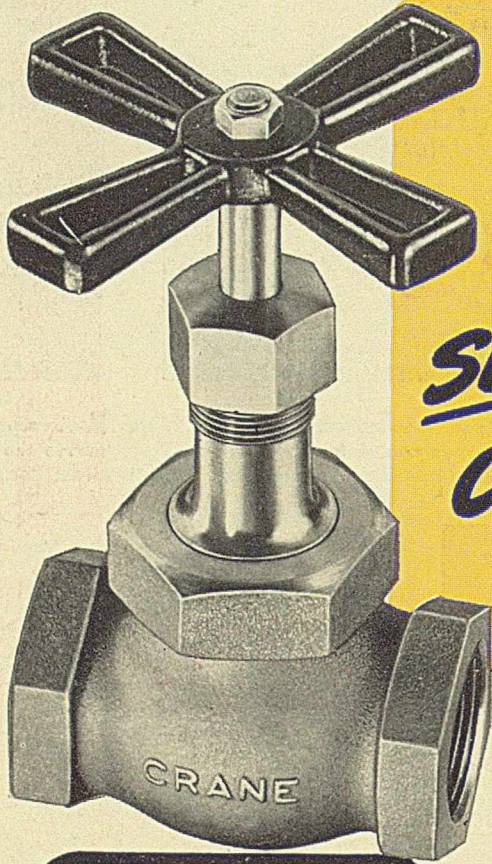
REDESIGN of its line of recording instruments for temperature, humidity, pressure, load, rate of flow, liquid level and pneumatically transmitted variables, has been announced by the Taylor Instrument Cos., Rochester, N. Y. The new design corresponds to that of the company's recently announced redesigned Fulscope controllers. The cases for the new recorders are, in fact, drilled and tapped to receive any of the five standard Fulscope control mechanisms which it might be desirable to add later. The cases are designed for both face and flush mounting and a new device which combines the chart lock and the pen lifter facilitates changing charts. One, two and three pen models are available with 10- or 12-in. round charts. If necessary, an explosion-proof clock motor is available.

New rubber-lined packless pump



Cutaway view of improved recorder





YOU DON'T NEED SPECIAL VALVES TO CHECK CORROSION

... Now Alloy Valves are Stocked by CRANE

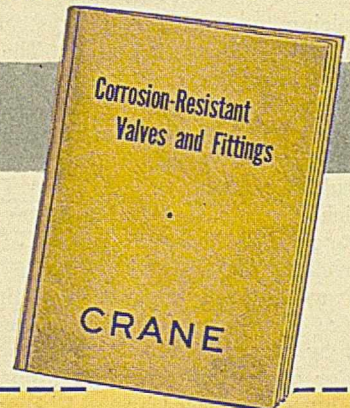
- ⚡ NICKEL
- ⚡ NI-RESIST
- ⚡ MONEL
- ⚡ 18-8 MO
- ⚡ EVERDUR
- ⚡ ALL-IRON

YOUR search for special valves and fittings to combat corrosion in power and process lines ends here. Now piping equipment of highly efficient corrosion-resisting alloys is immediately available from regular Crane stocks. You can choose from this broad range of proved materials the most effective protection against chemical reaction in piping.

Crane alloy valves and fittings come to you with a splendid record in actual service. Heretofore made on special order only, they have for years given thorough satisfaction in the most severe and exacting industrial uses.

Here is piping equipment that has been fully tested under widely varying working conditions—that's quickly available in a complete assortment of patterns—that can be conveniently purchased. Here are valves and fittings—backed by Crane's engineering ability and 85-year manufacturing experience—that will keep your corrosive fluid piping costs at a minimum.

**THIS NEW CATALOG HELPS YOU CHOOSE DEPENDABLE,
LOW-COST PIPING FOR EVERY CORROSIVE SERVICE!**



You'll find this catalog a handy manual. It gives a lot of practical information on the handling of corrosive fluids. It includes an authoritative, colored "Stop & Go" chart showing the suitability of

each alloy for specific services. It describes fully the Crane Corrosion-Resistant Line. Your Crane Representative will gladly supply a copy or you may use the coupon below to get one. It's free!

CRANE



CRANE CO., GENERAL OFFICES:
836 S. MICHIGAN AVE., CHICAGO
VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

CRANE CO., 836 S. Michigan Ave., Chicago, Ill.
Please send me your Catalog No. 312 on Alloy valves and fittings. No obligation, of course. C & ME-8-40

Name.....
Company.....
Address.....
City..... State.....

NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

SALT PRODUCTION

SALT IS NOT a standard product, for there are numerous varieties that have been developed to meet definite requirements of crystalline structure, grain size and purity. The requirements depend upon the use to be made of the salt. In order to meet the variety of specifications many manufacturers refine the natural product by either the grainer or vacuum pan system, some producers use both. The Diamond Crystal Salt Co. of St. Clair, Michigan, uses not only both of these methods but in addition, a third, which was developed in its plant by J. L. Alberger, a chemical engineer from Buffalo, N. Y.

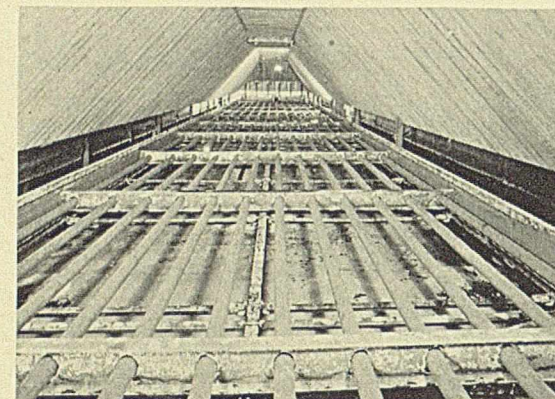
The grainer, vacuum pan and Alberger systems are distinguished from each other by the manner in which the evaporation of the brine takes place, the method by which the impurities are removed, and the processing equipment required.

Grainer salt is made by surface evaporation of brine in long, shallow pans. The salt crystals are washed with brine which removes most of the impurities. The equipment is operated so as to produce a coarser grain than is made by the other processes, the conveying and drying equipment having been designed so as to reduce grain breakage as far as possible.

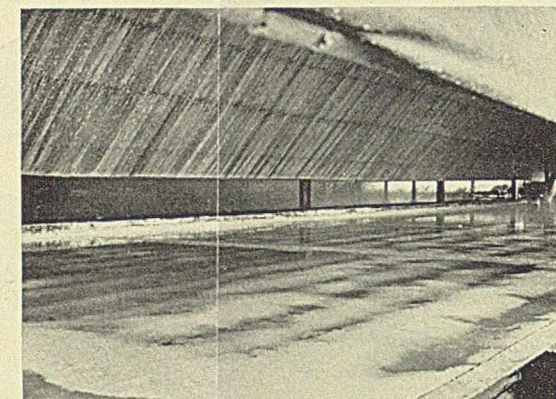
Vacuum pan salt is made by boiling brine at less than atmospheric pressure. The salt grains produced by the process are cubical in shape. This process was developed to produce an evaporated salt cheaply. The purity is obtained by retaining in the mother liquor a large percentage of the impurities and by washing.

An Alberger unit consists of brine heaters, a calcium sulphate removal system, flashers, and open evaporating pans. The evaporation of brine is carried out in what might be called a "closed" system by circulating brine through the equipment continuously. All of the brine which enters the suction of the circulating pump, except about 7 per cent which is evaporated during the cycle, passes through the entire system of heaters, gravellers, flashers and open pans and finds its way again to the suction of the pump—where feed brine is added to replace that lost by evaporation.

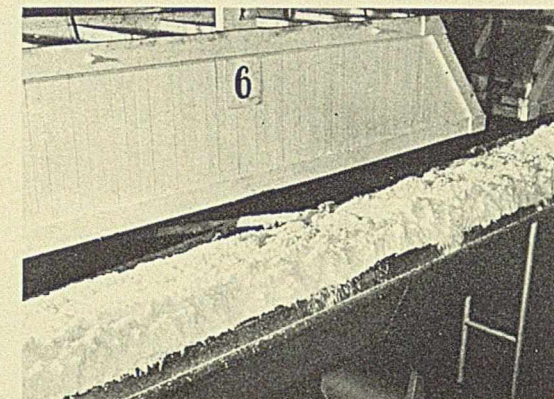
For more detailed information about the three processes used by the Diamond Crystal Salt Co. refer to pages 530-534.



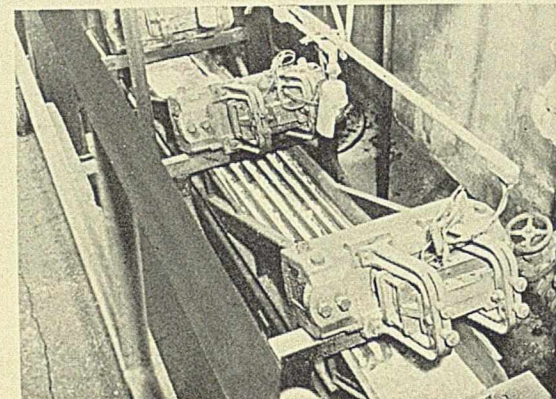
1 An empty grainer pan showing arrangement of steam pipes used for heating brine for evaporation. Vapors pass off through openings in the hood



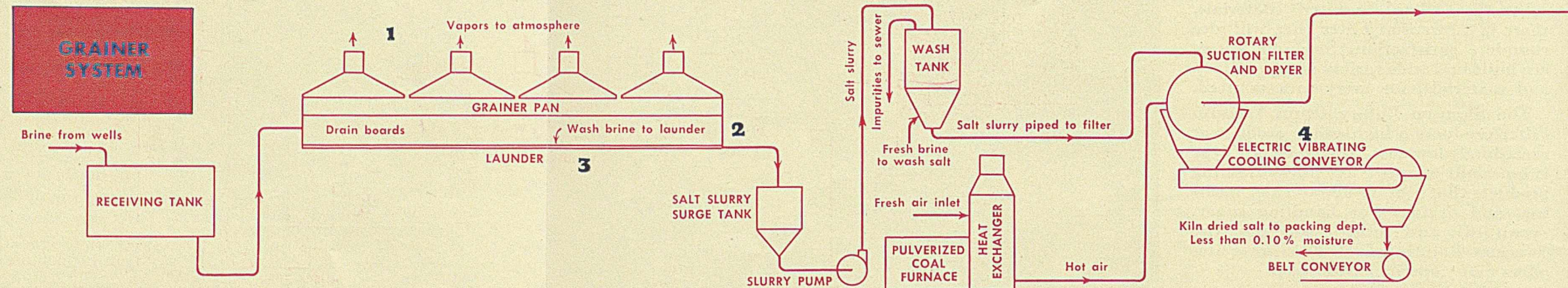
2 A scraping conveying system continually removes the salt from the grainers, elevates it to a drain board, discharges it into a Monel launder



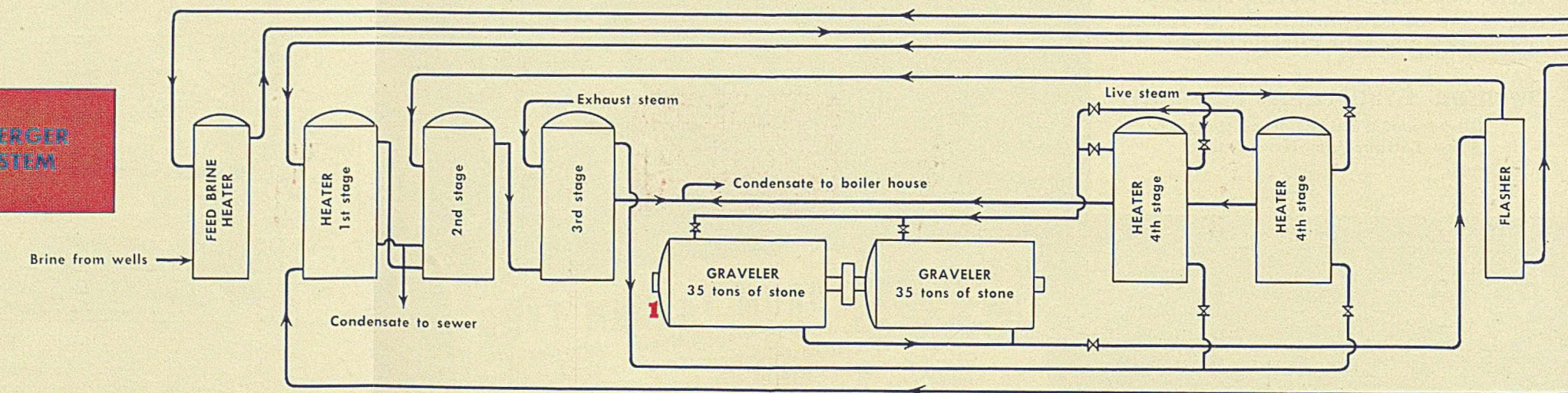
3 Salt discharging into the launder or trough, which carries it to a slurry pump. It is elevated to a combination washing and supply tank



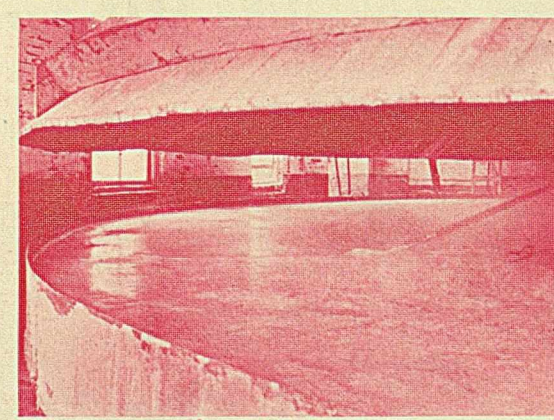
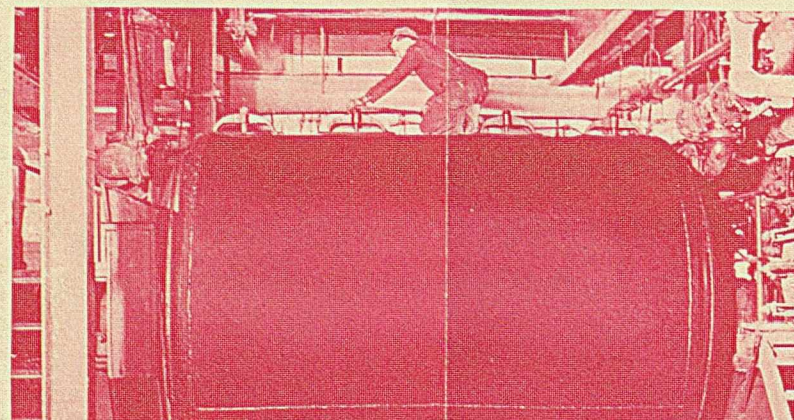
4 From the top feed Oliver filter which dewateres and filters, the salt falls into a magnetic, vibrating cooling conveyor



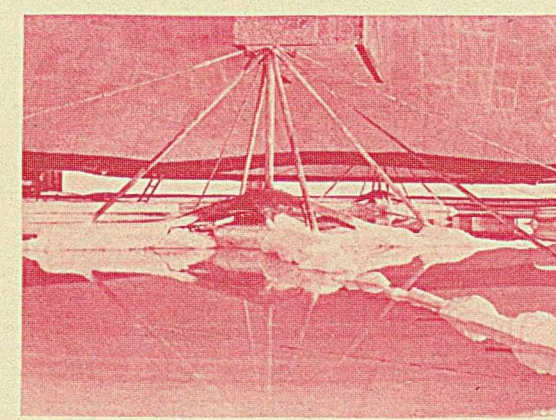
ALBERGER SYSTEM



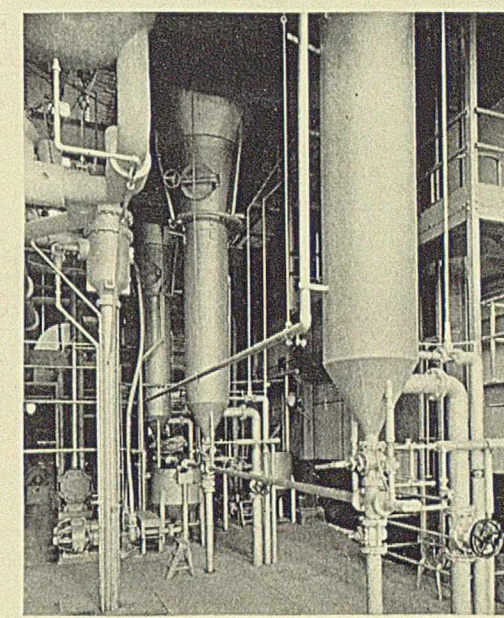
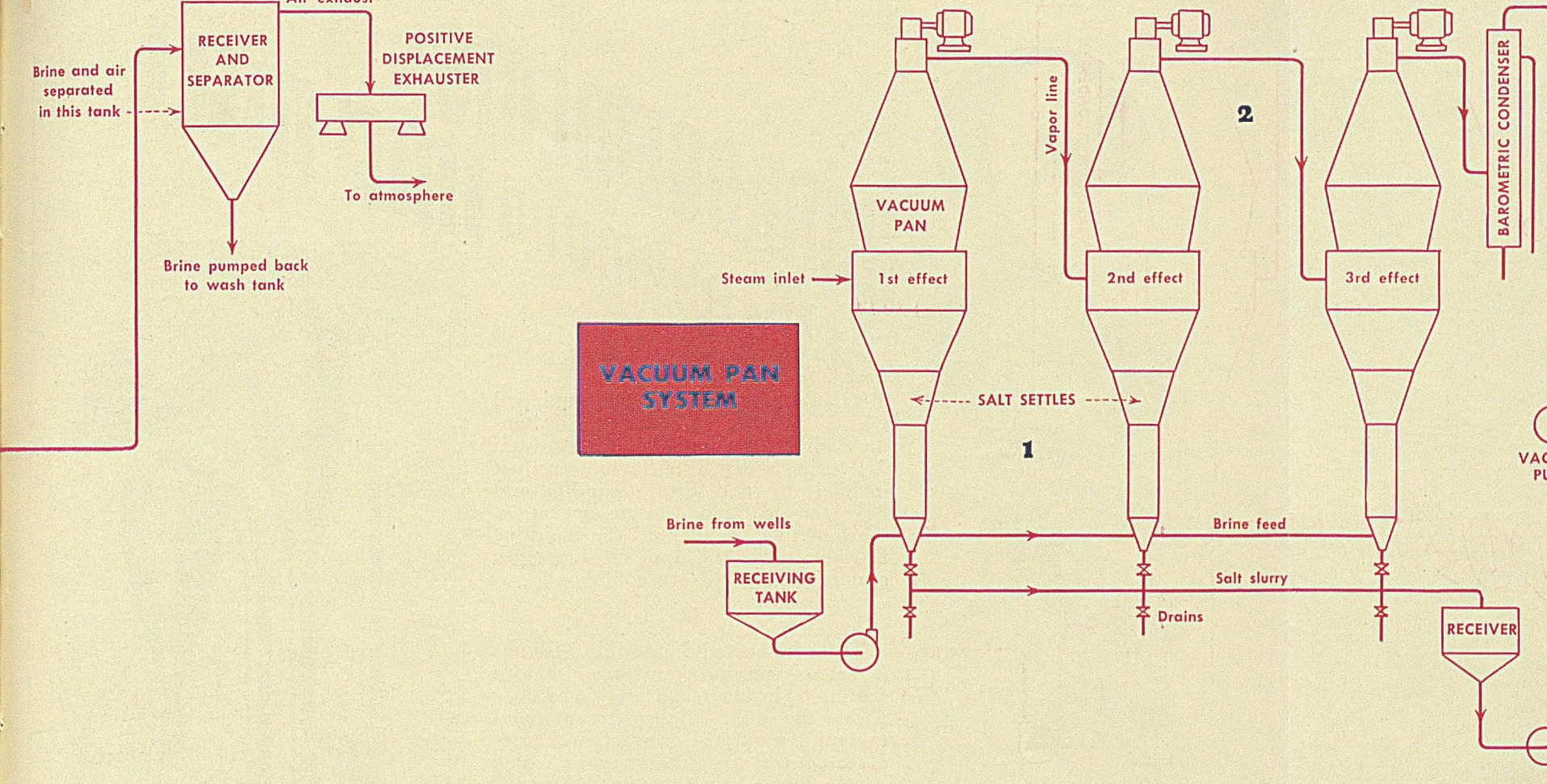
1 A graveller is used for precipitating calcium sulphate at a temperature of 90 deg. F.



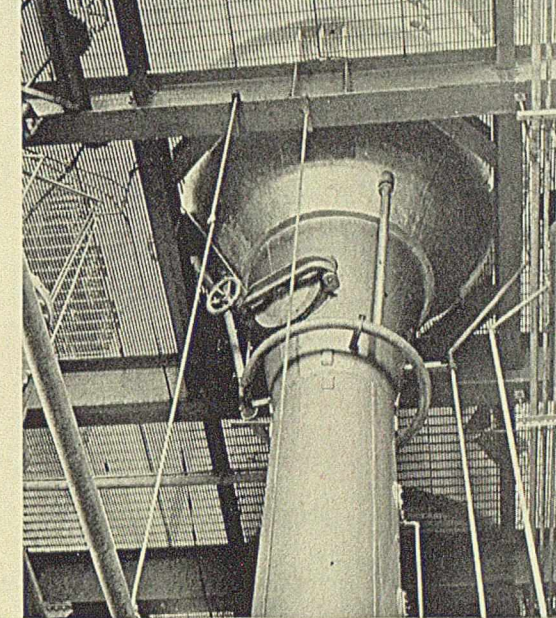
2 As the brine passes through the open pan, surface evaporation takes place and further crystallization occurs



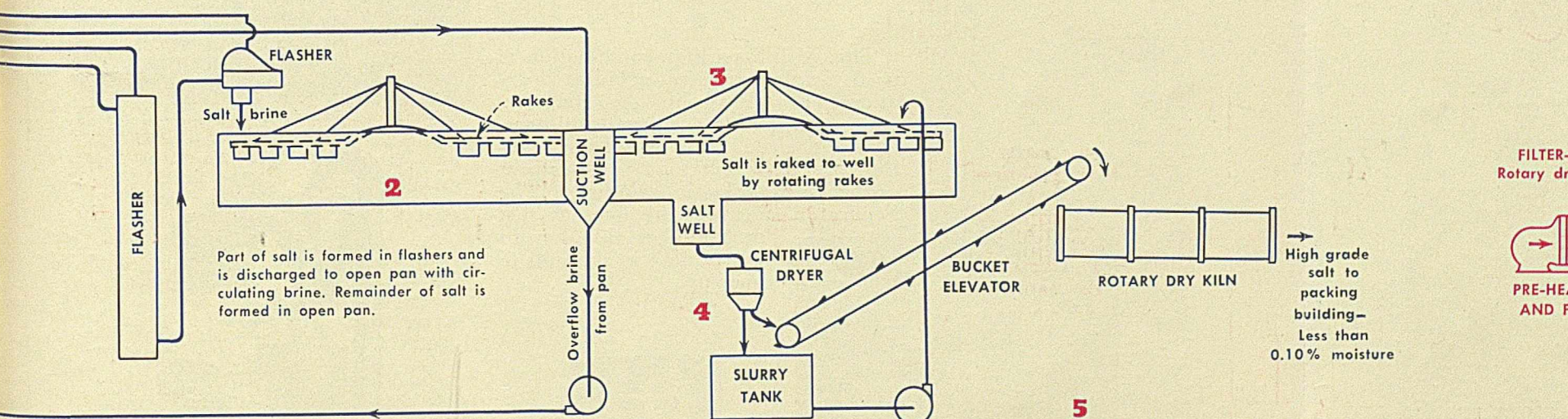
3 Pan after being idle for 24 hours. Brine overflows from the pan and passes to the suction of the circulating pump



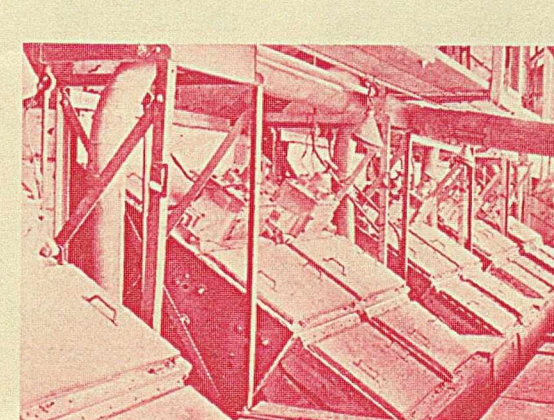
1 Showing piping and welded construction of the bottom of the triple-effect vacuum pans



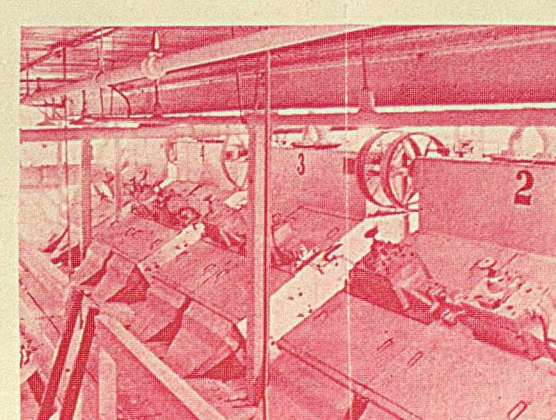
2 Welded steel bodies are justified by much lower cost over cast iron bodies. After five years corrosion is negligible



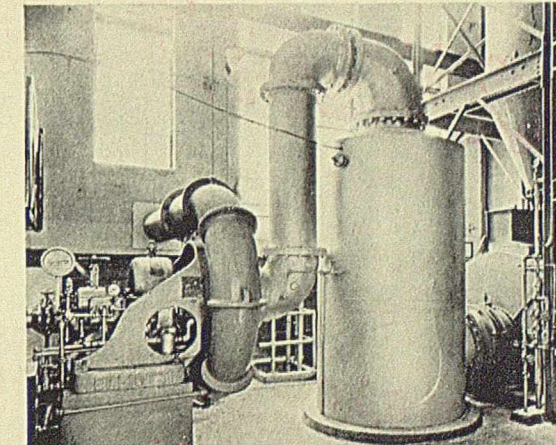
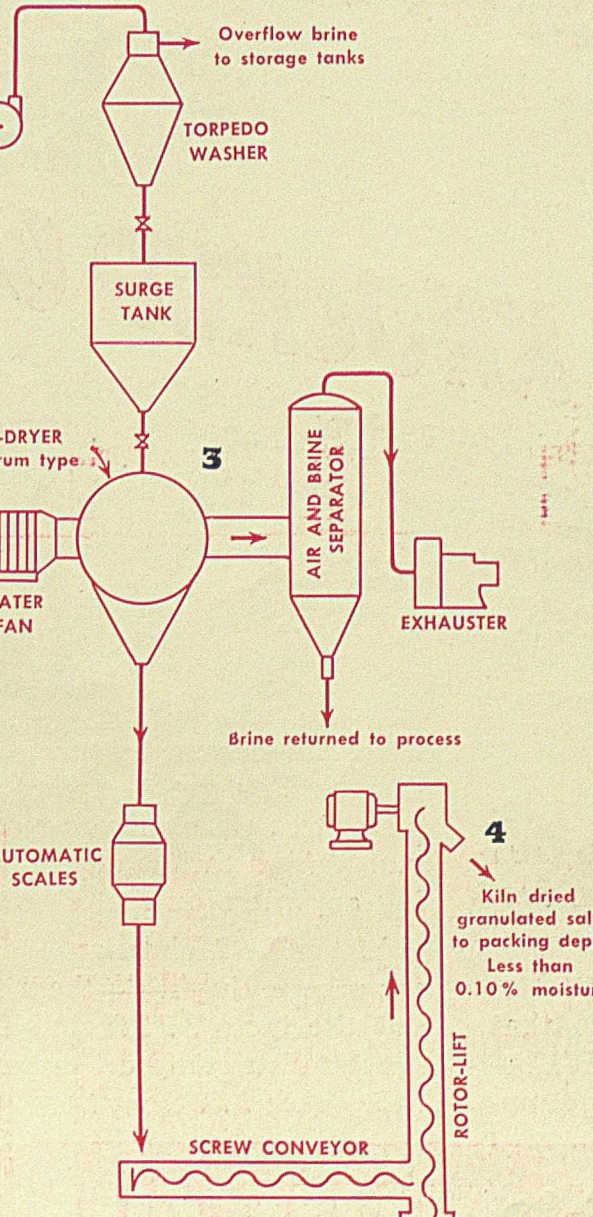
4 The salt is drawn from the open pan to a centrifuge from which it passes to a Monel lined rotary dryer



5 Rear view of the Hummer screens used in the Alberger process for refining salt in the Diamond Crystal Salt Co.'s plant



5 Front view of the screens previously illustrated, which are used in the Diamond Crystal plant at St. Clair, Michigan



3 Vacuum pan department, showing Elliott exhaustor, receiver and filter for drying salt, note welded construction of some equipment



4 Three processes make it possible to offer a variety of salts of different characteristics

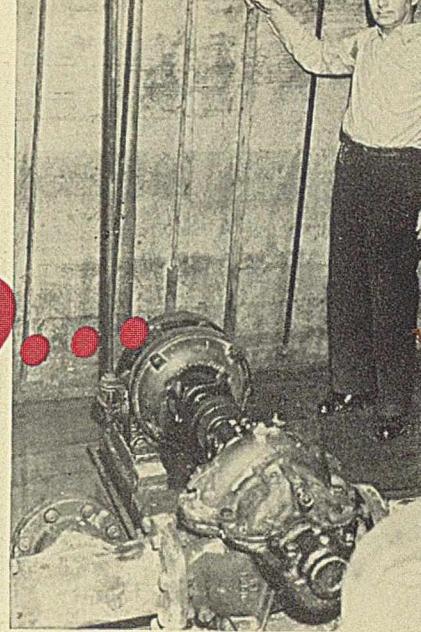


TRUE STORIES about Lo-Maintenance Motors that —

COULDN'T BE DROWNED...

Three times submerged by floods . . . actually running for hours under water . . . yet no trouble in 13 years! That's how two Allis-Chalmers Lo-Maintenance Motors have performed for the Beloit Box Board Co. And after

each flood, all that was ever done was to wash the silt and dirt out of the motors and let them dry. In picture, R. M. Fisher, vice-president, Beloit Box Board Co., points to high water mark of recent flood.



COULDN'T BE STOPPED BY DUST...

In this chemical plant, fine chemical dust that bit like acid caused maintenance expense of over \$500 on 22 motors of other makes. But 17 Lo-Maintenance

Motors brought a total repair bill of only \$17.30! That's why . . . when they needed 18 more new motors . . . they ordered from Allis-Chalmers!



COULDN'T BE KNOCKED OUT...

They were "killing" motors at the Alberene Stone Corp., Virginia, on their hard-pounding channeling machines . . . actually knocking them out! Then, four years ago, they tried

Lo-Maintenances for the job. Now, every one of their channeling machines is powered with a Lo-Maintenance Motor . . . and there are no break downs . . . no time-outs for repairs!



That's What Happens When Allis-Chalmers Lo-Maintenance Motors Are Called On To Do Extra Tough Jobs! Find Out How to Get Motor Performance Like This in Your Plant!

There's a reason why Allis-Chalmers Lo-Maintenance Motors give performance that is more than just a rated horsepower. It's because, in Lo-Maintenance Motors, you get un-

usual full-measure features of construction and design. You get — twistless, distortionless stator . . . removable, indestructible rotor . . . sturdy high carbon steel frame . . . no skimping anywhere on materials or workmanship!

Just as Lo-Maintenance Motors do these jobs for others, they'll do them for you, too. Find out the facts . . . from the engineer in the nearest district office...or write Allis-Chalmers, Milwaukee . . . today!

A 1270

*Over 90 Years of Engineering
Superiority Work for You When
You Specify Allis-Chalmers!*



ALLIS-CHALMERS

MILWAUKEE · WISCONSIN

3

ARRANGEMENTS of the RAYMOND IMP MILL

FLASH
DRYING

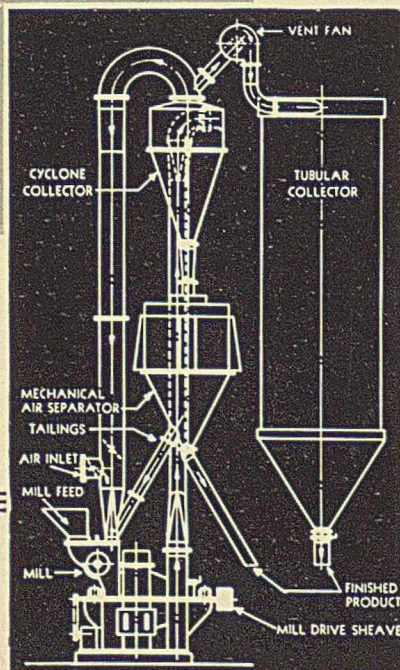
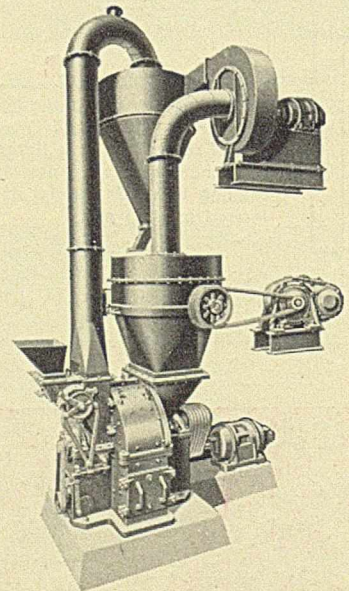
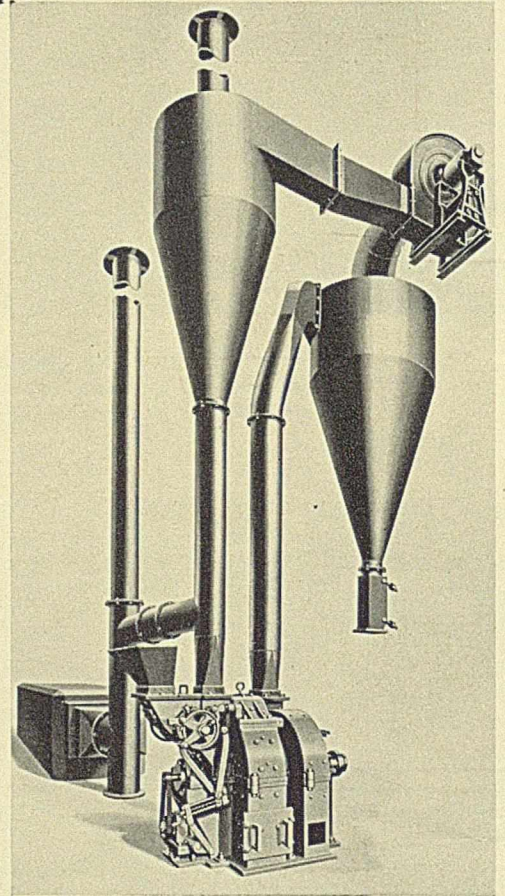
WHIZZER
SEPARATOR

MECHANICAL
AIR SEPARATOR

THE Raymond Imp Mill, equipped with Flash Drying, is efficient for handling high moisture materials, and delivering a dry, free-flowing product in finely divided form. Grinding and drying are combined in *one* operation. This method is adapted for handling filter-cake, drying industrial wastes, and calcining hydrate compounds.

The whizzer-equipped Imp Mill has a set of revolving whizzer blades mounted in the separating chamber above the mill. The whizzer maintains uniformity of product, and gives close control over the fineness, which can be varied by changing the speed of the whizzer, thus producing fine, coarse or medium grades.

This Mill-Separator combination is used for closed circuit grinding operations, as shown in the diagram, where extreme fineness and uniformity are desired. It is useful for handling products that tend to over-heat or become sticky in grinding. The Separator takes out the fines as fast as ground, so that they do not remain in the mill to heat up.



Tell us your problem,
and we will send you
detailed information.
Ask for Bulletin #41.

**RAYMOND PULVERIZER DIVISION
COMBUSTION ENGINEERING COMPANY, INC.**

1311 NORTH BRANCH STREET

CHICAGO

Sales Offices in Principal Cities • Canada: Combustion Engineering Corp., Ltd., Montreal

GOVERNMENT chemical contracts have not taken final form in many cases where really definite programs have been prepared. This has led to some feeling of uncertainty among observers. But the fact is that August opened with most of the important chemical problems of preparedness nearing satisfactory solution.

The government continues to apply the principle of safe location for new plants. A belt around the United States 200 miles wide at the land boundaries of Mexico and Canada and 250 miles wide along the water frontiers is a forbidden land. Except for very special purposes no new developments are to be made in this relatively exposed region.

Purchasing is being done in a variety of ways all under the coordination of Donald M. Nelson who must okay contracts to insure freedom from conflict between Army, Navy, Treasury Procurement, and other buying authorities. Most of the actual purchasing is being arranged by the usual government offices. The naming of this purchase coordinator is merely to insure cooperative and not competitive functioning. There are, however, a few new purchasing units such as Metals Reserve Co. organized by RFC to purchase tin and manganese, and the Rubber Reserve Co. which is the joint purchasing agency of the principal rubber manufacturers and RFC.

Commodity Arrangements

Manufacture of high explosives, both TNT and smokeless powder, can go forward as fast as the building of plants and their operation will permit. There will be no raw material difficulties. Ample toluol has been found (see this issue of *Chem. and Met.*, page 573), and arrangement is being made for ammonia supply in abundance. Anticipated shortage of cotton linters is being remedied by development of hull fiber and other satisfactory nitratable cellulose.

The synthetic rubber situation is improving weekly. No quantitative forecasts are ventured officially. But the splendid progress being stimulated has stirred much Washington enthusiasm. Cooperation is being organized between necessary chemical manufacturers and concerns doing the rubber synthesis work. One publicly announced example of this sort is Hydrocarbon Chemical and Rubber Co., the new joint subsidiary of Phillips Petroleum and B. F. Goodrich Co.

The bottleneck in aluminum production continues to be power supply. This, of course, rattles several public-ownership skeletons and spotlights the controversy as to the merit of TVA vs. private power projects in the Middle-South.

Chem & Met Pictured Flow Sheet



News from Washington

WASHINGTON NEWS BUREAU, MCGRAW-HILL PUBLISHING CO.

Very successful arrangements have been made for optical glass manufacture, for accelerated production of aviation gasoline and its storage, for armor plate, and for various strategic metal purchases. The contracts cleared through the Defense Commission were nearly two billion dollars in value by the first of August. Actually more commitments than that had probably been made as many hundreds of "small" contracts, those less than \$500,000 each, do not clear through that office.

Paper Price Probe

Price advances in pulp and paper have disturbed official price watcher Leon Henderson. His organization and the raw materials division of the Defense Commission, therefore, investigated the cause and future prospect of rapid rises in spot price noted in recent months. Though not devoid of criticism of the industry, the report really simmers down to a conclusion that the law of supply and demand still occasionally functions. The formal findings resulting from conferences between these government men and important industry units have been summarized as follows:

"1. No actual shortage of pulp exists, with possible minor exceptions.

"2. No immediate danger of a shortage is apparent.

"3. French and Italian inability to use United States markets and buy American rayon pulp will cut down shipments to those countries.

"4. Imports from Canada are expected to increase.

"5. A striking spread was noted between spiraling spot prices and contract prices, an important element because 90 per cent of pulp is sold on contract.

"6. The present spread between cost and contract prices appeared adequate to stimulate production.

"7. Further price changes would result only from changes in basic costs, such as labor, taxes and raw materials.

"8. Tonnage needed for national defense was not expected to divert substantial amounts of pulp from normal industry requirements."

New Regulations

The list of commodities first announced by the President as subject to export license control was increased during the last week of July by the addition of petroleum products (mainly aviation gasoline and aviation lubricating oil), tetraethyl lead, and iron and steel scrap. Restriction of export movement of these goods is naturally disturbing Japan seriously as that nation fears that Uncle Sam will set up a real embargo on materials urgently needed for war activity in the Orient.

Restriction on issue of patents or any publicity regarding them is authorized by a law which gives the Commissioner of Patents the right to demand secrecy for such inventions as are important in the national defense. Any owner of such an invention disclosing it contrary to the ruling of the Commissioner of Patents is assumed to have abandoned his invention. The National Inventors Council has also been organized to encourage inventions useful for national defense purposes. It will work under the chairmanship of C. F. Kettering of General Motors and in close cooperation with the National Defense Research Committee.

Priority governing industrial operations where any government orders may be involved is already in effect for certain goods and commodities. Although the government has ample authority to make such priorities official, they are actually being achieved thus far only by voluntary arrangement. The cooperation of all affected units of

industry has been so prompt and sincere as to make formal regulations unnecessary thus far.

Priorities

The Army-Navy Munitions Board has set up a Priorities Division under Lt. Col. A. B. Johnson. Its official function is to set up priorities (or, as they call them, precedents) on Army and Navy Orders, not only as to which service's order is to be produced first, but also which Army order or which Navy order shall be put ahead. There is no question of authority for this, the Government, as the purchaser, has the right to direct the order in which its contracts will be filled.

In addition, Army and Navy contracts all carry delivery dates and acceptance of such contracts, it is being made clear, means the manufacturer voluntarily commits himself to reshuffle other orders, if necessary, to get it out on time. This system, of course, does not reach down to the sub-contractors so that this voluntary arrangement may bog down. At the moment, however, there is little danger of this, except perhaps in some few cases—such as armor plate, some aluminum products, optical glass and rifling machines. Where such sub-contract bottlenecks develop, Donald M. Nelson, purchase coordinator, probably will try to work out a voluntary priority arrangement with the manufacturer.

The Army-Navy precedent list is not one based upon materials and items, but of equipment needs, i.e., one order for howitzers might be keyed ahead of another howitzer order, while a Navy gun order would be sandwiched between. Delivery is being keyed to expanding need, so that proper amounts of each type of ordnance will be available as the Army grows.

Formal priorities under Presidential proclamation are not in the immediate picture as it looks today. One reason is that Johnson and a good many others feel that the law is not adequate. It permits priority on Army and Navy orders ahead of private commercial accounts, but there is some doubt that it permits the Government to order a private contract filled ahead of another private contract. There are a number of potential reasons why this might be desired and important. When (or if) priorities do come, however, Nelson will be the man assigned to the job. Nelson now is making a report for the President on the priorities situation.

News Miscellany

Distillation apparatus at petroleum refineries is now exempted from the registration otherwise required for still equipment under the alcoholic beverage control laws.

I.C.C. regulation of private trucks did not take effect August 1, but was postponed until October 1 by I.C.C. order of mid-July. This is a postpone-

ment, not a cancellation as some first thought.

Minimum wage rates in the pulp and primary paper industry have been fixed by the Wage-Hour Division of the Department of Labor at a minimum of 40 cents per hour, effective September 16.

The Department of Justice was about to drag back into court numerous petroleum companies in an undertaking to divorce the production and refining facilities from distribution activities. At the request of the Defense Commission executives this antitrust action was postponed; but it is well known that the Department of Justice intends to proceed in due time with this type of attempted separation of the present industry into two distinct parts. The claim is that by divorcing distribution from the other functions of integrated companies a greater measure of competition may be set up.

Less than five per cent of the applications submitted under the new export control order are being rejected. Nothing is being stopped or diverted that is not imperatively needed for the national defense. In many cases articles that could be used at home to great advantage have been allowed to go forward with the idea that less inconvenience would result by giving notice that future consignments could not be passed.

Applications now are being passed upon the same day that they are received. In some cases it is necessary to tell the applicant that his request has been referred to the Defense Commission, the Munitions Board or the Advisory group made up of representatives of the various governmental agencies concerned.

Delays that occurred for a few days following the inauguration of the system will not continue, officers in charge believe. Certain initial rulings had to be made and the personnel at the Customs Houses had to become familiar with the new procedure.

In the beginning shippers were uncertain as to the scope of the order and submitted thousands of applications covering articles for which license is not required. Several hundred applications for such articles are continuing to come in. In order to prevent delay applications first are scrutinized for the purpose of segregating those not requiring license. These are stamped "No license required," and returned by airmail.

It is pointed out that a very small portion of our export trade is covered by the control order. Many of the items on the first order are not ordinarily exported. Only two petroleum products, aviation motor fuel and aviation lubricating oil, are covered by the second order. Literally hundreds of petroleum products and articles containing them are not affected. The second order also applies to one of the seventy-five classifications of iron and steel scrap.

While an army officer was chosen to head up the export control adminis-

tration, it is not a War Department activity. The President in his capacity as commander-in-chief of the army and navy has specified that the export control administration is to be an independent agency. He selected an army officer as administrator so the appointment would not be regarded as political and so as to have in charge one who is familiar with the problems of national defense.

Treasury Department officials warn industry that it is illegal to claim that any price increases are the result of new taxes unless such be wholly the case. Chemical executives might need to warn their overzealous salesmen if there happens to be a price increase that it might not be blamed on taxes unless that is wholly true. Offense may cause both fine and imprisonment, under the law.

Excessive claims as to the fertilizer value of "basic slag" must stop. This is the basis for the stipulation arranged by Federal Trade Commission with Tennessee Coal, Iron and Railroad Company which is alleged to have been marketing slag for fertilizer usage with extravagant claims as to its plant food value. The fertilizer industry is rather glad that this material will no longer be distributed with such marvelous promises as some of the selling has included in the past.

The present standards for employment will not be sacrificed if the President can prevent this. There is no shortage of employable persons which would justify breaking down any of the Wage-Hour requirements, President Roosevelt believes. He points out that employers can use their workers well beyond the 42-hour limit (40-hour limit after Oct. 24) because the only penalty is time-and-a-half for overtime. That, he thinks, is a reasonable provision even in the present emergency period and will meet with the full approval of labor.

Civil Service examinations are being announced for various grades of metallurgist, metallurgical engineer, explosives engineer, and other types of technical men for which the government has need. Applications will be received by the Civil Service Commission until late August for some of these posts.

Amortization of new investment for plants and facilities used in manufacture of defense material has been a serious problem. The exact form which legislation will take is not known early in August, but it is evident that most chemical industry executives can count on a 5-year amortization program if they take part in new defense manufacturing. This period has been chosen as a compromise between making the immediate cost of products too great (a probable result of a shorter period) and the danger of leaving unamortized capital as a burden on industry after the emergency passes (an almost certain result of a normal long amortization term which the Treasury Department would prefer).

PACIFIC NORTHWEST WILL PLAY HOST TO PULP AND PAPER MEN

The Fall Meeting of the Technical Association of the Pulp and Paper Industry will open at Seattle, Wash., on Aug. 20 and will continue for four days. The address of welcome will be delivered by Dr. Lee Paul Sieg, president of the University of Washington, in the auditorium of Bagley Hall.

Following the presentation of a moving picture showing operations in the manufacture of wood pulp, a symposium on Pacific Northwest forest resources will get underway with Prof. B. L. Grondal of the University of Washington presiding. Speakers will include E. P. Stamm of the Willamette Paper Co., W. H. Price of Weyerhaeuser Timber Co., and Warren Tilton of the West Coast Lumbermen's Association.

After luncheon at the University of Washington Commons, W. R. Barber of Crown Zellerbach Corp. will conduct a technical session at which numerous papers will be read. Among these will be "Studies on Absorption of Sulphur Dioxide" by Warren L. Beuschlein of the University of Washington; "Nitric Acid Pulping" by A. T. Walton of the same university; "Pulping of Douglas Fir by Sodium Sulphite" by K. A. Kobe, University of Washington and L. C. Haffner of Portland; "Use of Soda Ash-Sulphur in Sulphate Recovery Units from the Operating Viewpoint" by W. L. Gillespie, Gaylord Container Corp., Bogalusa, La.

Two technical sessions have been scheduled for the morning of Aug. 21. The first will be a symposium of lignin and the second will consist of a discussion of production problems. George H. McGregor of Weyerhaeuser Timber Co. and Clark C. Heritage of the Wood Conversion Co. will be the respective chairmen. Technical sessions also will feature the afternoon meeting with N. W. Coster of the Soundview Pulp Co. directing. In the evening five group dinners will be held in private dining rooms of the Olympic Hotel. Each dinner will be devoted to discussion of selected subjects under a group leader.

The real highlight of the meeting will come on Aug. 22 when Leo S. Burdon, chairman of the Woods Trip Committee, aided by the logging superintendents of the Soundview Pulp Co. plan to take the entire meeting into the woods to see the logging of big timber.

LIQUEFIED PETROLEUM GAS CODE REVISED

National Fire Protection Association is consolidating the four separate codes which dealt with various phases of handling and use of liquefied petroleum gases. The combined code to be published shortly in the Boston office of the Association will be the official guide of many insurance companies, fire marshalls, and other official or quasi-official groups. Plants in which propane, butane, or other

liquefied petroleum gas is handled or used will, of course, be expected to conform with the 1940 revision. Most of the fundamental provisions are identical with earlier codes. But numerous minor modifications and improvements have been made in line with the recommendation of the 1940 committee, accepted at the May meeting of N.F.P.A. Those desiring copies of the code will procure these at a nominal charge (exact price not yet announced) by addressing National Fire Protection Association, 60 Battery Street, Boston, Mass.

ABBOTT LABORATORIES FOUNDS CHEMISTRY FELLOWSHIPS

For the Academic year 1940-41, Abbott Laboratories has established fellowships in several universities with important departments of organic chemistry and biochemistry. The fellowships, carrying stipends of \$650 per year, will be available to graduate students in the last or next to last years of graduate work leading to the doctorate degree. The recipients, who are to be selected by the universities in which their work is being done, are not limited as to the subjects on which they will work.

Grants will be made to the following universities: In organic chemistry: Cornell, Harvard, Illinois, Michigan, Northwestern. In biochemistry: California, Columbia, Cornell.

GOODRICH-PHILLIPS FORM NEW CHEMICAL COMPANY

Shortly after the announcement that the B. F. Goodrich Co. had started construction on a plant at Niagara Falls in which production of Koroseal would begin in the fall months, came the report that this company and the Phillips Petroleum Co. had jointly formed a new company called the Hydrocarbon Chemical & Rubber Co. This announcement stated that the new company would strengthen the national defense position with respect to supplies of rubber. The Phillips company has long been prominent in processing petroleum hydrocarbon and has large supplies and reserves of raw materials used in the manufacture of synthetic rubber. The Goodrich company has spent 14 years on a program of rubber research which has resulted in the commercial production of synthetic rubber.

The main office of the Hydrocarbon Chemical & Rubber Co. will be in Akron. The Phillips interests will be represented by Frank Phillips, chairman, K. S. Adams, president, G. G. Oberfelder, vice-president in charge of research, while the Goodrich members include David M. Goodrich, chairman, John L. Collyer, president, and T. G. Graham, vice-president in charge of production. Ross W. Thomas of the Philgas division of the Phillips company will be in charge of sales and Dr. Waldo L. Semon director of research.

COURSE IN FOOD TECHNOLOGY OFFERED AT N. Y. U.

In order to meet the demand for men trained in the engineering aspects of the food industry, the Graduate Division, College of Engineering, New York University, under the auspices of the Department of Chemical Engineering, will inaugurate in September, a graduate course in food engineering.

Lectures will be under the supervision of Dr. Henry J. Masson, professor of chemical engineering and director of the graduate division, assisted by specialists from the faculty and from industry. Among the specialists from industry who will participate in the course will be: L. V. Burton, editor of *Food Industries*, C. G. Segeler, American Gas Association, H. O. Mercier, National Biscuit Co., G. N. Harcourt, Buffalo Foundry and Machine Co., Gardner Poole, Frosted Foods Sales Corp., C. O. Ball, American Can Co., J. A. Lee, *Chem. & Met.*, G. L. Montgomery, *Food Industries*, and J. Slade, General Foods.

NEW CLASSIFICATION FOR LUBRICATING GREASES

The National Lubricating Grease Institute at its last annual convention held at Chicago, adopted a classification for lubricating greases which it has copyrighted. This classification gives the grade numbers and the ASTM working penetration for each grade. While this classification is in no way a standard or specification of quality, it establishes the body of consistency of the grease and assures the manufacturers and consumers of lubricating greases of securing uniform bodies or consistencies while using this classification.

MONSANTO ACQUIRES SITE FOR NEW PLANT

An announcement from Detroit states that the Monsanto Chemical Co. has purchased a tract of 138 acres at Trenton, Mich., which will be used as a site for a new plant. The land has a frontage on the Detroit River which will effect savings in transportation costs both of raw materials to the plant and in the movement of finished products to consuming centers. While the purchase is said to be the first step in a development program, it is understood that production of phosphates is the immediate intention.

Edgar M. Queeny, president of the company, stated that the new plant will go into operation in mid 1941. It will be served by the Michigan Central Railroad and dock facilities will be constructed along the Detroit River. A contract with the Detroit Edison Co. for steam and electricity is being negotiated. Construction will be supervised by R. R. Cole as general manager of the phosphate division and by J. B. Rutter, director of engineering of the company.

LACK OF STATISTICS LEADS TO CONFLICTING REPORTS REGARDING GERMANY'S SUPPLY OF OIL

From Our German Correspondent

OIL is becoming the big question mark in the Reich's war machine. Since publication of most statistics has been discontinued, and since the extent of reserve supplies, both those built up in Germany and those captured in conquered areas, is unknown, the best one can do is to compare pre-war consumption and production figures and balance the conflicting statements from London and Berlin.

London estimates that Germany is short of oil and from every source of supply can obtain no more than 12 million tons a year, as compared with normal peace time consumption in all Europe (excluding Russia) of twice that amount. This would be an important factor in a long drawn out war, although some observers believe that with savings resulting from curtailed civilian consumption plus captured supplies, the Reich now has adequate oil to last for well over a year.

According to a recent statement in Goering's "Essener National-Zeitung," if the Reich were victorious, the continent could even be made self-sufficient in petroleum. In 1938 mineral oil consumption in Middle Europe (not including France, Spain, and Russia) was 19 million tons. This was distributed as follows: the German Reich, including Czecho-Slovakia and Poland 7.9 million tons, Italy 2.8, Netherlands, Belgium, and Switzerland together 2.6, Scandinavian and Baltic states 2.9, Southeastern Europe, including Turkey 2.9 million tons. Adding Russia's consumption in 1938 of 22 million tons, Middle and Eastern Europe together consumed 41 million tons of oil. Production in the same areas was 39 million tons, of which Russia according to this estimate—but not according to the Soviet's own figures—supplied 29 million tons, Rumania 6 million, and the Reich plus Czecho-Slovakia and Poland about 4 million tons.

If Russia's export surplus figure of 7 million tons is eliminated, there remains a deficiency for Middle Europe of 10 million tons, which is somewhat less than half of its peace time consumption. The extent of Russia's cooperation in the war as well as afterward is always an imponderable factor. Of the remaining areas, Rumania is the leading source of natural oil, with small quantities being produced in Germany, Poland, and Albania. It is believed that some of this deficiency could be overcome with synthetic motor fuel production, but it will be remembered that Hitler's statement in 1936 that within four years the Reich would be entirely self-sufficient in motor fuels has not materialized. Furthermore, this would still leave the

Reich short on heavy oils and lubricants. An additional source of oil is seen in the intensive development of newly discovered deposits in Hungary and Yugoslavia. The output of the Near East now under British control, amounting to 15 million tons in 1938, is of course also being watched.

Last year Rumania exported 4 of the 6.2 million tons of oil she produced, and it is assumed that under present circumstances a larger part of this would be diverted to the Reich. This is not quite so simple as it sounds, for lack of adequate transportation facilities both in Rumania and Russia is a handicap. Many tank cars and Danube river barges are being built for the purpose of transporting oil, and probably some French and Lowlands' rail tank cars will be pressed into service.

In Germany, savings of gasoline are being effected through curtailment of all but urgent civilian driving. The standardization of vehicles by reducing the number of types of cars and trucks being built should result in economies in fuel, materials, and parts. The use of liquid gas and sewage gas for motor buses and trucks as well as wood gas for stationary motors has also contributed to fuel conservation. A recent announcement, for example, indicates that a new type stationary coal dust burning motor is ready for industrial production. It is a three cylinder engine, without compressors, developing 300 HP with 240 revolutions per minute. The main defect of previous engines, such as the highly discussed Rupa dust diesel engine, built by the Schichau Werke in Elbing, has been the excessive wear of the cylinder caused chiefly by sulphur compounds in the fuel. Wear on the new type cylinder, it is claimed, is reduced to 1.37 millimeters in 9000 hours' running time under full load.

Insofar as motor production for other than military purposes continues, it is interesting to note that some avenues of automobile as well as general export must still remain open to the Reich. In fact, although detailed figures are no longer published, Baron Carl von Schroeder recently claimed in the "Deutscher Volkswirt," leading economic publication, that in the first eight months of the war neither the volume nor value of German foreign trade experienced any appreciable decline.

The Austrian-American Rubber Works "Semperit" also reported increased productions and sales and declared an 8 per cent dividend—most of the recent large engineering and chemical concerns report dividends varying between 6 and 8 per cent, and

occasionally 10 per cent. Semperit, like Continental Rubber and other important rubber manufacturers have now almost completely adapted their machinery and manufacturing methods to processing raw materials produced domestically.

Kali Chemie A.G., large potash and chemical concern, reported a 10 per cent increase in sales during 1939 and a 6 per cent dividend. It invested 27 million RM in new construction since 1937 and is financing plant additions from a 10 million RM, 5 per cent loan issue.

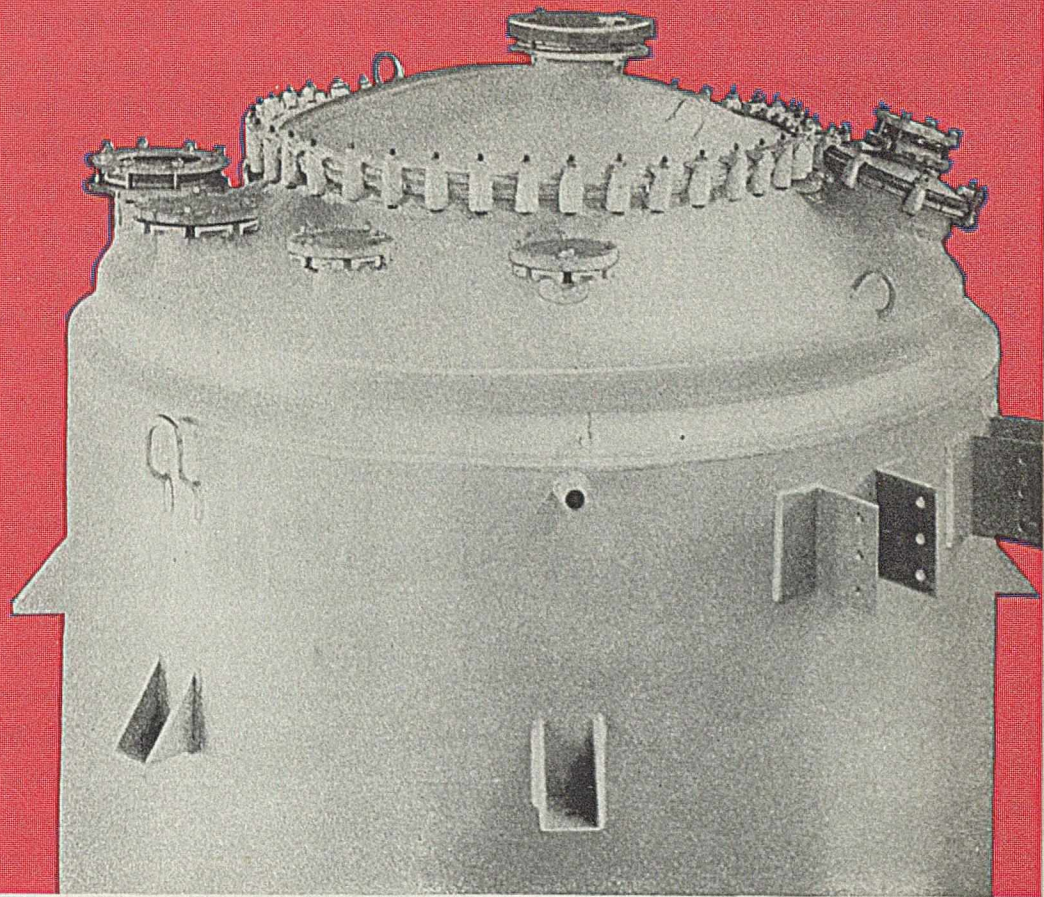
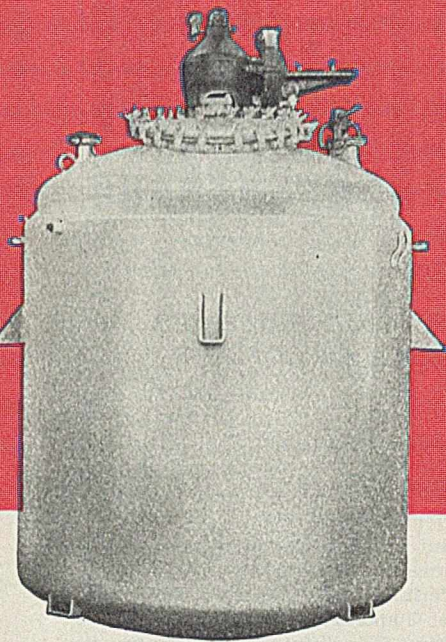
The timber of Poland, Norway, and Sweden assures adequate wood supplies as well as high grade cellulose for the staple fiber industry. Under a recent agreement between representatives of the German and Swedish cellulose and paper industries, Germany will be taking considerably larger quantities of Swedish production than heretofore.

In the past the Reich cellulose industry used primarily pine-wood. Since this is now required for other technical purposes, beech and other woods are being substituted wherever possible. Illustrating the extent to which the attempts to increase domestic wood production have gone, is a report by the Kaiser Wilhelm Plant Research Institute in Muenchenberg. Through the application of ultra-violet and Roentgen rays it has been possible to accelerate the growth of trees so that in two years poplars were ready to be cut for manufacture of cellulose. Measurements have shown that the yield from artificially treated trees was fully as large as that for much older trees grown under normal conditions. To what an extent such processes could be applied commercially seems largely a matter of cost.

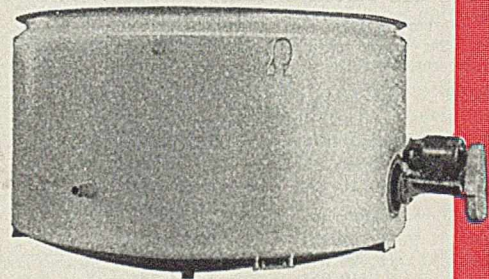
Staple fiber in the Reich is being manufactured more and more out of wheat and rye straw. Italian reed also offers possibilities as a textile raw material, and great tracts of land that are of little value for other purposes are being cultivated with this plant on a large scale by a newly founded company in Vienna. The Italian cane is claimed to yield 10,000 pounds of fiber per acre as against 1,200 pounds from hemp, 500 from flax, and 200 from cotton.

A new rivet whose exploding end automatically locks it firmly in place has been perfected in the Reich after a number of years of research. Instead of inserting a heated rivet into the hole and hammering it as heretofore, the force of the explosive in the ends of the new type rivet is enough to blast the rivet and seal the joint firmly and securely.

The early completion of a new edition of the famous Leopold Gmelin's "Handbook of Organic Chemistry" is expected. From three volumes published by the Heidelberg chemist in 1817, the work has grown to 25 volumes with 24,770 pages. A large staff of German chemists is at work under the auspices of the Gmelin Institute on the 10,000 unfinished pages of the new edition.



Above and at right: New one-piece, all welded Pfaudler Glass-Lined process kettles for high pressure work. Manhole covers are designed to permit installation of glass coated agitators. Note large number of openings in head, once thought impossible.



Large diameter jacketed glass-lined tanks with motor-driven agitator used by prominent ink manufacturer for blending inks.

DO YOU REALLY KNOW HOW MANY OF YOUR NEEDS GLASS-LINED STEEL CAN MEET?

PERHAPS you always thought of Pfaudler Glass-Lined Equipment only in terms of handling corrosive acid solutions. It's true that Pfaudler glass, fused into steel, is resistant to all acids (except HF) in any concentration or at any temperature.

It is also true that Pfaudler equipment can show you remarkable savings in meeting mild conditions, particularly for storage. For example, the storage of any product, perhaps a solvent, a costly essential oil or a vitamin concentrate which must be kept 100% free of "parts-per-million" of dissolved metallic impurities, discoloration or turbidity.

When you process or store in Pfaudler equipment, you are, in effect, placing your product in a glass

bottle fused into rugged steel for reinforcement. Here is all the strength you need *plus* the protection glass affords against contamination. The long life of such equipment makes the initial cost of secondary importance.

The wide capacity and pressure range Pfaudler now offers enables you to utilize glass for more diverse usage than you might otherwise have thought practical. So for processing or storage, it will be to your advantage to "put glass-lined steel to work" for you. Have you Catalog No. 792?

THE PFAUDLER CO., Executive Offices: Rochester, N. Y. Factories: Rochester, N. Y. and Elyria, O. Branch Offices: New York, Boston, Philadelphia, Chicago, Cincinnati. Pfaudler Sales Co., San Francisco and Los Angeles. Representatives in principal cities.



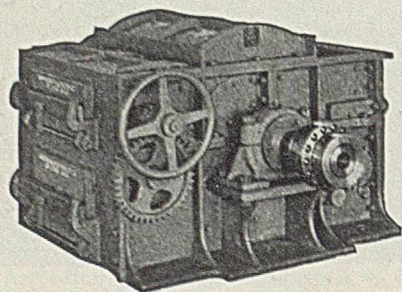
PFAUDLER

GLASS-LINED AND ALLOY EQUIPMENT

GRINDING EQUIPMENT

for all kinds of
CHEMICALS

AMERICAN RING AND HAMMER TYPE CRUSHERS



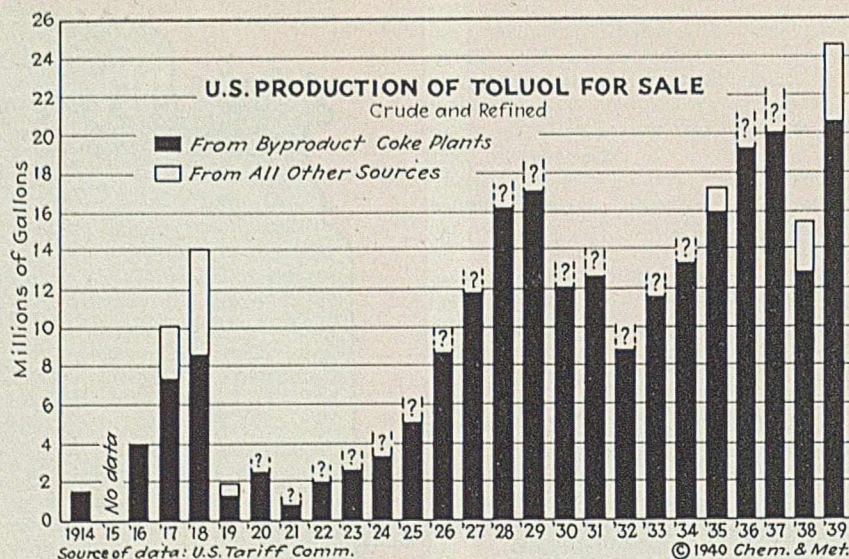
- ★ wide operating range—
- very flexible—
- all parts accessible—
- dependable operation—
- low maintenance—
- simple construction and operation

Every part of American Crushers is tested for quality, wear, and endurance to assure absolute satisfaction in actual service. They stay right on the job, day after day, delivering more tonnage per hour and producing a more uniform product with minimum fines—no slivers or chips. Installation and maintenance is low—economy is high.

Many well-known process industry plants are enjoying fine service in crushing and grinding all kinds of chemical raw materials uniformly and economically. The grinder shown is used for grinding glass and tank cullet, salt briquettes, sinter, skimmings, limestone, gypsum, oyster shells, phosphate rocks, etc. We will send descriptive literature on the type of equipment best suited to your needs if you will let us know what you want to grind. We maintain a testing plant for prospective users of our equipment—make use of it—

AMERICAN PULVERIZER COMPANY

1219 MACKLIND AVENUE
ST. LOUIS, U. S. A.



WARTIME DEMAND FOR TOLUOL MAY RAISE PRICES TO POINT WHERE PETROLEUM PROCESSES CAN COMPETE

BEFORE the World War of 1914-18, the market for toluol was not large. Only 1,500,000 gal. was made—all from byproduct coke ovens—in 1914. It went into commercial explosives, paint thinners and other types of solvents. During the war its production rose to a peak of 14,103,237 gal. in 1918 because of the Army's large requirements for TNT.

After the war production fell off sharply but a new industry had been born. Coal-tar refining and the manufacture of hundreds of intermediates became necessary in the United States

to replace former imports from Germany. Some of these intermediates, notably benzoic acid and saccharin were made from toluol.

But toluol found other uses, too. It became a solvent for many organic materials, one of them rubber cement. Most important of all, it became a diluent in solvents and thinners for use in lacquers, some kinds of paints, pyroxylin and other fabric coatings. Following the automotive, airplane and furniture industries, the use of these materials grew quickly until in 1937 toluol gallonage passed way above the

U. S. PRODUCTION OF TOLUOL FOR SALE, ALL GRADES (IN GALLONS)

Data from U. S. Tariff Commission and Bureau of Mines

Sales instead of production data have been used for byproduct coke plant and gas works output to avoid duplication between crude and refined grades. Tar refiners produce only the refined grade. The total, therefore, represents the amount available for consumption.

Year	Byproduct Coke Plants (Sales)	Gas Works (Sales)	Tar Refiners and other Establishments (Production)	Total Production For Sale
1914	No data			1,500,000 ¹
1915	No data			
1916	3,939,636			
1917	7,395,174	1,035,813	1,788,843	10,219,830
1918	8,541,366	3,965,518	1,596,353	14,103,237
1919	1,353,827	20,000 ¹	510,957	1,884,784
1920	2,470,364	2,000 ¹	?	?
1921	835,493	1,000 ¹	?	?
1922	1,910,060	?	?	?
1923	2,634,783	2,000 ¹	?	?
1924	3,231,502	2,000 ¹	?	?
1925	5,038,147	2,000 ¹	?	?
1926	8,650,605	200 ¹	?	?
1927	11,784,984	1,000 ¹	?	?
1928	16,181,650	1,000 ¹	?	?
1929	17,064,206	1,000 ¹	?	?
1930	12,083,423	1,000 ¹	?	?
1931	12,693,294		?	?
1932	8,725,572		?	?
1933	11,541,990		?	?
1934	13,240,880		?	?
1935	15,960,968		1,687,318	17,648,286
1936	19,695,792		?	?
1937	20,173,723		?	?
1938	12,884,734		2,703,421	15,588,155
1939	20,484,568		4,198,483	24,683,051 ²

¹ Estimated by U.S.T.C.

² Data not reported to avoid disclosing production of individual tar refiners.

³ The 1939 total is greater than the actual production because some toluol was held over from 1938.

20,000,000 mark. How much above it is not known exactly because of the way Census data are reported for toluol.

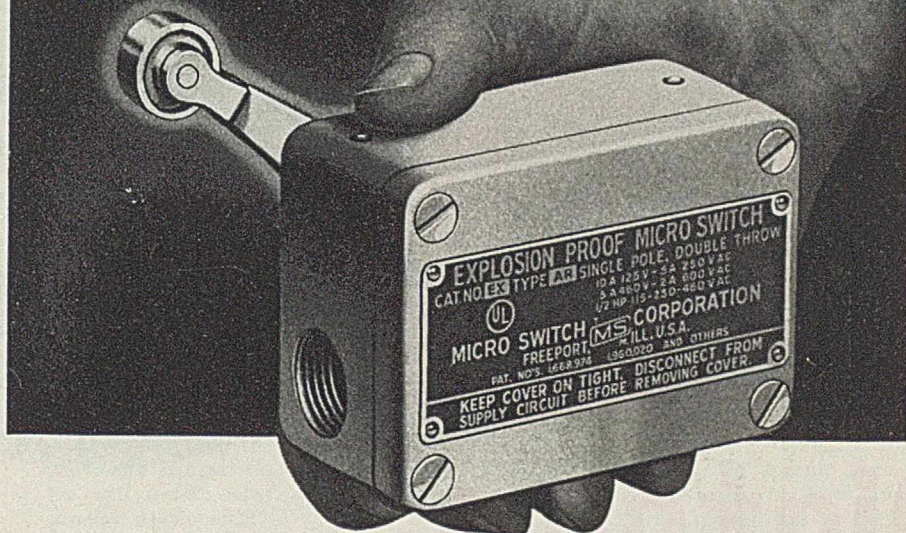
The Bureau of Mines collects data on the production of toluol from by-product coke ovens. The Tariff Commission collects data from other sources. Since 1919 there have not been enough companies making toluol from other sources to permit the data to be reported. (The U. S. T. C. does not report data unless production is evenly divided between three or more producers.) However, in 1935, 1938 and 1939 these data could be reported because of several new companies in this field. For many years the Barrett Co. was the principal refiner in this classification. The Portland (Ore.) Gas & Coke Co. has reported to the Tariff Commission for several years. Then about four years ago Calco Chemical Co. started refining the coal-tar light oils. Now the duPont Company, Inland Steel Co. and Nord & Schulich are also listed as producers of toluol at plants other than by-product coke plants.

The capacity of U. S. coke ovens in terms of toluol has been estimated by various authorities as 22,000,000, 25,000,000 and 30,000,000 gal. However, in view of the fact that 20 to 25 per cent more toluol per ton of coal coked can be made today than in 1917 and the quantity of coal so coked is about double, the higher figures seem more likely. By using new processes, it is thought that production may be stepped up to 32,000,000 gal.

Normal peacetime requirements for toluol are estimated to be about 15 to 17,000,000 gal. annually. The average for the past ten years is in that range. Unofficial sources indicate that the Government's defense program will require about 10,000,000 gal. a year for at least three years. Added to that the British Government wants 7,000,000 gal. next year. All in all it would seem that the 1941 requirements for toluol might be in the neighborhood of 33,000,000 gal., assuming a continuation of peace in the United States. If coke ovens can produce 32,000,000 gal. and tar refineries can add 4,000,000 gal., the supply will be ample.

In the case of war, however, a different situation would exist. U. S. wartime requirements have been estimated at about 37,000,000 gal. annually. Most of that would have to come from petroleum. City gas works could install emergency stripping equipment, but the cost would be too high. It has been estimated that petroleum toluol can compete with coke-oven toluol at a price of 45c. per gal. (present quoted price 28½c. per gal.). That figure includes a high investment cost and therefore could probably be shaded considerably if the Government put up investment money. On the other hand, some refiners may consider an aromatization plant a good investment for the years after the war because aromatics are fine blending agents to improve the octane rating of motor fuels.

Announcing the Explosion-Proof MICRO SWITCH



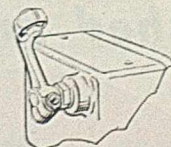
**Small Size—Less than 18 Cubic inches . . .
Underwriters' Listed for Hazardous Locations
... Single Pole, Double Throw... Three Types
of Actuators... Standard ½" Conduit Accom-
modates three #14 rubber-covered wires**

Here is an explosion-proof switch that is designed to fit in small space. It measures only 2½" high x 2" wide x 3¾" long and weighs only 2½ lbs. It is Underwriters' Listed for hazardous locations: Class I, Groups C and D; Class II, Group G . . . The streamlined, cadmium plated cast iron housing is drilled and tapped for mounting on either of four sides. A convenient mounting plate provides foot mounting where needed . . . The switching element is a single pole, double throw precision snap acting Micro Switch which provides accurate reproducibility of the point of operation . . . This unit is mounted in the housing so as to be easily removable for inspection or replacement after it may have served its normal life of millions of operations . . . Underwriters' Laboratories list and recommend this Explosion-Proof switch for 1200 watts up to 600 volts A.C. or ½ h.p. motor loads . . . Complete details of this new switch are covered in Data Sheet No. 9. Write for it.

**MICRO SWITCH
is the Name of a
Particular Product,
Not a General
Term.**



This rugged push rod type actuator has an overtravel of 3/16". Actuator button is case hardened steel.



Roller arms are provided with the roller parallel to or at right angles to the arm. The sparkless rollers of close concentricity are carried on oilless bearings so that full advantage may be taken of the extremely close movement differential of this switch.

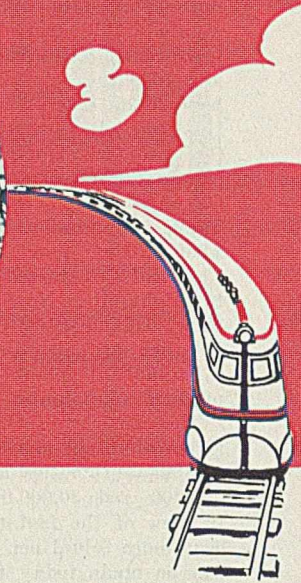
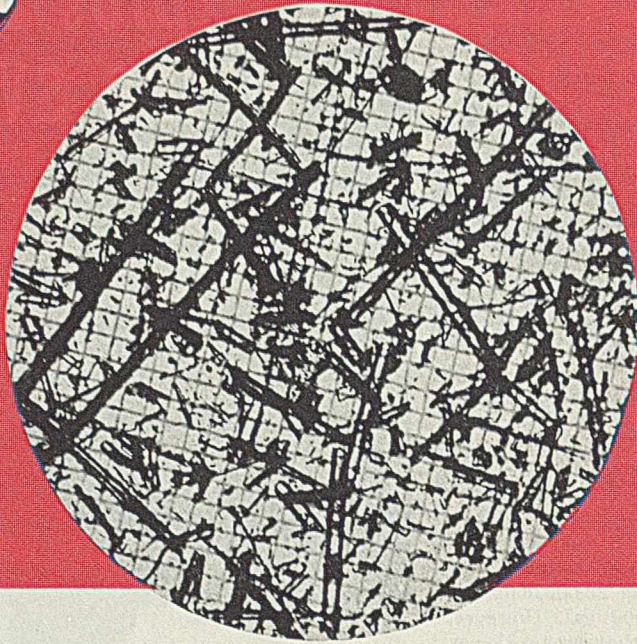
Copyright 1940, Micro Switch Corporation

MICRO SWITCH

Manufactured in FREEPORT, Illinois, by Micro Switch Corporation. Sales Offices: New York, Chicago, Boston

Streamlined for **SPEED**

with accuracy—dependability—efficiency



DICALITE

Diatoms

were streamlined by **MOTHER NATURE!**

That is why

DICALITE FILTERAIDS

give the clarity desired
at **HIGHER** flowrates—
therefore, at **LOWER**
cost per unit of your
finished product.

THE *Elongated* or *streamlined* diatoms, which predominate in DICALITE, give DICALITE FILTERAIDS their **HIGHER** Flowrates—faster **SPEED** of flow. (See the photomicrograph above.) This higher flowrate is made possible by the greater number of *microscopically tiny* openings formed in the filter cake by the DICALITE FILTERAIDS, permitting a larger volume of liquid to flow through in a given time.

It is the tiny size of these openings that gives the brilliant clarity. Even colloidal material and microscopic particles are caught in the cake. Only the clear filtrate flows through.

Thus, with the use of the right grade and amount of DICALITE FILTERAIDS, you get your filtering job done the way you want it done—and at **LOWER** cost per unit of your finished product.

Why not write for complete information and specific recommendations?

These other
DICALITE PRODUCTS

are made of the same
Streamlined Diatoms

Extenders and Filling Agents for
Paint and Allied Products

Insulating Materials

Whorl Filters for all types of
products

Dicalite for Uniform Concrete
Dicalite for Asphalt



THE DICALITE COMPANY

520 N. Michigan Ave.
CHICAGO

120 Wall St.
NEW YORK

756 S. Broadway
LOS ANGELES

PERSONALITIES

†FRANK A. HOWARD, president of Standard Oil Development Co., has been elected a vice president of Standard Oil Co. (N.J.) with responsibility for all chemical, research and patent matters. Mr. Howard's election is in recognition both of the growing importance of the Jersey company's investment in the field of chemistry and of his own outstanding part in chemical development. He will continue as officer or director in the companies engaged in these activities.

†CLAIRE C. BALKE has rejoined the research staff of Fansteel Metallurgical Corp., North Chicago, Ill., to participate in important studies in the powder metallurgy of tantalum, tungsten, columbium, molybdenum, other metals, and refractory metal carbides.

†PAUL V. MCKINNEY has been appointed director of research for the Neville Co., Pittsburgh, Pa. Dr. McKinney leaves the position of senior fellow in the work of the Texas Gulf Sulphur Co. at Mellon Institute to engage in research for the Neville Co. on the production of synthetic resins and organic chemicals.

†G. H. CLAMER has been elected president and general manager of the Ajax Electrothermic Corp.

†J. EUGENE JACKSON has been appointed metallurgical engineer of the Copper Iron and Steel Development Association with headquarters in Cleveland.

†BRADWAY S. PHILLIPS has been appointed development engineer by the Continental Carbon Co. He will engage in carbon black development problems at the company's plant at Sunray, Texas. During the past ten years he has been associated with the B. F. Goodrich Rubber Co. at Akron.

†WILLIAM A. MAXWELL, who has just



Conway Studios

FRANK A. HOWARD

received his chemical engineering degree at the South Dakota School of Mines, has joined the research staff of the Foote Mineral Co. of Philadelphia. He will devote most of his time to process development.

†E. GORDON FOX, vice president of the Freyn Engineering Co., Chicago, has recently assumed the office of president of the Western Society of Engineers.

†H. M. ELLSWORTH, who for many years was advertising manager of the Sterling Products Co. in Easton, Pa., has been appointed manager of advertising of the Pennsylvania Salt Mfg. Co. and its subsidiaries, succeeding Miss I. J. Denney who has resigned.

†C. O. BARTLETT has been appointed district manager in the Detroit territory for the C. O. Bartlett & Snow Co., Cleveland, Ohio. Mr. Bartlett, who is the son of the founder and organizer of the company, graduated from Case School of Applied Science in 1915. He has been associated with the Ameri-

can Agricultural Chemical Co. for some time.

†J. B. JOHNSON, formerly director of purchases has been appointed assistant general manager of the explosives department of the Hercules Powder Co. K. W. Jappe, formerly manager of the company's plant at Port Ewen, N. Y., has been appointed director of purchases to succeed Mr. Johnson.

†ANDREY ABRAHAM POTTER was recently honored with the award of the Lamme Medal for 1940 of the Society for the Promotion of Engineering Education. It was in recognition of his many achievements in the advancement of engineering education and its application to industry. For 20 years Dr. Potter has been dean of the school of engineering and director of the engineering experiment station at Purdue University.

†PHILIP E. PRATT, who recently received his doctorate in organic chemistry at the University of Iowa and Allison S. Burhans, graduate of Duke University, have been appointed to the research and development staff of the Bakelite Corporation, a unit of Union Carbide & Carbon Corp. They will be located at the Bloomfield, N. J., laboratories.

†OTTO L. KOWALKE has announced his retirement on July 1 from the administrative duties and the chairmanship of the department of chemical engineering of the University of Wisconsin. Professor Kowalke has been chairman of the department for 27 years and a member of the teaching staff for over 33 years. He is retiring because he wants to spend all of his time on his teaching and research work.

†WESLEY A. STURGES has announced the termination of his services as executive director of the Distilled Spirits Institute. He will return to the teaching of law.

†W. RUSSELL GREER, vice president of the Porcelain Enamel & Mfg. Co., Baltimore, Md., has been appointed chairman of the committee to coordinate the porcelain enameling industry for national defense.

†H. MARK of Hawkesbury, Canada, has been appointed professor of organic chemistry at Polytechnic Institute of Brooklyn. Professor Mark, previously of the University of Vienna, will direct research in the field of high molecular weight compounds at the Institute.

†G. E. HILBERT has been selected to head the Starch and Dextrose Division

CALENDAR

AUG. 20-23, Technical Association of the Pulp & Paper Industry, fall meeting, Olympic Hotel, Seattle, Wash.

SEPT. 9-13, American Chemical Society, fall meeting, Detroit, Mich.

OCT. 2-5, Electrochemical Society, fall meeting, Ottawa, Canada.

OCT. 7-10, American Gas Association, Atlantic City.

DEC. 2, 3, 4, American Institute of Chemical Engineers, New Orleans, La.

DEC. 11-15, National Chemical Exposition, Chicago, Ill.

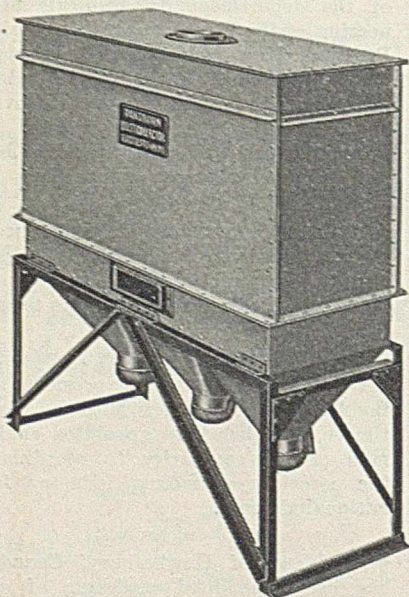
CONTROL



THE DUST HOG-- TURN HIM INTO PROFIT

HOW? With a Pangborn Cloth Screen Dust Collector. For more than 25 years this method has been successfully used by industry in all parts of the world—for all types of dusts.

The small Dust Collector illustrated below is shipped fully assembled, ready for immediate use. Its cost is easily within reach, even of the smallest plant. Write for information on Type "CD" Dust Collectors.



PANGBORN

THE WORLD'S LARGEST MANUFACTURER OF DUST
CONTROL AND BLAST CLEANING EQUIPMENT
PANGBORN CORPORATION - HAGERSTOWN, MD.

of the Northern Regional Research Laboratory at Peoria, Ill. In his new position Dr. Hilbert will direct fundamental studies of starches, dextrans and dextrose as a basis for the possible development of new and expanded industrial uses for these agricultural products.

† R. T. STEINDORF has just been appointed district manager of the Chicago office of Chain Belt Co. of Milwaukee.

† JOHN W. ALDEN has joined the Steel and Tube Division of The Timken Roller Bearing Co. as mill metallurgist.

† JOHN G. BERGDOLL has been appointed engineer of the York Ice Machinery Corp.

† J. MERRIAL PETERSON, head of the testing department of Hercules Powder Co., has been appointed assistant professor of chemical engineering at Cooper Union. Dr. Peterson will teach physical chemistry and chemical engineering thermodynamics.

† C. C. SMITH, vice president in charge of sales for the Potash Company of America, is retiring from this position Sept. 1, 1940. He will continue with the company in the capacity of sales advisor and will remain in touch with his many friends in the fertilizer industry. George E. Pettitt, at present first vice president of the Chilean Nitrate Sales Corp., will succeed Mr. Smith as vice president in charge of sales for the Potash company.



A. B. Nixon

† A. B. NIXON, director and formerly general manager of the Hercules Powder Co.'s naval stores department, has been elected a vice president and a member of the executive committee. A. E. Forster, assistant general manager, of the department, has been made general manager, succeeding Mr. Nixon.

† CHESTER L. BAKER became chemical director of Philadelphia Quartz Co. on July 1, succeeding James G. Vail, who retired from this position in order to

devote more time to the work of the American Friends Service Committee, of which he is an official. Mr. Vail will continue as vice president of the company, actively connected with its technical and administrative problems. Mr. Baker joined the company at Berkeley, Calif., in 1927 and was prominently identified with the design and construction of the plant at Southgate, Calif.

† A. OAKLEIGH BUSH has been appointed assistant chief sales engineer of the abrasives division of Norton Co. He has been with the company for 16 years, first in the electric furnace plant at Niagara Falls and then in the research and sales engineering departments at Worcester.

† KARL F. KREBS, who recently received his doctorate in organic chemistry at the University of Illinois has joined the Bakelite Corp. He will be connected with the research and development staff at Bloomfield, N. J.

† ROY F. LAB is now chief chemist at Copperweld Steel Co.'s new plant at Warren, Ohio.

† H. S. PAINE of the Bureau of Agricultural Chemistry and Engineering has been placed in charge of an enlarged division of food research and carbohydrates. This represents essentially a merger of Dr. Paine's carbohydrate investigations with the research formerly directed by Dr. Fred C. Blanck who resigned from the Bureau to take an industrial position about a year ago.

† NELSON MYERS has been made a vice-president of the Chilean Nitrate Sales Corp. effective August 1. For a number of years he occupied several positions of responsibility with Virginia-Carolina Chemical Corp.

† M. A. CARPENTER has been elected executive vice-president of the Falk Corp. He has been associated with the corporation for 16 years.

† G. HAGERUP-LARSEN, engineer of Elektrokemisk, Oslo, Norway, is at the present time in New York in connection with his work with the Soderberg electrode system and the electric pig iron furnaces.

† WILLIAM D. KOHLINS, formerly associated with Mathieson Alkali Co. at Saltville, Va., is now with the Swenson Evaporator Co.

† RALPH M. PALMER, president of the Ferro-Nil Corp., New York City, has been re-elected president of the Brown University Club of New York.

† FRED L. LAWRENCE has been appointed Detroit district manager for Copperweld Steel Co. He attended the University of Michigan and had previously been connected with the Frost Gear & Forging Co., as chief metal-

lurgist, and the Pittsburgh Crucible Co. as senior metallurgist.

† A. I. RICHARDSON has been appointed manager of Allis-Chalmers Mfg. Co.'s district office at Dallas, Tex. He was previously located at the company's office in Charlotte, N. C.

† W. L. MARTWICK has been elected to the position of vice president in charge of sales of the Foster Wheeler Corp.

† STANLEY M. MERCIER has been appointed to the position of chief engineer, Conveyor Division, of the Jeffrey Mfg. Co., Columbus, Ohio. He will direct all conveyor engineering and engineering sales activities for the company.

† C. K. BRYCE has been elected vice president of Oxweld Acetylene Co., a unit of Union Carbide & Carbon Corp., New York. Mr. Bryce was formerly manager of factories.

† T. D. CARTLEDGE and L. A. BLISS are now vice presidents of the Linde Air Products Co., a unit of Union Carbide & Carbon Corp. E. J. Hayden has been made vice president, Central Division, of the company. E. B. Suydam, formerly assistant general sales manager, has been appointed general sales manager to succeed Mr. Cartledge and P. B. Pew, formerly assistant works manager, has been appointed works manager to succeed Mr. Bliss.

† C. R. MITCHELL, JR., has been appointed assistant district manager of sales for the New York district office of the Allegheny Ludlum Steel Corp. He graduated from the University of Pittsburgh in 1928 where he had majored in chemistry.

† HUGH R. LAMBERT is now manager of the Cooling Tower Division of the Fluor Corp., Ltd. His duties will include responsibility for cooling tower design, manufacturing and sales. He comes to the Fluor organization from the Southern California Gas Co., where he was engaged in industrial engineering. His headquarters will be at Fluor's Los Angeles office.

† MAX F. BECKER has been appointed vice president in charge of sales representatives of the Whiting Corp., Harvey, Ill. His latest promotion comes to Mr. Becker after 20 years of service with Whiting; starting in June 1920 after graduation from Purdue University, he served with the Pulverizer Division. After several years in various departments, he was made manager of the Whiting Foundry Equipment Division. Last year he was made sales manager of the Industrial Division.

OBITUARY

† JAMES F. NORRIS, professor of organic chemistry at Massachusetts In-

stitute of Technology and director of its organic chemistry research laboratory, died in Boston on August 3 at the Phillips House. He had been ill for three months after undergoing an eye operation. His age was 69. Dr. Norris had been a member of the M.I.T. staff since 1916, with the exception of the World War period when he was in charge of our chemical warfare in England.



James F. Norris

† JOCELYN F. THORPE, a past-president of The Chemical Society and of the Institute of Chemistry, died suddenly on June 10 at the White House, Coo-den Beach, Sussex, England. He was born in London on December 1, 1872 and was educated at Worthing College, at Kings College, London, and at the Royal College of Science, London. He studied organic chemistry under Victor Meyer at Heidelberg, where he took his doctorate.

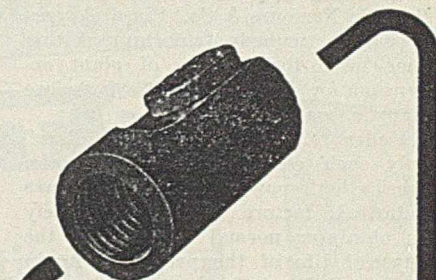
† HOWARD F. WEISS died July 7 at Wisconsin Dells, Wis., of a heart attack. His age was 57. Mr. Weiss, who was a graduate of Yale, was treasurer of the Burgess Laboratories, Inc. until 1938 when he founded Research Products Corp. of which he was president.

† ALVAH H. SABIN, consulting engineer in the paint industry, died recently in the Flushing (N.Y.) Hospital of complications resulting from a fracture of his right arm suffered a short time before. He was 89 years old. Mr. Sabin was born in Norfolk, N. Y., was graduated from Bowdoin University in 1878 and took his master's degree the following year. In 1925 he received the honorary degree of Doctor of Science from that institution. Mr. Sabin who had lived in Flushing 50 years retired in 1937 as consulting engineer for the American Lead Co., a post he had held since 1910.

† HERBERT C. REED a former State Senator, who was president of the Reed-Blair Laboratories in New York, died in the Stamford (Conn.) Hospital, July 25. He had gone there for an operation. His age was 66.

MONARCH CHEMICAL SPRAY NOZZLES

Of



HARD RUBBER:

The Fig. B-27 nozzle illustrated is of the "non-clog" type; i.e. it contains no internal vanes, slots, or deflectors which might facilitate clogging.

Available $\frac{1}{4}$ " to 1" pipe. Small sizes produce a very fine, soft, wide angle spray at low pressures. Capacities 4.7 G.P.H. up.

STONEWARE:

Monarch Fig. 6020 and Fig. 6040 stoneware sprays have replaced most other types of nozzles used in acid chamber plants throughout the world. Last almost indefinitely in sulfur gases and will not break or crack from temperature changes.

STAINLESS:

Available in capacities from .0095 G.P.M. (Fig. F-80 style) to 104 G.P.M. (Fig B-8-A style).

"Hollow" cone, "Solid" cone, and "Flar" sprays furnished in pipe sizes and capacities to suit practically any problem where corrosive liquids are sprayed.

Write for
Catalogs 6A and 6C

MONARCH MFG. WKS, INC.

2730 E. WESTMORELAND ST.
PHILADELPHIA, PA.

READERS' VIEWS AND COMMENTS

Readers are invited to express their views on articles appearing in Chem. & Met. or on other subjects of interest to chemical engineers. As far as our space permits such views and comments will be published in these columns. Address your letter to the Editor of Chem. & Met., 330 West 42 St., New York, N. Y.

DEPRECIATION VS. OBSOLESCENCE

To the Editor of Chem. & Met.:

Sir:—In your July 1940 issue you show under "Planning for Cost Reduction" an instructive chart presented by G. M. Read of the Industrial Engineering Department of E. I. du Pont de Nemours & Co. Fixed charges appear particularly important at this time when the problem of plant expansion for national defense is before many a management.

Under "Low Depreciation Rate" only such elements as maintenance, lubrication, power transmission are indicated, factors bearing exclusively on obtaining normal service over the physical life of the property. Again under "Reduced Investment" development and design are stressed.

A minimum of fixed charges does not necessarily result from the smallest investment, nor a low depreciation rate, when a unit must be scrapped in the prime of its physical life, due to obsolescence of plant, process or product. Proper planning in this regard should be primarily concerned with the following questions:

1. What is the physical life expectancy of the unit—provided normal standards of maintenance?

2. Which obsolescence hazards may shorten the physical life—considering changes in plant, process or product? These hazards may be reduced by using, even for special purpose, standardized equipment elements with high reuse or resale value.

3. Which investment will yield the minimum total cost, including labor, material, overhead and gross return on the required investment, assuming "normal life expectancy" as determined under (2) as controlling?

Considering the large element of fixed charges in many process industries, such studies—often neglected—will frequently pay their way more easily than the painstaking technical development, saving minor portions of labor or material cost.

R. M. FISCHER

The American Appraisal Co., Inc.
New York, N. Y.

MATERIALS OBSOLESCENCE

To the Editor of Chem. & Met.:

Sir:—The remarks of Mr. R. M. Fischer have been reviewed. If you will note in the first item that he discusses "Low Depreciation Rate," you will find that under this group are Materials of Construction, Maintenance Systems, Mechanical Power Transmission and Lubrication. Mr. Fischer has eliminated one of the most important factors, namely, Materials of Construction. In so far as we know, most of our money going into plants is spent for materials of construction of one kind or another—an item which might easily escape the attention of the average accountant.

Under "Reduced Investment" the items of Equipment Development and Plant Design could be expanded indefinitely, but they certainly do cover the cardinal factors that govern investment in any chemical plant. No attempt has been made here to exhaust discussion of these factors for we preferred merely to indicate and focus attention on them.

After studying the question of obsolescence (and I say we have had some obsolescence during the past 25 years) and depreciation rates, we are of the opinion that sound engineering attack

is preferable to accounting methods, admitting that it is necessary to keep accurate records. We have written and compiled many figures on the subject of depreciation rates and obsolescence which we will be glad to discuss with interested parties.

GRANVILLE M. READ

Assistant Manager
Industrial Engineering Division
E. I. du Pont de Nemours & Co., Inc.
Wilmington, Del.

DRUM CONSTRUCTION

To the Editor of Chem. & Met.:

Sir:—Concerning "Further Improvements in Drum Construction," which appeared in the June issue of *Chem. & Met.*, we note that you did not find it possible to publish all of the photographs submitted with the draft of the article. Absence of these photographs is especially apparent in the case of the lower left-hand illustration on page 408. This shows test results only in the case of 18-gage sidewall drums of medium-low yield point steel. To bring out the point we wish to make and which was demonstrated by costly test procedure, comparison with 20-gage sidewall drums of high yield point steel was most desirable.

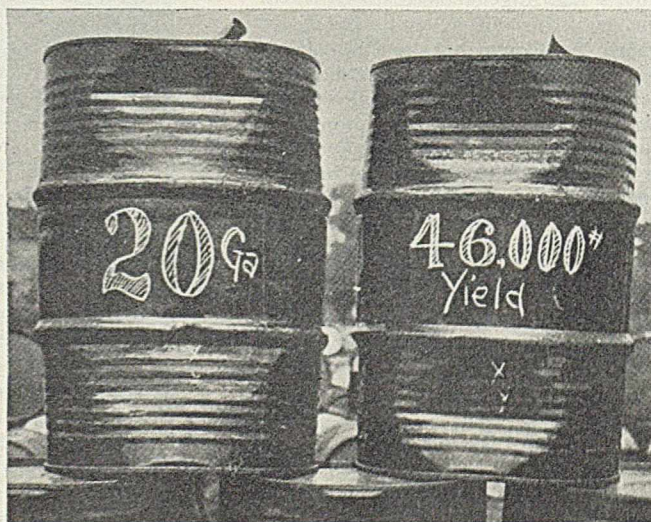
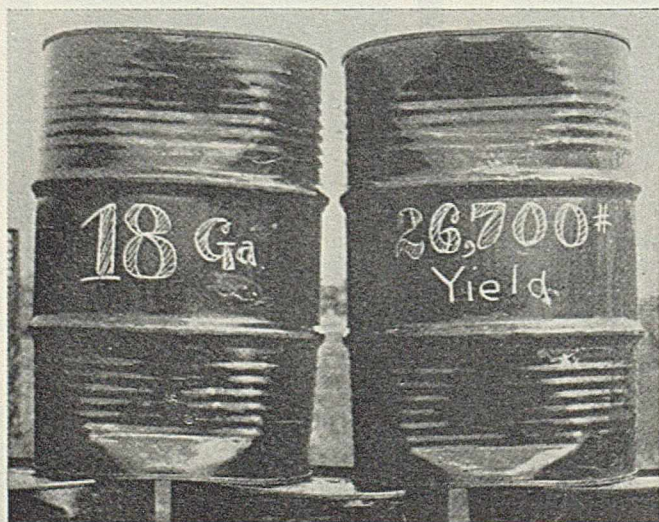
In addition, the caption of the illustration may prove misleading in that the official drop tests consist of dropping water-filled drums from a prescribed height on to solid concrete so as to strike diagonally on their chimes. A test of this type is illustrated in the upper right-hand corner of page 407. "Sidewall Stability Tests" would perhaps have been a more accurate caption.

M. F. CRASS, JR.

Assistant Secretary
Manufacturing Chemists' Association
Washington, D. C.

In the illustrations below it can be seen that the high yield point of the steel in the thin-wall drum makes that type of drum as satisfactory as the older type with 18-gage sidewalls.—Editor.

Appearance of drums after being subjected to identical treatment in the sidewall stability tests to which Mr. Crass refers



1920 **Butanol** 1940

*The First Lacquer Solvent
Is Still First Today!*

SOLVENTS

You Have Wished For A
FUSEL OIL Substitute
Here It Is:
BUTANOL
ACETONE, U. S. P.

Commercial Solvents Corporation

Eastern Sales and Export:
17 East 42nd St., New York

General Office and Plant:
Terre Haute, Indiana

Cable Address "Consolvent" New York.

See Our Exhibit at the Seventh National Exposition of Chemical Industries

A reproduction of the first advertisement for Commercial Solvents' Butanol published in plain black and white, in Chemical Age for August 1921.

IN 1920 Butanol came into commercial production, making possible for the first time the manufacture of quick-drying lacquer finishes, and thus revolutionizing the automobile industry, the furniture industry and many others. In the twenty years intervening, many good solvents have entered the market, yet — today as twenty

years ago — Butanol, the first of the lacquer solvents, still holds first place. Unvarying in quality, its price greatly reduced, the uses of Butanol have steadily increased until today it serves with new and varied usefulness not only in the protective coating industry but in many other industries as well.

COMMERCIAL SOLVENTS
Corporation

17 EAST 42ND STREET
NEW YORK, N. Y.

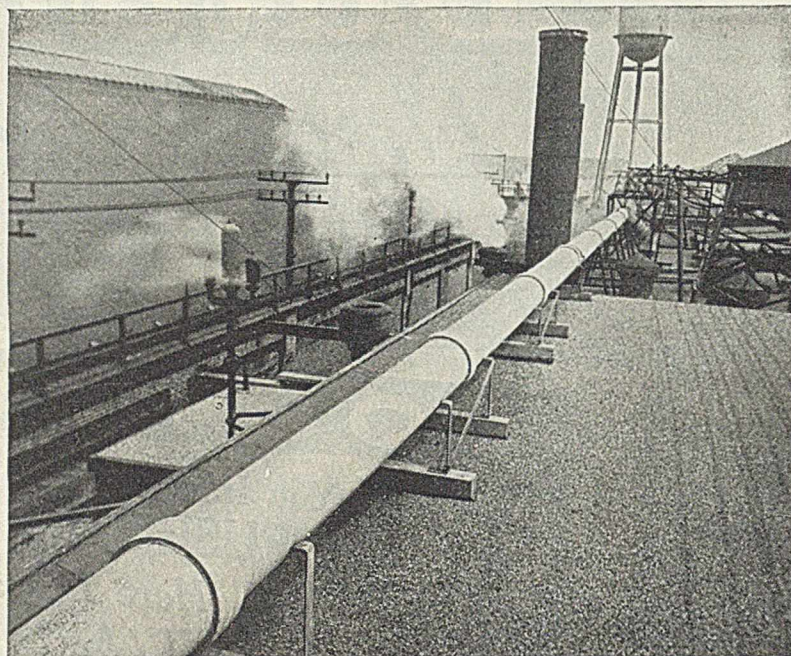
Vent-pipe replacements costing too much?

**WHY NOT
TRY
TRANSITE?**

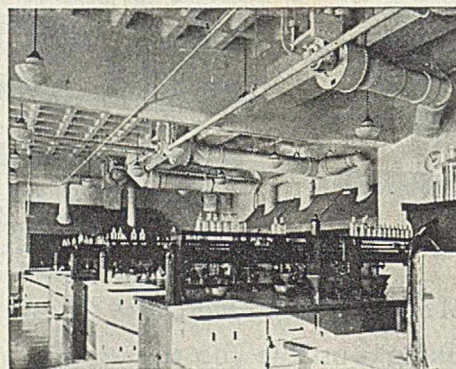
Proved in a wide variety of industrial services, J-M Transite "S" Pipe brings all the advantages of asbestos-cement construction to industrial venting systems

TIME AND AGAIN, plant operators have made sizable reductions in venting costs by using J-M Transite "S" Pipe. Custom-made for industrial service, this asbestos-cement material is uniformly strong and durable and has proved highly successful in service against a wide variety of fumes, gases, vapors and dust.

But that's not the whole story. Transite "S" Pipe is supplied in long, 13-foot lengths with a complete line of fittings. It can be easily cut and sawed. Installations are completed in the shortest possible time . . . even in restricted working quarters. For details on this money-saving vent pipe, write for brochure D. S.-336. Johns-Manville, 22 East 40th Street, New York, N. Y.

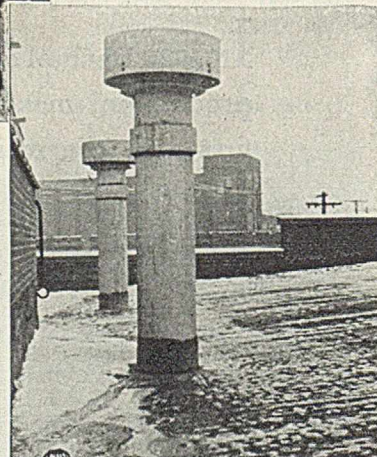


WEATHER OUTSIDE, chlorine fumes inside have had little effect on this installation of Transite "S" Pipe in a leading industrial plant. Made of asbestos and cement, this modern vent pipe is custom-built for the venting of industrial fumes, gases, vapors, dust. Its uniform strength and durability have helped many plants keep venting costs at a minimum.



LABORATORY FUMES are handled economically in this Transite "S" Pipe system. Even on complicated jobs like this, Transite "S" Pipe is quickly, easily installed, for it comes in a size for every need . . . and with a complete line of fittings.

ASBESTOS-CEMENT in composition, J-M Transite "S" Pipe provides advantages that make it an economical material for stacks. It offers unusual resistance to weather . . . provides low heat conductivity that keeps stack temperatures high for long distances. As a result, draft is improved and condensation minimized.



Johns-Manville TRANSITE "S" PIPE

FOR EFFICIENT, LOW-COST VENTING SYSTEMS

New Titles, Editions and Authors

PREPARING FOR PREPAREDNESS

CHEMISTRY IN WARFARE: ITS STRATEGIC IMPORTANCE. By *F. A. Hessel, M. S. Hessel, and Wellford Martin.* With foreword by *Crosby Field.* Published by Hastings House, N. Y. 164 pages. Price \$2.

Reviewed by *S. D. Kirkpatrick*

THIS is a chemical war, but in a different sense than the layman has been led to believe. Poison gases, toxic smokes and high-pressure flames have so far proved less important than aerial bombing and the coordinated advance of mechanized troops. Quite likely, therefore, the chief contribution to be made by chemical industry to the national defense will be in the production of goods not differing greatly from peace-time materials. These authors have clearly recognized this for their approach, as Colonel Field has remarked, is via "the important role played by chemistry in feeding, clothing, sheltering and protecting the soldier, transporting him by land, sea and air, arming him with both offensive and defensive weapons, feeding his weapons with propellants, high explosives, shrapnel and gases—describing briefly the chemical processes and chemical products required in these various functions with the approximate quantities used."

Furthermore, the authors have succeeded in making their little book as interesting to the layman as to the technologist. Mrs. Hessel, whom we suspect had a major role in that process, has become adept at taking the mystery out of chemistry. Her husband has drawn on his broad background of economic knowledge and industrial experience. Captain Martin knows his military tactics as well as the technique of explosive manufacture.

Reference in this book to happenings in Europe as late as April and May, 1940, show how up to date is its content. But its appearance this month is even more timely, because American chemical industries are just now beginning to attack in earnest the problems of the national defense. Chemists, engineers and executives will find this book of engaging interest and considerable value in preparing for the months ahead.

COAL—ITS PROPERTIES, ANALYSIS, CLASSIFICATION, GEOLOGY, EXTRACTION, USES AND DISTRIBUTION. Second Edition. By *Elwood S. Moore.* Published by John Wiley & Sons, Inc., New York, N. Y. 473 pages. Price \$6.

Reviewed by *R. S. McBride*

THE FIRST EDITION of this volume was prepared "in an attempt to satisfy the demand for a handy volume on coal." The second edition now avail-

able appears to continue the same effort. And this effort is well served for those who require a small reference book bringing together a considerable amount of unrelated information. The selection is good and the scope of the book very wide.

The chemical engineer will, however, be much disappointed in the volume if he expects from it very much on either the scientific or engineering aspects of coal properties and coal processing. There is considerable detail on coal analysis, principally reprinting standard methods, and quite a discussion of coal classification. The section on making of coal products is very brief indeed. For example the section on coking takes only approximately 10 pages and includes practically no reference to plant methods or machinery of modern types.

NEW DICTIONARY

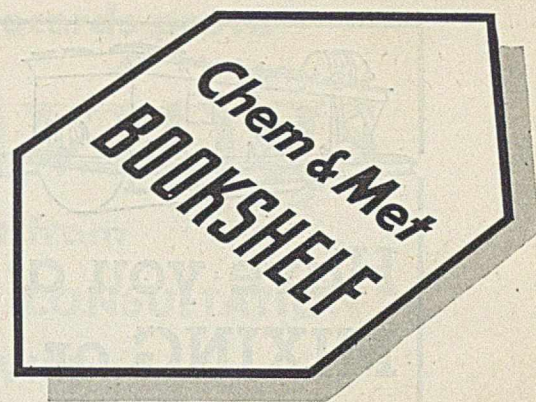
THE DICTIONARY OF PAPER. Published under the auspices and direction of the American Paper and Pulp Association, New York, N. Y. 365 pages. Price \$5.

IT is important to note that this book was "written so that it could be used by a non-technical person, unacquainted with the paper industry and its particular problems." Thus the book will be of maximum value to all who may consult it.

After a chapter on classification and definitions of pulps and one on classification of waste materials, the book is devoted to definitions of the many terms used in the various branches of the paper industry. The formula followed for most definitions of papers is: important uses, significant manufacturing history and important properties. Other definitions are clear and as brief as accuracy will permit; there are many cross references. The book concludes with a bibliography of references.

ELEMENTARY QUANTITATIVE ANALYSIS. Third edition. By *H. H. Willard and N. H. Furman.* Published by D. Van Nostrand Co., New York, N. Y. 531 pages. Price \$3.25.

IN the five years since the second edition of this "quant" text appeared, it was reprinted no less than six times. Considering the variety and number of books on the particular subject, perhaps such consistent underestimation is understandable. However, we venture to guess that unless the original printing of this third edition was considerably larger than that of the second, the publishers again will be forced to reprint. Drs. Willard and Furman have done no slipshod job; the book was taken back to manuscript form and many changes have



been made in the arrangement of chapters. While the subject matter remains substantially the same, the new arrangements should result in better understanding and more accurate laboratory work on the part of students. Most important of the new material are chapters on scientific measurement (accuracy, precision, errors, etc.) and on colorimetry.

MINES REGISTER. Volume XX. Published by Atlas Publishing Co., New York, N. Y. 942 pages. Price \$25.

LONG familiar as the Mines Handbook, this successor brings up-to-date the information contained in the edition of 1937. It contains descriptions of active mining companies and lists of inactive or dormant mines. Other sections give statistics of production, imports, price trends, etc.; lists of mining engineers, managers, superintendents and purchasing agents; lists of metal mining securities; and lists of manufacturers and distributors of machinery, equipment and supplies.

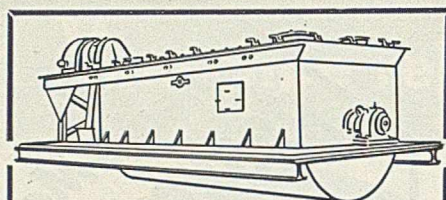
All changes in mining methods, costs and earnings, company personnel and other information in the book have been checked in an attempt to present the latest authentic information.

UNIT OPERATIONS

UNIT OPERATIONS LABORATORY EQUIPMENT. By *O. T. Zimmerman and Irvin Lavine.* Second Edition. Published by the authors, University of North Dakota, Grand Forks, N. D. Approximately 250 pages. Price \$1.50.

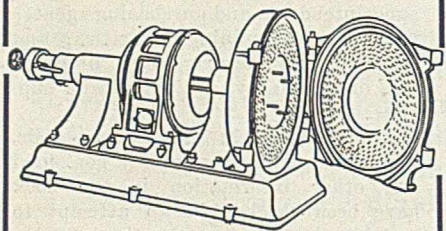
ADMIRABLY adapted for chemical engineering instruction, this paper-bound mimeographed laboratory manual consists of 19 sections or chapters dealing with the principal unit operations—flow of fluids, flow of heat, evaporation, drying, distillation, gas absorption, etc. In addition, it includes a 92-page section on cost estimating of chemical engineering equipment. The two concluding sections are concerned with shop equipment for a chemical engineering laboratory and the prices of materials and equipment involved.

The section on cost was made pos-



Have you a MIXING or BLENDING Problem?

● For MIXING—the uniform particle distribution of two or more materials into a mass, without the individual particles losing their identity—we offer vertical, horizontal, continuous and conveying mixers in a wide variety of designs and sizes. For BLENDING—the co-mingling of particles so intimately that separate ingredients have lost their original identity—you should have a mixer with spatulating paddles, or a disc blender with inter-meshing cone projections for vigorous rubbing action. As designers and manufacturers of all these types of equipment, we are familiar with the abilities and limitations of each, and are qualified to recommend for any mixing requirement.



● If your production requires mixing or blending of chemicals, foodstuffs, soap, salts, cement, fertilizers, explosives, meat scraps, pulp or any other material, we think we can show you a way to do it better, faster, cheaper. Our recommendation involves no fee or obligation, of course. A letter puts it up to us. SPROUT, WALDRON & CO., INC., 143 Sherman St., Muncy, Pa.

**SPROUT,
WALDRON
& CO., INC. - MUNCY, PA.**
MANUFACTURING ENGINEERS
Since 1866

sible through the cooperation of representatives of several of the most important manufacturers and, to the best of this reviewer's knowledge, is the most comprehensive attempt which has yet been made to bring together cost data in the process equipment field. It is still sketchy and of limited application, but constitutes an important start in the accumulation of worthwhile information.

The authors are also to be complimented on the abundance of excellent drawings used.

AN OUTLINE OF METALLURGICAL PRACTICE. Second edition. By *C. R. Hayward*. Published by D. Van Nostrand Co., New York, N. Y. 690 pages. Price \$7.50.

PRESERVING the essential form of his first edition, Prof. Hayward has added chapters on beryllium and zirconium. There are now 25 chapters in the Outline and, with the exception of one on non-ferrous alloys, each is devoted to one particular metal. With minor variations necessitated by the amount of information available, each chapter covers the occurrence and sources, extraction, and properties of the metal under consideration. In many cases references are given for supplementary reading.

Industrial importance of the various metals is reflected in the number of pages given to each. Copper (with the greatest number) and iron together account for almost 40 per cent of the total. Addition of the pages on lead, gold and zinc raises this percentage to more than 60.

It is stated that the volume is intended to fill two demands: to meet the desire of many engineers for a quick reference book of modern practice, and to assist students who are starting metallurgical studies. The nature of the material and the form of its presentation are both well suited to fulfill these two requirements.

After a rather careful examination only one typographical error was found. It is hoped that there are none more serious than that on page 353 where this magazine is referred to as: "Chem. Wet. Eng."

THE MERCK INDEX. Fifth Edition. Published by Merck and Co., Rahway, N. J. 1060 pages. Price \$3.

NO introduction to this reference work is necessary for most chemists, pharmacists, physicians and others concerned with the production or use of drugs and chemicals. In addition to descriptions, formulas, constants and other information on more than 5,900 drugs and chemicals, this edition has a new section containing more than 4,500 tests, reactions and reagents. Another new section gives formulas for preparation of staining solutions, culture media and fixatives. There are also sections on minerals, on indicators and on coal tar colors for use in foods, drugs and cosmetics. Nearly double the size of its predecessor, this new edition will surely prove twice as useful.

CHEMICAL PUBLICATIONS. Second edition. By *M. G. Mellon*. Published by McGraw-Hill Publishing Co., New York, N. Y. 284 pages. Price \$2.75.

TEXTBOOK for an undergraduate course in chemical literature, this revision follows the form of the previous edition. It contains a chapter of general introductory material, four chapters on original sources, four on secondary sources, one on searches and one of problems for students. More than one quarter of the book's pages are devoted to this last chapter indicating the importance of making actual searches in order that the student familiarize himself with the literature.

The revision consists mainly of addition of new publications, omission of a few that were unimportant or out of date, and some changes in descriptive material. The process of elimination might have been carried somewhat further to omit references which are no longer published and which are out of print.

ELECTRONIC PROCESSES IN IONIC CRYSTALS. By *N. F. Mott* and *R. W. Gurney*. Published by Oxford University Press, New York, N. Y., Vol. 18 of the International Series of Monographs in Physics. 275 pages. Price \$5.50.

Reviewed by *C. F. Nachod*
and *R. Simha*

BASED on the fact that "the optical and electrical behavior of electrons in ionic crystals are intimately related," the authors have undertaken a comprehensive description of all phenomena connected with this topic.

The first chapter deals with perfect ionic lattices and contains mainly a review of Born's work. Lattice defects of the Frenkel and Schottky type, and diffusion and electrolytic conductivity in polar crystals are treated in the following chapter. Chapter three briefly discusses the quantum-mechanical theory of electrons in periodic fields and the absorption spectra of light of non-metallic substances. Crystals with non-stoichiometric composition (excess metal) and the coloring effects associated with it are the subject matter of chapter four. Two possibilities to explain the inclusions of excess metal in the polar crystals are put forward: first, the atom occupies the place of a positive ion adjacent to that from which a negative ion is missing; second, there exists an excess of vacant lattice points from which negative ions have been removed over the number of vacant places belonging to positive ions. The excess charge is neutralized by electrons. These singularities are called "F-centres" and are believed to be identical with Pohl's "Farzentren." The absorption bands causing the coloration are assumed to be due to the second possibility. Phenomena connected with F-centres, such as photoconductivity in insulating crystals are thoroughly discussed for the halides of the alkali metals and for those of silver and thallium.

The rest of the book contains chap-

Operating records prove
big savings

result from

**GULF PERIODIC CONSULTATION
 SERVICE**



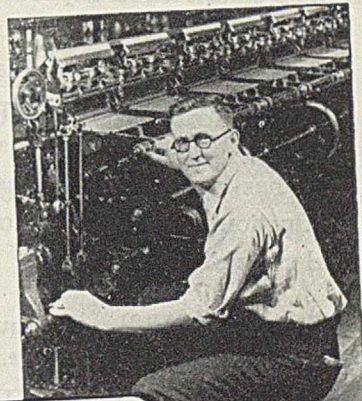
COAL MINE

"It pays us to use Gulf's higher quality lubricants for all the equipment in our mine," says this mine manager. "Proper lubrication procedure, as recommended by the Gulf engineer, has helped us make low production cost records."



TEXTILE MILL

"The Gulf engineer has shown us how we can eliminate oil stains and get better performance from our equipment," says this mill superintendent. "We've paid nothing extra for this service, and find it is a real economy to use Gulf quality oils."



METAL WORKING PLANT

"There has been a definite improvement in the operation of our equipment since we adopted the Gulf engineer's recommendations," says this plant engineer. "We are getting better work and smoother operation with Gulf's higher quality lubricants."



DIESEL POWER PLANT

"We've cut our maintenance costs at least 60% since we adopted the Gulf engineer's recommendations, and began using Gulf Diesel Oil in our six big Diesels," says this plant superintendent. "Better lubrication helps us keep cleaner engines and avoid trouble."



Gulf quality oils and greases are quickly available to you through more than 1100 Gulf warehouses located in principal distributing points from Maine to New Mexico. Write today for your free copy of the booklet "GULF PERIODIC CONSULTATION SERVICE."

Gulf Oil Corporation - Gulf Refining Company
 3813 Gulf Building, Pittsburgh, Pa. C.&M.E.
 Please send me my copy—no charge—of the booklet "GULF PERIODIC CONSULTATION SERVICE."

Name.....
 Address.....
 Company.....

IT'S NOT THE HEAT ...IT'S THE... HUMIDITY!

We've heard that expression used many times in a joking manner, but it's no joke to many manufacturer's when the humidity rises. In some processes, work has to stop, and in others, production is sharply effected and costs rise accordingly.

HUMIDITY CONTROL, with equipment using **SILICA GEL***—a powerful and effective adsorbent material, is being used in an ever increasing list of industrial processes, such as:—

TELEPHONE CABLES must be stored in *dry air* before lead sheathing is applied to increase

dielectric strength of insulation, thereby decreasing "cross-talk".

DRUGS AND PHARMACEUTICALS of many kinds must be packed in moisture-free air, otherwise, materials get sticky and automatic machinery won't work.

HARD CANDY must be mixed and packed in moisture-free air. If humidity is not controlled, the candy sticks together and has a very poor appearance.

SAFETY GLASS must be laminated in rooms with the relative humidity kept below 20% at 60°.

New and unexpected uses are being discovered all the time for this unique adsorbent agent, **SILICA GEL**. For information as to how you can use **SILICA GEL** to best advantage, write **The Davison Chemical Corp., Silica Gel Dept., 20 Hopkins Pl., Baltimore, Maryland.**



***SILICA GEL** which has millions of ultra-microscopic pores, removes moisture by a combination of surface adsorption and capillary attraction. It is reliably estimated that the interior pore surface of one cubic inch of Silica Gel is in excess of 50,000 square feet.

ters on semi-conductors and insulators, on luminescence and the dissipation of energy, on photochemical processes in silver halides and the photographic latent image, and on processes involving the transport of both ions and electrons. Each of these last four chapters contains an appendix on recent developments, thus bringing the book up-to-date.

Of special technical interest are discussions on the mechanism of formation of contact currents between metal and insulator, the rectifying action of a contact between metal and a semi-conductor and dielectric breakdown. The conditions for occurrence of luminescence are investigated in connection with the role of impurities in phosphorus. The authors' theory of the photolytic process is also given. The attack of a solid metal by an electronegative substance and the reverse process, i. e. the decomposition of an ionic crystal, conclude chapter eight. Concluding the text is a table of the conventional ionic radii giving the values of Pauling and Goldschmidt.

Some of the work reported can be found in handbooks and texts, but the greater part is entirely new. The authors must be congratulated for such a fine and comprehensive text.

VOLUMETRIC AND PHASE BEHAVIOR OF HYDROCARBONS. By *Bruce H. Sage* and *William N. Lacy*. Published by Stanford University, Palo Alto, Calif. 294 pages. Price \$5.

Reviewed by *R. W. Millar*
EXPERIMENTAL work carried out by the authors and their students under the auspices of the American Petroleum Institute through its Research Project 37 has provided the petroleum and natural gas industries with a large body of valuable data on hydrocarbons and their mixtures. These data have been of use in the planning and execution of research in the laboratories of the industry, in the design of fractionating columns and in the solution of some of the problems connected with the production of petroleum and natural gasoline recovery.

"It is the purpose of this volume to set out for consideration the fundamental principles and some of the facts relating to that type of hydrocarbon behavior which does not involve chemical reactions or changes in the molecular species present. The treatment is also limited to cases characterized by the absence of solid phases. The portion of the subject thus chosen for discussion finds application in the processes of petroleum and natural gas production and transportation, of natural gasoline manufacture and of certain parts of petroleum refining."

Two introductory chapters describe the materials to be considered, define the terms used and discuss the mathematics which are useful in treating the experimental data. This introduction is followed by chapters on the behavior of pure substances, two-component systems, three-component systems, multi-component systems, the

THE DAVISON CHEMICAL CORP.

phase rule, partial quantities, ideal solutions and an appendix on retrograde phenomena.

While most of the fundamental principles discussed are presented either in treatises on physics and physical chemistry or in the journal literature, their inclusion in one place makes the book a valuable one to those interested in the phase equilibria of hydrocarbon systems. Each type of behavior is illustrated by a diagram based, when possible, on data for some pure substance or mixture, and when data are not available, as for the equilibrium compositions of liquid and vapor in ternary systems, by qualitative diagrams. The authors are to be commended for setting down on each diagram all the information as to variables and units required to make it intelligible. The three-dimensional diagrams are exceptionally well drawn, and are valuable in showing the way in which the two-dimensional projection changes as its plane is shifted up and down the third axis.

Mathematical treatment is by means of perfectly general equations which can usually be applied only by graphical means. The book is not cluttered with empirical equations and discussions of their limitations, nor as is too often the case, without such discussions. Empirical equations are, however, suggested for use in connection with the calculation and plotting of residual quantities, the advantages of which are properly emphasized.

Special attention is paid to the critical region of pure hydrocarbons and their mixtures, and the definition and description of retrograde phenomena are clear and enlightening to those who are not familiar with it. The chapter on ideal solutions is largely introductory to the problem of predicting the distribution of one component between liquid and gas in a multi-component system under high pressure.

The book is of value to the petroleum technologist in that it shows what types of relations between the variables volume, pressure, temperature, and composition he can expect; how he can best represent data graphically; and how he can treat measured quantities mathematically in order to obtain the derived quantities which are sometimes more useful than the original data.

The book is well printed and bound, and free from errors. The authors are to be congratulated on a well written, logical, useful book.

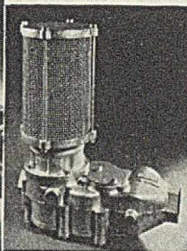
ALCOHOLIC BEVERAGE AND INDUSTRIAL ALCOHOL REGULATIONS. A series of documents from the Bureau of Internal Revenue, Treasury Department, Washington, D. C. Each item is, or will be, available separately, from the Superintendent of Documents, Washington, D. C., at the prices indicated.

THE TREASURY DEPARTMENT is engaged in an extensive revision of the Internal Revenue regulations which relate to alcoholic beverages. The vari-

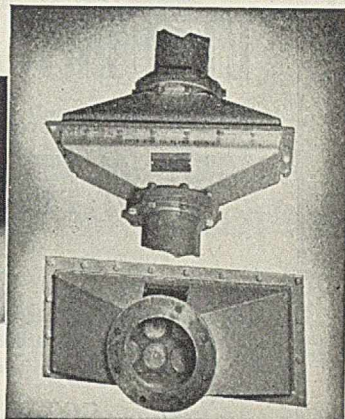
Here's a Job for SPECIALISTS



Type B. F. P. (Outdoor Arrestor)



Type Q. S. H.
(Indoor Arrestor)



Type N. A. (Indoor Arrestor)

Stop us if you *haven't* heard this one, the time-honored cliché for danger . . . "playing with fire". But, do you take it to heart?

Kemp engineers have been playing with fire *literally* since the eighties, have won international recognition as experts in combustion. And distilled from over a half century of day-in-day-out experience are the advanced principles embodied in **Kemp Flash Arrestors**. Of the many types available, the three illustrated have proved of especial interest to the chemical industry.

For detailed information on these and other Flash Arrestors, and for engineering assistance on combustion problems in general, you are most cordially invited to write **The**

C. M. Kemp Manufacturing Company,
405 East Oliver Street, Baltimore, Md.

and for **DRYING . . .**

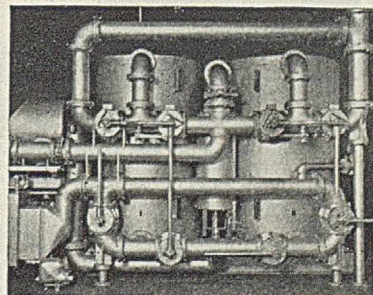
KEMP ADSORPTIVE DRYERS

with *Silica Gel*



Desiccation of gases, liquids or solids to the commercial absolute, —76°C. with single or twin towers for intermittent or continuous operation at capacities from 10 to 100,000 c.f.m., and pressures from atmospheric to 2,500 lbs. (more if desired).

Silica Gel which is composed of a myriad of ultra-microscopic pores, having an estimated 50,000 square feet of pore surface in a cubic inch, is activated in Kemp Dryers by gas, electricity or steam. Write for Bulletin.



KEMP of BALTIMORE

COTTRELL PROCESS OF ELECTRICAL PRECIPITATION

universally recognized as a
standard method of removing
DUST, FLY ASH, FUME, MIST & FOG
from GASES

28 years of research development and operating experi-
ence by the affiliated Cottrell Companies throughout
the world is incorporated in the

COTTRELL INSTALLATIONS

offered to meet the requirements of any problem by

RESEARCH CORPORATION

405 LEXINGTON AVENUE
NEW YORK CITY

59 EAST VAN BUREN STREET
CHICAGO, ILL.

associated with

WESTERN PRECIPITATION CORP.

1016 W. 9th St., Los Angeles

ous Treasury regulations are numbered and titled as indicated below. The parenthesis after some of the numbers indicates the price of recent pamphlets, or the date of recent issues of Federal Register that give this material in printed form. Generally speaking, the Federal Register makes the official promulgation and as soon as practical after the issue of rulings, a pamphlet is then prepared to give the regulations in more convenient form. The industrial alcohol regulations (No. 3) are well known to chemical engineers. A new edition of these will be prepared. That is a big job, of course, and apparently is to be postponed so that the other sets of regulations will not be delayed.

3-Industrial Alcohol. 4-Production of distilled spirits (20¢). 5-Production of brandy (20¢). 6-Bottling of distilled spirits in bond. 10-Warehousing of distilled spirits (May 25, 1940). 11-Bottling of tax-paid distilled spirits (May 18, 1940). 13-Traffic in containers for distilled spirits (5¢). 15-Rectification of spirits and wines (May 28, 1940). 16-Denaturation of rum (10¢). 18-Fermented malt liquors (May 18, 1940). 19-Production of vinegar by the vaporizing process. 20-Wholesale and retail dealers in alcoholic liquors. 21-Relating to importers of distilled spirits. 23-Still and distilling apparatus (5¢). 24-Importation of liquor and articles from Puerto Rico, Philippine Islands, Virgin Islands, etc. 28-Drawback on distilled spirits and wine.

RECENT BOOKS and PAMPHLETS

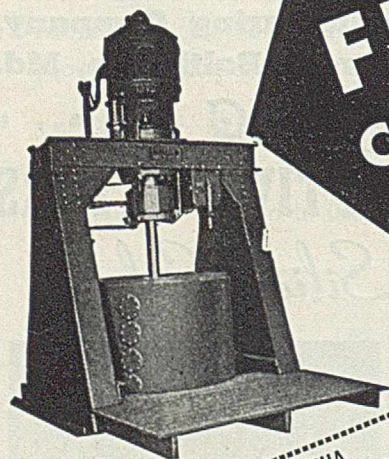
Government Procedure. Senate Document No. 186 in 13 parts describing the administrative procedure in various government agencies has just been announced for sale by the Government Printing Office at \$1.25 per set of paper pamphlets. This is a series of monographs giving the results of investigations made by the Attorney General's Committee on Administrative Procedure, dealing in turn with the following agencies: 1—Division of Public Contracts, Department of Labor, The Walsh-Healey Act; 2—Veterans' Administration; 3—Federal Communications Commission; 4—United States Maritime Commission; 5—Federal Alcohol Administration; 6—Federal Trade Commission; 7—Administration of the Grain Standards Act, Department of Agriculture; 8—Railroad Retirement Board; 9—Federal Reserve System; 10—Department of Commerce, Bureau of Marine Inspection and Navigation; 11—Administration of the Packers and Stockyards Act, Department of Agriculture; 12—Post Office Department; 13—Federal Control of Banking, Comptroller of the Currency, and Federal Deposit Insurance Corporation.

Individual pamphlets are priced at 10 cents with the exception of item 7 which is 5 cents.

Fire—Its Cause, Prevention and Control. By Harold Joe Davis, Tulsa, Okla. Price 25 cents. A 10-page booklet giving classifications of fires and cause, prevention and methods of extinguishment. According to the author, a fire costing an average of \$944.80 occurs every minute and between eight and ten thousand people die yearly by fire. Much of this property damage and loss of life could be prevented "Once we realize the chemical reaction necessary before a fire can exist."

Conference on Metallurgical Research. Published by the Bureau of Mines, Metallurgical Division, Salt Lake City,

**HIGH
SPEED**



FLETCHER CENTRIFUGALS

Fletcher owners take care of increased demands without proportionate increase in centrifugal investment . . . Exceptionally high basket speeds of Fletcher Centrifugals give thorough drying or separating in less time, step up production—and profit—without increase in overhead!

How this is done safely is a story pertinent to current problems—told in brochures that fully describe exclusive Fletcher features. All data sent without obligation; use the coupon now!

FLETCHER WORKS • PHILADELPHIA
I want to know more about "Extra Profits from High-Speed Centrifugals"; send the data to

Name.....
Company.....
Address.....

Title.....

Mail Coupon to **FLETCHER WORKS**
GLENWOOD AVE. & SECOND ST.
PHILADELPHIA, PA.

"Tested Readership" Means Greatest Advertising Value

TESTED READERSHIP, as an attribute of each and every McGraw-Hill Publication, gives the advertiser who buys space in any of these papers, another logical evaluation factor in addition to the A.B.C. and N.I.A.A. statements. It gives you extra assurance that here are media with a vitally interested body of readers whose needs and interests the editors know and serve specifically.

It means, too, that if the advertiser will follow the editor, and produce informative sales messages tied-in to the same needs and problems of the reader, the advertising will be more widely read, and will be effective in carrying a substantially larger share of the sales burden.



Chemical & Metallurgical Engineering

How is industry today making use of X-Rays?



Just Out!

New 3rd Edition

APPLIED X-RAYS

By GEORGE L. CLARK, Professor of Chemistry,
University of Illinois. 674 pages, 6 x 9,
342 illustrations\$6.00

WHAT X-rays are, how they may be used, what results they produce, why they can be applied to practical problems in industry, are the practical questions which receive complete and up-to-date answers in this latest edition of a standard work.

Noteworthy are the chapters on the measurement of intensity; the measurement of quality; photochemistry; a complete survey of the biological effects of x-radiation; the structures of minerals, soils, clays, ceramics and cements; and on polymers, natural and synthetic materials (such as plastics, Nylon, polyvinyl derivatives, etc.) with giant molecules.

We urge you to send for a copy of this authoritative work,—to examine without obligation or to add to your library. Just fill in and mail the coupon below.

McGRAW-HILL BOOK CO., INC., 330 W. 42nd St., N. Y. C.
Send me Clark—Applied X-rays for 10 days' examination on approval. In 10 days I will send \$6.00, plus few cents postage, or return book postpaid. (We pay postage on orders accompanied by remittance.)

Name

Address City and State

Position Company M. 8-40
(Books sent on approval in U. S. and Canada only.)



A Few Ounces of This Protection Against Industrial Dermatitis

—is better than hundreds of dollars spent in cure! Leading industries all over the nation depend upon the simple, inexpensive use of Stover Protective Cream to protect their employees (and themselves) against the hazards of working in—

- | | |
|-------------------|---------------------|
| Chemicals | Lime and Cement |
| Coal Distillation | Oil Refining |
| Explosives | Paint Manufacturing |
| Fertilizers | Paper and Pulp |

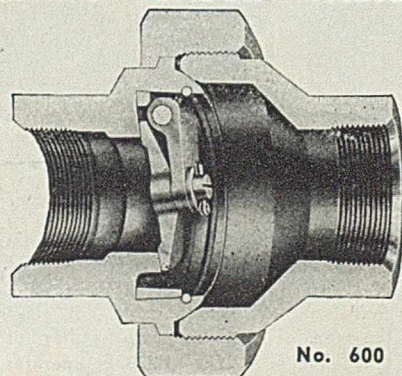
—and scores of other occupations that are hazardous to the skin. The cost is less than one cigarette per man per day! But don't take our word... nor the word of satisfied users.

Send for Free Test Supply

Just write. Ask us to send a liberal test supply. See how Stover Protective Cream prevents irritating and poisonous solids, liquids and fumes from reaching the skin. Then you decide!

H. W. STOVER COMPANY
1013 Madison St. Oakland, Calif.

CATAWISSA SWING CHECK VALVES

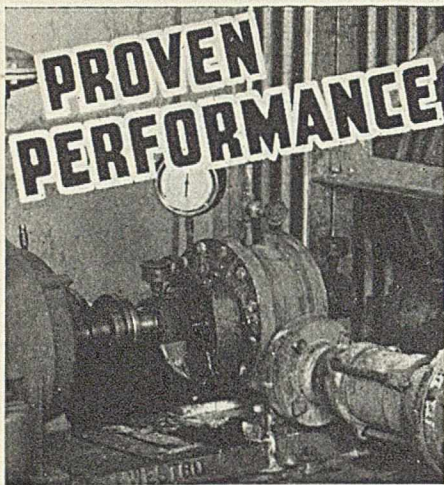


Will Outlast Your Boilers

This new valve is practically indestructible. Every part made of steel. Both ends and nut made of forged steel. The seat in the male end is an integral part of the body formed from the solid steel. All inside working parts are made from stainless steel. Designed to give a greater unobstructed flow—opening the Union Nut opens the line, eliminating additional union and nipple. Made in 2" size only.

Will replace any 350-lb. check valve, union and nipple in your boiler feed line—at less cost—will "outlast your boiler." Write for details and prices.

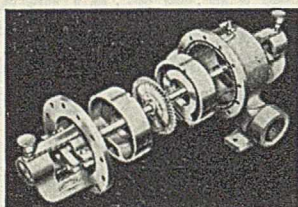
THE CENTRAL FORGING CO.
CATAWISSA, PENNA.



Westco PUMPS

Where the going is tough . . . and the operating requirements out of the ordinary . . . there is where you will find Westco Turbine - Type Pumps! Thousands of units already installed in the chemical and metallurgical field prove this point with dependable, trouble-free service. Pump sizes to 420 G.P.M. Write for complete details today.

225°
to
230°
FAHREN-
HEIT



And only Westco Pumps have patented, renewable liners which protect pump casing against wear.

The Westco Turbine-Type Pump shown above is located in a large West Coast plant (name upon request), replaced a centrifugal unit which could not meet the specifications. This pump handles hot Ethanolamine at 225° to 230°F., operates against a total head of 70 pounds. Capacity 9,600 G.P.H. A 5 to 6 pound pressure on the suction side plus a 6 foot liquid head, puts a total positive head of approximately 16 feet on suction. Specific gravity hot Ethanolamine 1.00.

MICRO-WESTCO, INC.,
51008 State St., Bettendorf, Iowa

Name
Address
City State

MICRO-WESTCO, INC.

Utah. 156 pages. Not a regular Bureau publication, this mimeographed report consists of papers presented at a conference on metallurgical research by the staff of the Metallurgical Division of the Bureau of Mines held last May. The fourteen papers cover various aspects of ore testing and microscopy, magnesium, manganese, titanium, flotation, antimony recovery and several other metallurgical processes and problems.

Annual Survey of American Rubber Chemistry for 1937. By Webster N. Jones. Published by Carnegie Institute of Technology, Pittsburgh, Pa. 63 pages. Price 75 cents. A brief survey of the rubber industry and of the developments and progress which occurred during 1937.

Sulphur, An Essential to Industry and Agriculture. Published by the Texas Gulf Sulphur Co. 45 pages. Gratis. Prepared for teachers, students and specialists, this well written booklet treatise is the first English text on the element which plays so important a part in chemical industry.

Transactions of the Institution of Chemical Engineers. Volume 17, 1939. 201 pages. An annual publication, in which some of the more important papers are: Floors for Industrial Purposes, Administrative Training for the Chemical Engineer, The Transference of Chemical Processes from Small-to-Large-Scale Operation, Some Aspects of Fundamental Research on the Corrosion of Metals.

A Study of Methods for Producing Chromate Salts from Domestic Ores, by H. A. Doerner and others. Bulletin V, issued jointly by U. S. Bureau of Mines

and State College of Washington. 51 pages. Price 35 cents. The Bureau of Mines is cooperating with the State College of Washington in the State Metallurgical Research Laboratory to make studies and investigations looking to the establishment of new metallurgical industries in the Northwestern States and thus provide a useful outlet for the power generated at Bonneville and Grand Coulee. A summary of this work is given in Bulletin V and is available from State College of Washington, Pullman, Washington.

Geology and Metalliferous Deposits of Kootenai County, Idaho. By Alfred L. Anderson. Published by University of Idaho, Moscow, Idaho. Pamphlet No. 53. Price 50 cents. A complete study of the geography, geology, ore deposits and properties in one county of the state of Idaho. Numerous sketch maps accompany the text.

Tests on the Liquefaction of Canadian Coals by Hydrogenation. By T. E. Warren and K. W. Bowles. Published by Mines Branch, Dept. of Mines, Canada. Report 798. 106 pages. Price 25 cents. Results of hydrogenation tests on a series of coals of varying rank and mostly of Canadian origin.

Collected Papers from the Faculty of Science. Series C, Chemistry, Vol. VI. Osaka Imperial University, Osaka. The booklet contains 35 papers, six of which are written in English and the remaining 29 in German. Most of them have already been published in the Bulletin of the Chemical Society of Japan. The majority are physico-chemical papers dealing with isotopic exchange reactions, but there are also some physical, colloidal-chemical and some organic papers in the collection.

GOVERNMENT PUBLICATIONS

Documents are available at prices indicated from Superintendent of Documents, Government Printing Office, Washington, D. C. Send cash or money order; stamps and personal checks not accepted. When no price is indicated, pamphlet is free and should be ordered from bureau responsible for its issue.

Synthetic Rubbers: A Review of Their Compositions, Properties, and Uses, by Lawrence A. Wood. National Bureau of Standards, Circular 427; 10 cents.

Sanitary Cast-Iron Enameled Ware. National Bureau of Standards, Commercial Standard CS77-40; 5 cents.

Lumber, American Lumber Standards for Softwood Lumber. National Bureau of Standards, Simplified Practice Recommendation R16-39; 5 cents.

Animal and Vegetable Fats and Oils, Quarterly for Calendar Years 1935 to 1939. Gives production, consumption, imports, exports and stocks. Bureau of the Census; 5 cents.

National Defense Procurement, July 1940. A guidebook for use in cooperation with the National Defense procurement program, giving the locations of the War and Navy Departments' field procurement offices and a partial list of materials being purchased by these agencies. Prepared by Bureau of Foreign and Domestic Commerce with the collaboration of War and Navy Departments. Available from Bureau of Foreign and Domestic Commerce, Washington, D. C.; processed.

The Shipment of Samples and Advertising Matter Abroad, by Roberta P. Wakefield. A revising supplement to Trade Promotion Series No. 72, issued in 1932. Bureau of Foreign and Domestic Commerce. Available only from Bureau of Foreign and Domestic Commerce; 10 cents.

List of Available Publications of the U. S. Department of Agriculture, as of January 2, 1940. U. S. Department of Agriculture, Miscellaneous Publication No. 60 (Revised 1940); printed.

Workers in Subjects Pertaining to Agriculture in Land-Grant Colleges and Experiment Stations, 1939-40, by Mary A. Agnew. U. S. Department of Agriculture, Miscellaneous Publication No. 378; 20 cents.

The United States Department of Agriculture, Its Structure and Functions, by

A. P. Chew. U. S. Department of Agriculture, Miscellaneous Publication No. 88 (Revised May 1940); 25 cents.

Production of Hops, by G. R. Hoerner and Frank Rabak. U. S. Department of Agriculture, Farmers' Bulletin No. 1842; 10 cents.

Corn and Fiber Charts. The Department of Agriculture is issuing a series of educational charts on corn (Group 10) and fiber (Group 14). Group 10, priced at 15 cents per set of 7 charts, consists of the following illustrations: Corn and corn plants; Structure of corn kernel; Corn production; Pests of corn; Corn harvesting; Seed corn; Corn crop. Group 14, priced at 10 cents per set of 3 charts, consists of the following illustrations: Fiber flax; Fiber plants—1; Fiber plants—2. These charts are not in color.

A Study of Rapid Deterioration of Vegetable Seeds and Methods for Its Prevention, by Victor R. Boswell et al. U. S. Department of Agriculture, Technical Bulletin No. 708; 10 cents.

Factors Influencing the Use of Some Common Insecticide-Dispensing Agents, by Lynn H. Dawsey. U. S. Department of Agriculture, Circular No. 568; 5 cents.

Production and Consumption of Manufactured Dairy Products, by Edmund E. Vial. An elaborate statistical report. U. S. Department of Agriculture, Technical Bulletin No. 722; 15 cents.

Production of Manufactured Dairy Products, 1938, and Miscellaneous Dairy Statistics, 1939. Agricultural Marketing Service, U. S. Department of Agriculture; processed.

Hourly Earnings in the Leather Industry, September 1939. Bureau of Labor Statistics, U. S. Department of Labor, Serial No. R. 1108; printed.

Protecting Eyes in Industry. Addresses presented before Industrial Section, National Society for the Prevention of Blindness at its Annual Conference in New York City, October 27, 1939. U. S. Department of Labor, Division of Labor Standards Bulletin No. 37; 5 cents.

Hearings on Amendments to Patent Laws. Before Committee on Patents, House of Representatives, 76th Congress, 3rd Session. May 9 and 16, 1940; 10 cents.

Digest of Public General Bills with Index, Supplement to No. 9. Briefly summarizes bills introduced September 21, 1939 to April 30, 1940, 76th Congress, 2nd and 3rd Sessions. Library of Congress; 20 cents.

Precautions in Handling Gasoline. War Department. Army Regulations No. 850-20; 5 cents.

Coast Artillery Ammunition. War Department, Technical Manual 4-205; 15 cents.

Chloropicrin as a Prewarning Gas in Ship Fumigation, by G. C. Sherrard. U. S. Public Health Service, Public Health Reprint No. 2124; 5 cents.

Reciprocal Trade — Supplementary Agreement and an Accompanying Protocol between the United States and Cuba. State Department, Executive Agreement Series No. 165; 5 cents.

Federal Specifications. SS-P-391, Plaster; Acoustic. SS-A-118, Acoustical-Units; Prefabricated. 5 cents each.

Metal-Mine Accidents in the United States: 1937, by W. W. Adams and M. E. Kolhos. U. S. Bureau of Mines, Bulletin 428; 10 cents.

Bentonite: Its Properties, Mining, Preparation, and Utilization, by C. W. Davis and H. C. Vacher, revised by John E. Conley. U. S. Bureau of Mines, Technical Paper 609; 15 cents.

Developments in Coal Research and Technology in 1937 and 1938, by Arno C. Fieldner. U. S. Bureau of Mines, Technical Paper 613; 10 cents.

Iron and Steel Scrap. A report of available supplies of iron and steel scrap at the end of March 1940. U. S. Bureau of Mines, Quarterly Iron and Steel Scrap Stock Report No. 5; mimeographed.

Differential Grinding of Alabama Iron Ores for Gravity Concentration, by Will H. Coghill and Philip H. Delano. U. S. Bureau of Mines, Report of Investigations 3523; mimeographed.

Mining of Feldspar and Associated Minerals in the Southern Black Hills of South Dakota, by Joseph R. Guiteras. U. S. Bureau of Mines, Information Circular 7112; mimeographed.

Properties of Suspension Mediums for Float-and-Sink Concentration, by F. D. DeVaney and S. M. Shelton. U. S. Bureau of Mines, Report of Investigations 3469-R; mimeographed. This is a revised edition of Report of Investigations 3469 issued in September, 1939, made because of numerous errors in the original publication.

Some Information on Reduction of Quarry Accidents, by Frank E. Cash and Forrest H. Shuford. U. S. Bureau of Mines, Information Circular 7114; mimeographed.

More Jobs for Minerals, by Paul M. Tyler. U. S. Bureau of Mines, Information Circular 7118; mimeographed.

Concentration of Manganosiderite Ore from Leadville, Colorado, by F. D. DeVaney and S. M. Shelton. U. S. Bureau of Mines, Report of Investigations 3513; mimeographed.

Contributions to the Art of Smelting Lead Products, by Virgil Miller, R. Bainbridge, and R. Ellison. U. S. Bureau of Mines, Report of Investigations 3512; mimeographed.

Composition of Exhaust Gas from Engines in Proper Mechanical Condition—Diesel Engines Underground, by John C. Holtz, et al. U. S. Bureau of Mines, Report of Investigations 3508; mimeographed.

Explosive Properties of Cyclopropane: Prevention of Explosions by Dilution with Inert Gases, by G. W. Jones, R. E. Kennedy, and G. J. Thomas. U. S. Bureau of Mines, Report of Investigations 3511; mimeographed.

Cushioned Blasting. 1. Orienting Studies, by A. R. T. Denués, U. S. Bureau of Mines, Report of Investigations 3510; mimeographed.

World Retail Prices and Taxes on Gasoline, Kerosene, and Motor Lubricating Oils, Vol. 9, No. 2. The Bureau of Mines issues a quarterly inventory of information from U. S. Government foreign service offices and other sources that may not otherwise be made available promptly. U. S. Bureau of Mines; mimeographed.

RYERSON *Certified* STEELS

IN STOCK . . . IMMEDIATE SHIPMENT

Over 40 kinds of alloy steels—both standard S.A.E. analysis, and special heat treated Ryerson alloys—are included in the wide range of Certified Steel products carried in Ryerson stock for Immediate Shipment.

A special quality control plan on alloy steels gives the heat treater exact data on every bar to guide him in securing better results in less time. Write for complete information.

If you do not have the blue and grey Ryerson Stock List—the Key to Immediate Steel—we will gladly send a copy. Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Detroit, Cincinnati, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

Principal Products Include: Bars, Shapes, Structural, Plates, Sheets, Floor Plates, Alloy and Tool Steels, Allegheny Stainless, Screw Stock. C. F. Shafting, Mechanical Tubing, Reinforcing Steel, Welding Rod, Nuts, Bolts, Rivets, etc.

DATA SHEETS

. . . On Materials of Construction 1938-1939 Edition


(Supplement to November 1938 issue)

Literally a Materials Handbook, this 38-page booklet presents essential information for more than 800 corrosion-, heat- and abrasion-resistant materials used in the construction of process equipment.

Included are: (a) non-ferrous metals and alloys, (b) ferrous metals and alloys and (c) non-metallic materials of construction. Physical properties, chemical composition and names of manufacturers are given. Price 50c

Ask for DATA SHEETS—1939

Chemical & Metallurgical Engineering, 330 West 42nd St., New York, N. Y.



*Valves and Pipe
of Chemical Porcelain*

**FOR TROUBLE-FREE HANDLING OF
TROUBLESOME CORROSIVE LIQUIDS**

Lapp Chemical Porcelain is dense, thoroughly vitrified, homogeneous, resistant to corrosion and strictly non-porous, has already established a record for trouble-free handling of corrosive liquids. The Lapp valve is of sound design, accurately machined and finished for smooth, tight, non-contaminating operation. *Write for descriptive literature.*

VALVES • PIPE • RASCHIG RINGS

LAPP (CHEMICAL PORCELAIN DIVISION)
INSULATOR CO., INC.
914 GILBERT STREET LE ROY, NEW YORK

MANUFACTURERS' LATEST PUBLICATIONS

Publications listed here are available from the manufacturers themselves, without cost unless a price is specifically mentioned. To limit the circulation of their literature to responsible engineers, production men and industrial executives, manufacturers usually specify that requests be made on business letterhead.

Air Conditioning. American Blower Corp., Detroit, Mich.—Bulletin 3723—16 pages on this company's capillary air washers for use in air cleaning, humidification, evaporative cooling and dehumidification. Includes specifications and erection information.

Air Conditioning. Carrier Corp., Syracuse, N. Y.—Bulletin 53B3—2-page leaflet describing and giving specifications on this company's new air and gas dehydrators for comfort and process conditioning; Bulletin AC-127, 12-page chart form presenting this company's newly revised psychrometric charts for low and normal temperatures, with tabular data for barometric and other factors and complete description of use. Numerous examples are given to illustrate calculation methods.

Alloys. Republic Steel Corp., Cleveland, Ohio—Chart 381—4-page folder containing tables listing analyses and properties of 13 most used types of this company's stainless steels, giving information also on heat treatment, heat resistance and fabricating properties.

Brazing. Handy & Harman, 82 Fulton St., New York, N. Y.—4-page folder describing types and advantages of low-temperature silver brazing alloys made by this company.

Chemicals. American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York, N. Y.—Leaflet 573—12 pages describing this company's tetra sodium pyrophosphate, with information on its use in applications such as soap, detergents, clay refining, and asphalt emulsion production.

Chemicals. The R. & H. Chemicals Dept., E. I. duPont de Nemours & Co., Inc., Wilmington, Del.—Revised Data Book on methyl chloride, with information on the material as a refrigerant; complete new tabulation on thermodynamic properties, a new Mollier chart and other information.

Controls. Friez Div., Bendix Aviation Corp., Baltimore, Md.—Catalog K—26 pages featuring this company's complete line of instruments for controlling, measuring and recording in automatic heating, refrigerating and air conditioning.

Coolers. Condenser Service & Engineering Co., 310 12th St., Hoboken, N. J.—Catalog 31—8 pages describing this company's lubricating oil coolers with engineering data and information on selection.

Crushers. Denver Equipment Co., 1400 17th St., Denver, Colo.—Bulletin C16-B—8 pages describing this company's horizontal crushing rolls in diameters from 24 to 72 in.

Crushers. Straub Mfg. Co., 507 Chestnut St., Oakland, Calif.—Bulletin 39—Folder describing the new Kue-Ken balanced crusher and giving performance reports from six actual installations.

Dust Collectors. Prat-Daniel Corp., Port Chester, N. Y.—Catalog 108—8 pages describing this company's recently developed tubular dust collector with information on construction, principle, performance and typical applications and layouts.

Electrical Equipment. Burndy Engineering Co., 459 East 133d St., New York, N. Y.—Catalog 41, Second Edition—Complete catalog on this company's electrical connectors with line drawings, list prices, shipping weights and dimensional data. Also 15-page electrical connector guide to facilitate proper connector selection.

Electrical Equipment. General Electric Co., Schenectady, N. Y.—GEA-2733D—4-page illustrated folder on this company's synthetic-insulated wire and cable, describing various types and

showing industries in which its use is indicated.

Electrical Equipment. Electric Machinery Mfg. Co., Minneapolis, Minn.—Publication 159—8 pages describing this company's polarized field frequency automatic control for synchronous motors with explanation of function and construction of the control parts, and connections of a typical control.

Electrical Equipment. Westinghouse Electric & Mfg. Co., Dept. 8N-48, East Pittsburgh, Pa.—Publications as follows: Booklet B-2243, 16 pages on air and compressed air circuit breakers to 1.5 million kva.; DD 33-700, 12 pages on De-Ion grid-type oil circuit breakers; DD 3105, 4 pages on inclosed fan-cooled squirrel-cage motors to 200 hp.; Catalog Section 26-325, 4 pages on portable a.c. welders; Booklet A-3618, 23 pages on fluorescent lighting, serving as a practical guide to this new method of illumination.

Equipment. Koppers Co., Engineering and Construction Div., Pittsburgh, Pa.—Form D-2—12-page booklet describing in detail this company's equipment for the semi-continuous refining of light oils for the production of motor fuel, benzol, toluol, xylol and solvent naphtha.

Equipment. Prater Pulverizer Co., 1801 South 55th Ave., Chicago, Ill.—84-page book covering this company's enlarged line of processing equipment, showing cross section and dimensional drawings of all standard grinding and mixing equipment made by this concern, including five types of mill in 16 models; two types and two models of feeders; and nine models of mixers.

Equipment. Roots-Connorsville Blower Corp., Connorsville, Ind.—Bulletin 23-B12—20 pages on this company's equipment for sewage treatment and water works plants describing rotary blowers of various types, with information on drives and sludge gas meters.

Fans. The New York Blower Co., 32d St. and Shields Ave., Chicago, Ill.—New fan capacity tables, 1940 editions, for this company's slow-speed and high-speed fan wheels; respectively 16- and 24-page booklets with information on design, fan laws and extensive tables to facilitate selection.

Fans. B. F. Sturtevant Co., Hyde Park, Boston, Mass.—Catalog 449—75-page wire-bound catalog on this company's Design 7 Silenavane fan with information on construction, characteristics, installations, control and complete selection tables.

Filters. American Seitz Filter Corp., 204 21st Ave., Paterson, N. J.—12-page bulletin on this company's sheet filters with information on various types for clarifying and sterilizing in industrial and laboratory use.

Filters. T. Shriver & Co., 808 Hamilton St., Harrison, N. J.—Bulletin 109—6-page folder on the use of this company's filter presses in the manufacture of drugs, chemicals and cosmetics, with information on types, construction and typical applications.

Floor Gratings. Borden Metal Products, Elizabeth, N. J.—4-page leaflet describing this company's metal gratings for safety steps and floors; also metal floor armour for reinforcement and protection of surfaces of concrete floors.

Furnaces. Harry W. Dietert Co., 9330 Roselawn Ave., Detroit, Mich.—Leaflet describing this company's No. 3400 Varitemp combustion furnace for temperatures up to 2750 deg. F.; for metallurgical use and combustion of coal, coke and oils for sulphur determination.

Heat Treatment. Air Reduction Co.,

60 East 42d St., New York, N. Y.—Form ADC-624—10 pages on this company's flame-hardening equipment and accessories.

Hydrocarbons. Phillips Petroleum Co., Bartlesville, Okla.—Bulletins 87 and 88—4-page folders describing this company's pure hydrocarbons, technical hydrocarbons and solvents from petroleum, available for chemical industry use.

Illum. Burgess-Parr Co., Freeport, Ill.—8-page bulletin on this alloy, describing forms available, physical properties, fabrication characteristics and corrosion resistance with specific corrosion data on a large number of chemicals.

Incinerators. Nichols Engineering & Research Corp., 60 Wall Tower, New York, N. Y.—Bulletin 210—36 pages on this company's Herreshoff incinerator for disposing of industrial wastes and sewage solids, with information on installations, typical plant designs and construction of the equipment.

Instruments. The Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.—Catalog 6705—8 pages describing this company's circular case indicating and recording thermometers and pressure gages.

Instruments. Coleman Electric Co., Maywood, Ill.—Bulletin 203—4-page leaflet describing this company's new low-price glass electrode industrial pH indicator.

Instruments. Leeds & Northrup Co., 4901 Stenton Ave., Philadelphia, Pa.—Catalog N-33A(6)—40 pages describing completely for the first time this company's complete line of thermocouples, with complete information on types and accessories, tabulated in easy-to-use form.

Lead. Alpha Metal & Rolling Mills, Inc., 363 Hudson Ave., Brooklyn, N. Y.—4-page leaflet on lead products showing weights of sheet lead and lead pipe and price lists on lead fittings.

Lighting. Benjamin Electric Mfg. Co., Des Plaines, Ill.—46-page handbook on fluorescent lighting, giving charts, diagrams, tables and illustrations showing how to determine how and when to use fluorescent lighting, and describing equipment.

Lubrication. The Farval Corp., 3255 East 80th St., Cleveland, Ohio—Bulletin 10-A—4-page leaflet describing this company's new Farval Jr. centralized system of lubrication for distributing oil or grease to moving parts of smaller equipment.

Masks. Mine Safety Appliances Co., Braddock, Thomas & Meade Sts., Pittsburgh, Pa.—Publications as follows: Bulletin EE-3, 4 pages on this company's ammonia gas mask with all-vision facepiece; Bulletin ED-7, 6 pages describing this company's complete line of industrial gas masks and canisters for all purposes; Bulletin EA-6, 4 pages on the all-service gas mask for combinations of carbon monoxide, poisonous industrial gases, vapors or smokes; Bulletin EB-4, 8 pages on hose masks for high gas concentrations, covering also blowers and accessories.

Motors. Allis-Chalmers Mfg. Co., Milwaukee, Wis.—Bulletin B-6002—40-page book on large direct-current motors and their control, for use on heavy duty drives. Describes design features, shows many installation views and discusses switchboards and control.

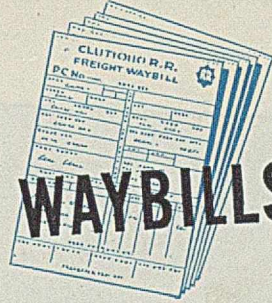
Odor Adsorbers. W. B. Connor Engineering Corp., 114 East 32d St., New York, N. Y.—Bulletin 106—2-page leaflet on this company's Type G Dorex activated carbon odor adsorber, on which new reduced prices have recently been announced, describing this equipment and showing how to figure sizes, capacities, resistance and other information.

Oil Circulator. Durametallic Corp., 2104 Factory St., Kalamazoo, Mich.—4-page leaflet describing a new self-contained oil circulating unit produced by this company for supplying lubricating oil at uniform pressure to stuffing boxes and large bearings. Incorporates tank, cooling coil and filter, circulating

Ready Now...



FOR TOMORROW'S WAYBILLS



Instead of being content merely to meet today's equipment needs, General Chemical Company is providing for the future—building more and more new acid tank cars of advanced design.

This steady increase and improvement in General Chemical rolling stock is anticipatory in character . . . designed to better serve customers' fluctuating requirements today and in the future.

It pays to be a General Chemical Company customer.



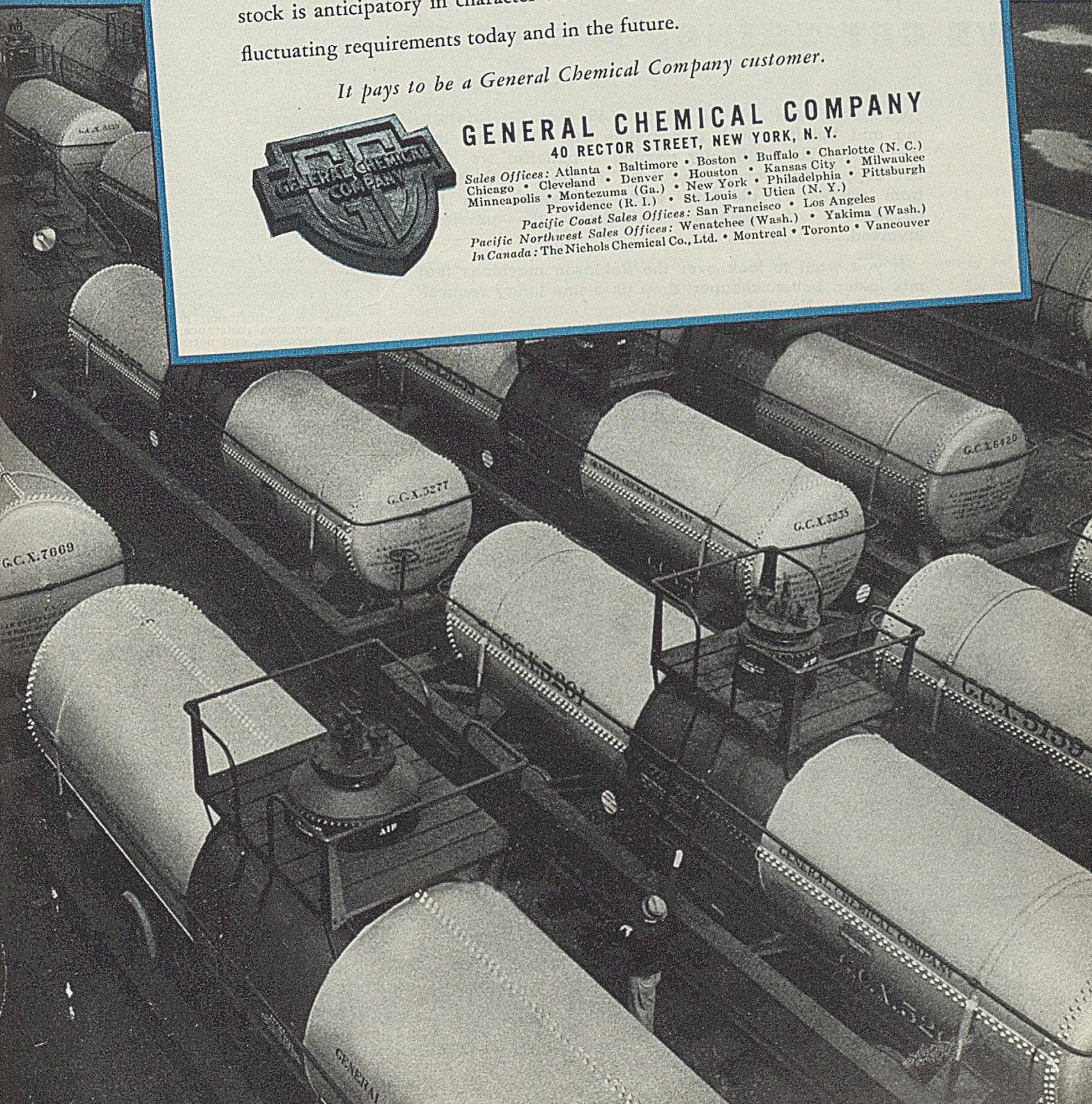
GENERAL CHEMICAL COMPANY

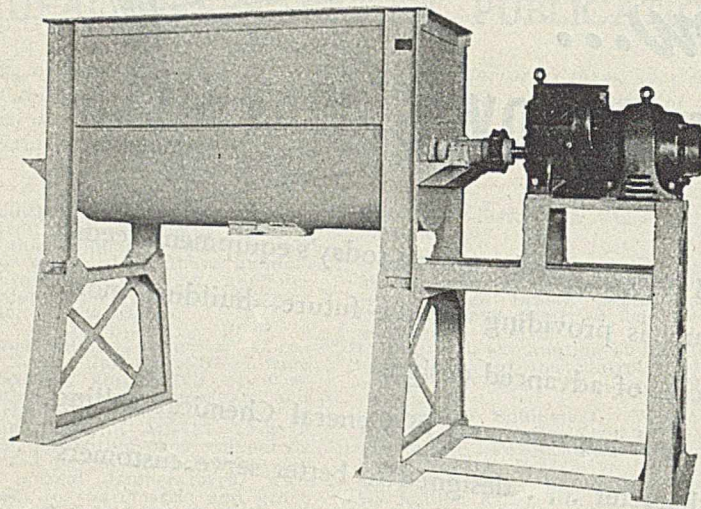
40 RECTOR STREET, NEW YORK, N. Y.

Sales Offices: Atlanta • Baltimore • Boston • Buffalo • Charlotte (N. C.)
Chicago • Cleveland • Denver • Houston • Kansas City • Milwaukee
Minneapolis • Montezuma (Ga.) • New York • Philadelphia • Pittsburgh
Providence (R. I.) • St. Louis • Utica (N. Y.)

Pacific Coast Sales Offices: San Francisco • Los Angeles

Pacific Northwest Sales Offices: Wenatchee (Wash.) • Yakima (Wash.)
In Canada: The Nichols Chemical Co., Ltd. • Montreal • Toronto • Vancouver





WE GET THINGS MIXED UP

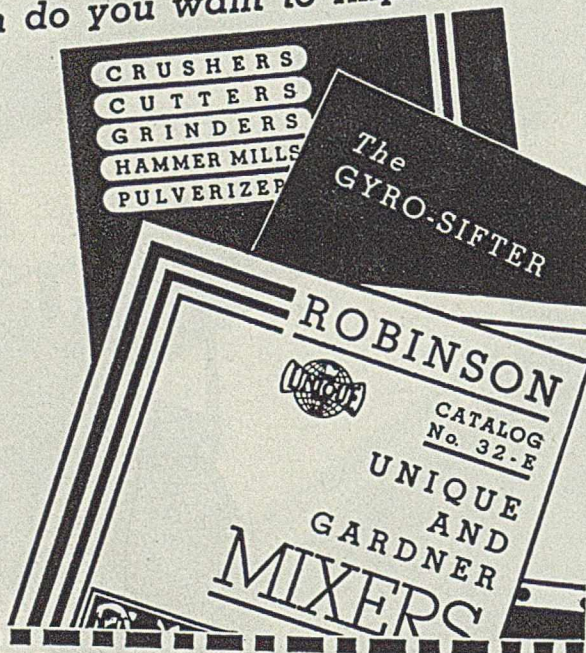
..... for other people

And we've been doing it for over 40 years . . . designing and building such a complete line of mixers that you would have difficulty naming a material we have not coped with—everything from feathers to fertilizer, from pepper to plastics—each job getting the full cooperation of engineers who know the problems involved.

If you want to look over the Robinson machines that mix faster, better, cheaper, drop us a line today requesting Bulletin No. 32-E.

What Operation do you want to Improve?

GRINDING
CRUSHING
CUTTING
DEFIBERIZING
PLASTICIZING
PULVERIZING
BAG CLEANING
ELEVATING
CONVEYING
MILLING
MIXING
SIFTING
SORTING



ROBINSON MANUFACTURING COMPANY

72 PAINTER STREET, MUNCY, PA.

Kindly send particulars on your equipment

for (process) (material)

Name

Firm

Address

pump, pressure gage and pressure regulator.

Packing. Greene, Tweed & Co., 101 Park Ave., New York, N. Y.—12-page booklet on mechanical pump packings and sheet packings with comprehensive selection chart showing types of packing to use for resistance against a large number of chemicals and solutions. Describes in detail various types of packings made by this company.

Piping. American Locomotive Co., Alco Products Div., 30 Church St., New York, N. Y.—4-page leaflet briefly describing this company's prefabricated piping, illustrating types and discussing technique.

Regulators. Sarco Co., 183 Madison Ave., New York, N. Y.—Catalog 52—16-pages on self-operated temperature regulators made by this company and available in a large number of different types. Gives prices, dimensions and design characteristics.

Rubber. B. F. Goodrich Co., Akron, Ohio—30-page book reprinting a series of advertisements by this company describing unusual uses of rubber.

Respirators. H. S. Cover, South Bend, Ind.—12-page booklet describing this company's respirators for protection against dusts, fumes and smokes; also covers gas-tight, fog-proof goggles. Describes a new midjet respirator which covers nose only.

Solvents. Carbide & Carbon Chemicals Corp., 30 East 42d St., New York, N. Y.—Reprint of an article by A. K. Doolittle on "Active Solvents," listing and describing the principal classes of solvents used in surface coatings, giving applications and discussing selection and balancing of solvents for controlling evaporation rates and compatibility.

Stainless Tubing. The Carpenter Steel Co., Welded Alloy Tube Div., Kenilworth, N. J.—16-page book on properties and uses of this company's welded stainless tubing, with information on types of applications, physical properties, corrosion resistance, sizes, weights and tolerances, and notes on design and fabrication.

Steam Generation. York Oil Burner Co., York, Pa.—Bulletins 40042 and 40043—2-page leaflets discussing respectively this company's high pressure boiler units; and Model T oil burners for oil rates from 3 to 27 g.p.h. Both bulletins give complete specifications.

Steel. Joseph T. Ryerson & Son, Inc., 16th and Rockwell Sts., Chicago, Ill.—8-page bulletin on this company's cold finished bars with information on types, characteristics and analyses.

Valves. Merco-Nordstrom Valve Co., 400 Lexington Ave., Pittsburgh, Pa.—Bulletin V-134—4-page leaflet describing this company's new Merchromed lubricated plug valves, a type produced by a new process making possible operation at temperatures to 1,000 deg. F. or even higher.

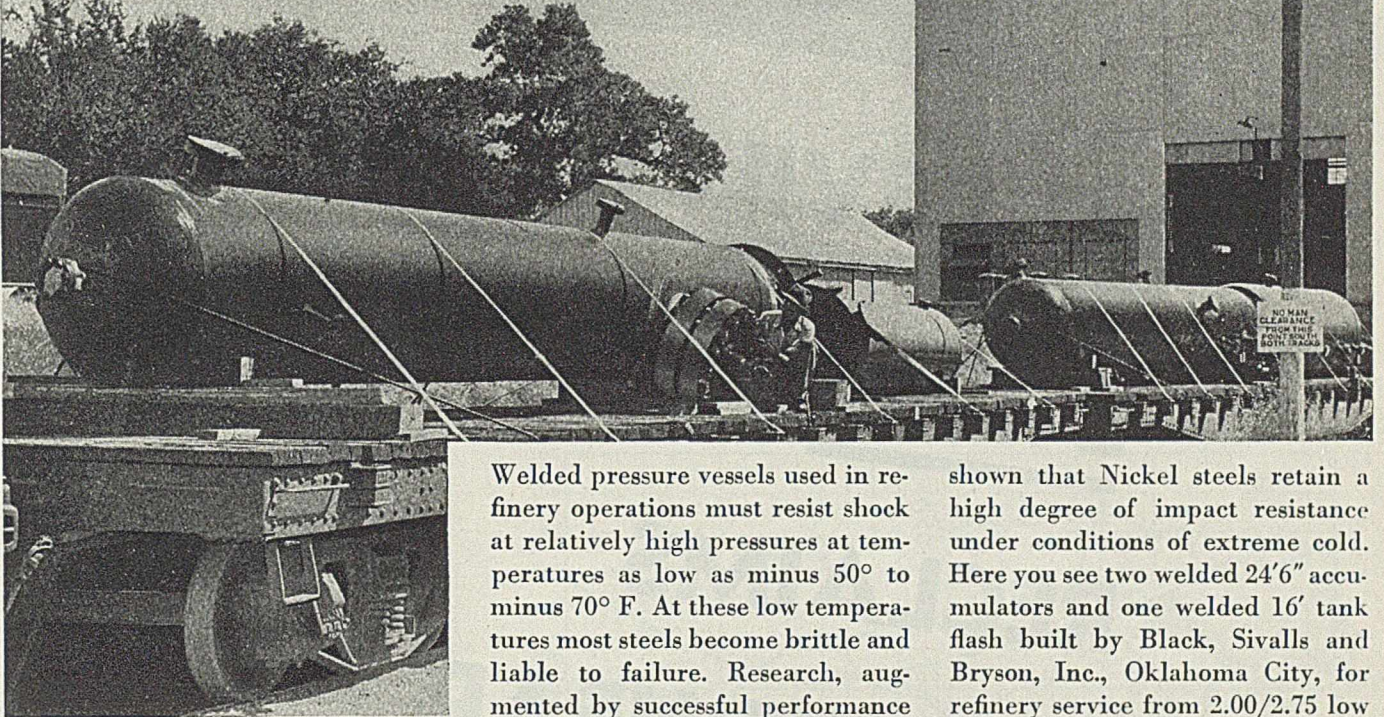
Water Treatment. The Permutit Co., 330 West 42d St., New York, N. Y.—Bulletin 2345—4 pages describing in detail this company's new oscillating type dry chemical feeder; Bulletin 2357, 12 pages relating to history and development of deaerating heaters for removing oxygen and free carbon dioxide from boiler feed water and for use in connection with hot process lime soda softeners, Zeolite softeners and new Zeo-Karb softening treatment.

Welding. Lincoln Electric Co., Cleveland, Ohio—Large wall chart covering properties, sizes and procedure for a large number of types of arc welding electrodes made by this company.

Welding. Metal & Thermit Corp., 120 Broadway, New York, N. Y.—Pamphlet 4—21 pages on Murex welding electrodes, giving information on physical properties, chemical analysis, qualifications, approvals and recommended procedures. Covers both mild steel and alloy steel electrodes.

Winches. Stephens-Adamson Mfg. Co., Aurora, Ill.—New 4-page folder describing this company's complete line of hand and motor winches. Bulletin 340.

WELDED PRESSURE VESSELS *for* LOW TEMPERATURE PROCESSING

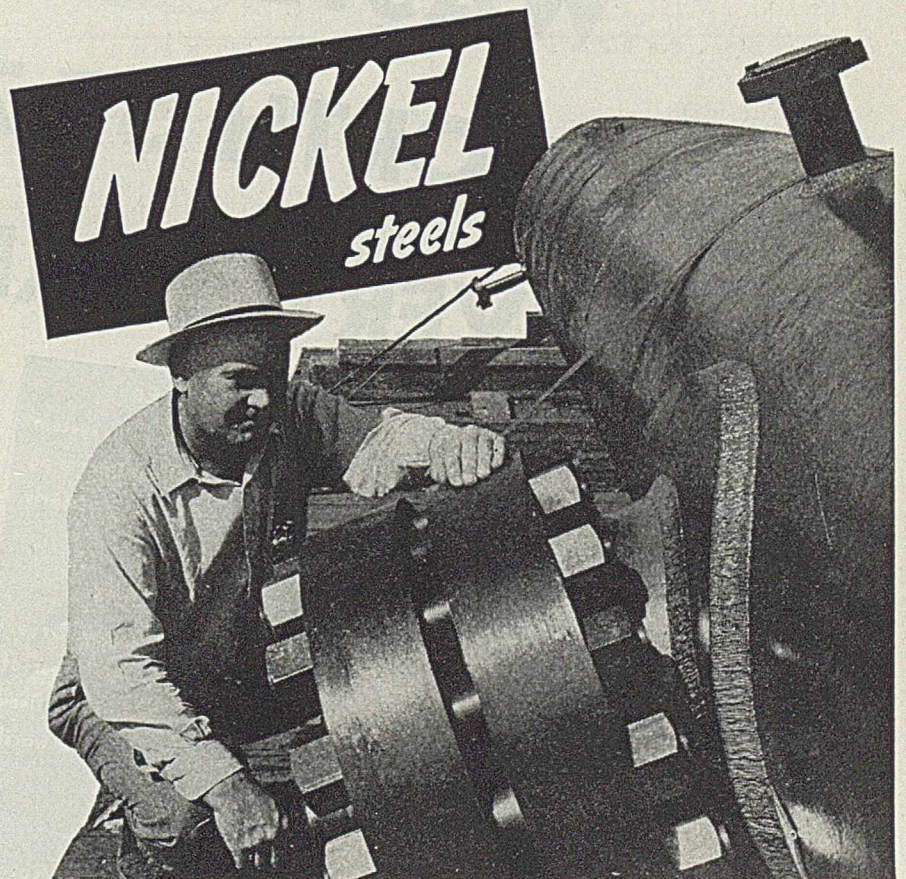


Welded pressure vessels used in refinery operations must resist shock at relatively high pressures at temperatures as low as minus 50° to minus 70° F. At these low temperatures most steels become brittle and liable to failure. Research, augmented by successful performance in industrial applications, has

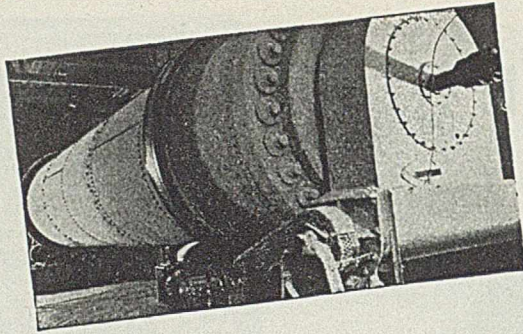
shown that Nickel steels retain a high degree of impact resistance under conditions of extreme cold. Here you see two welded 24'6" accumulators and one welded 16' tank flash built by Black, Sivalls and Bryson, Inc., Oklahoma City, for refinery service from 2.00/2.75 low carbon Nickel steel plates.

Close-up of a 42" O. D. accumulator built by Black, Sivalls & Bryson, Inc., from Nickel alloy steel. Note the smooth weld made with Murex 2.25% Nickel steel electrodes, furnished by the Metal & Thermit Co. These jobs conform to ASTM specifications # A-203-37T, Grade B. Nickel steels are uniformly workable, weldable and dependable.

During the past 30 years, Nickel alloyed steels, cast irons and non-ferrous materials have been specified more and more for refinery applications subject to high heat, stress, corrosion and sub-zero temperatures. Your consultation is invited regarding money-saving applications of materials alloyed with Nickel.



THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET
NEW YORK, N. Y.



LOUISVILLE

DRYER

RECLAIMS

WASTE HEAP

WORTH \$7,740—

EVERY YEAR!

There it was—a small mountain of “used” processing material, adjudged *worthless* simply because it had become wet in the manufacturing process. A “waste heap” that was growing at the rate of one ton a day, and costing the manufacturer \$30 a ton to replace!

The “blueprint” at the right tells the rest of the story. Louisville engineers proved that proper drying would make the “worthless” wet material as good as new. A Louisville Dryer was designed and installed—and has since saved \$7,740 *every year!*

PROBLEM

To develop a drying system for reclaiming wet processing material that was formerly thrown away.

SOLUTION

A Louisville Rotary Dryer operating at a total cost of \$4.20 per day, including fixed charges, reclaims \$30 worth of material per day.

RESULT

\$4,100 Louisville Rotary Dryer pays for itself every seven months.

Is your company throwing money away on a *waste heap* of supposedly worthless wet materials? Unless you are absolutely sure that your “waste” wet materials are really worthless, write us at once! We’ll send you—without cost, obligation, or unwanted follow-up—a few questions which, when answered, will enable our engineers to analyze your problem, and perhaps save you a great deal of money. *Address:* Louisville Drying Machinery Company, Incorporated, 451 Baxter Avenue, Louisville, Kentucky.

CHEMICAL CONSUMPTION SHOWED LESS-THAN-SEASONAL DECLINE IN JUNE AND JULY

INDEXES of industrial production for the last two months indicated a rather sharp rise in outputs from that reported for May. Consumption of chemicals appears to have followed the general pattern with actual increases in some industries, notably iron and steel and coal products. Activities in the fertilizer, paint, glass, and rubber trades were on a reduced scale but the drop was of moderate proportions. Pulp and paper mills have been working at an unusually high rate with a record outturn of pulp reported for May and a fairly uniform rate having been maintained in recent weeks. The preliminary index for consumption of chemicals for July is 135 which com-

Chem. & Met. Index for Consumption of Chemicals

	May revised	June
Fertilizer	27.27	26.05
Pulp and paper	21.64	21.60
Petroleum refining	14.50	14.22
Glass	12.76	11.80
Paint and varnish	14.11	12.25
Iron and steel	9.28	10.86
Rayon	11.41	11.43
Textiles	7.92	7.13
Coal products	8.61	8.73
Leather	3.51	3.59
Explosives	5.03	4.80
Rubber	3.03	2.82
Plastics	2.64	2.62
	141.71	137.90

pared with 111.41 for July last year. The revised index for June is 137.90 as against 116.35 for June 1939.

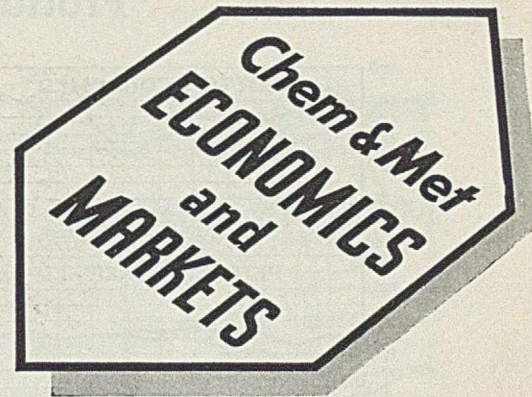
While the defence program has had but little effect so far in the way of direct purchases of chemicals, orders have been placed for some finished products which have had bearing on consumption of chemicals. The outlook in the principal consuming industries is favorable. Pulp production has been aided this year not only because of enlarged plant installations but also because the reduced volume of imports has placed greater demands upon domestic producers. Glass makers likewise have been helped by the lessening in competition from foreign markets and this has been especially noted in the case of glassware. Petroleum refining has been held down somewhat because of increased inventories but the rate of daily runs to stills has held considerably above ordinary levels.

Steel mills started July with operations reduced but quickly speeded up work and reached a rate but little below that which was in effect in November and December of last year with the possibility that a new high will be established in the latter part of this year.

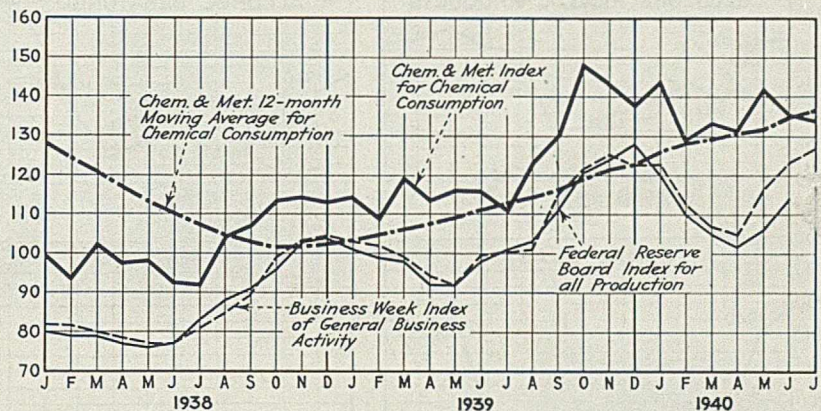
Despite a smaller crush of cottonseed, domestic production of vegetable oils for the first six months of this year was a little higher than that reported for the corresponding period of 1939. Refineries, however, were less active and a small decline in consump-

tion of chemicals in that quarter was noted for the six-month period.

The Department of Commerce in reporting on foreign trade states that exports of chemicals and related products for the first half of this year reached a value of \$128,361,000 which represents a gain of 55 per cent over the total for the first half of last year. Confining the commodities to those listed under Group 8, exports in June were valued at \$23,306,904 and for the six months \$110,438,383. Exports of toluol in June fell off from the average for the preceding months, amounting to 2,009,238 lb. with 28,703,364 lb. for the six months. Outward shipments of acetone for Jan.-June period were 12,128,410 lb. A large increase is noted in foreign buying of sodium compounds with total shipments reach-



Imports of chemicals in June were relatively light amounting in value to \$3,744,763 with the Jan.-June total \$34,279,792. The decline was fairly general throughout the different groups. It is noted that arrivals of salt cake were but 2,428 tons and only



ing a total of 326,370,058 lb. including 14,285,131 lb. of bichromate, 75,120,496 lb. of borate, 66,452,589 lb. of soda ash, and 118,551,321 lb. of caustic.

Up to June export shipments of explosives had not been unusually large but in June such shipments were valued at \$6,977,881 making the six-months total \$9,309,581.

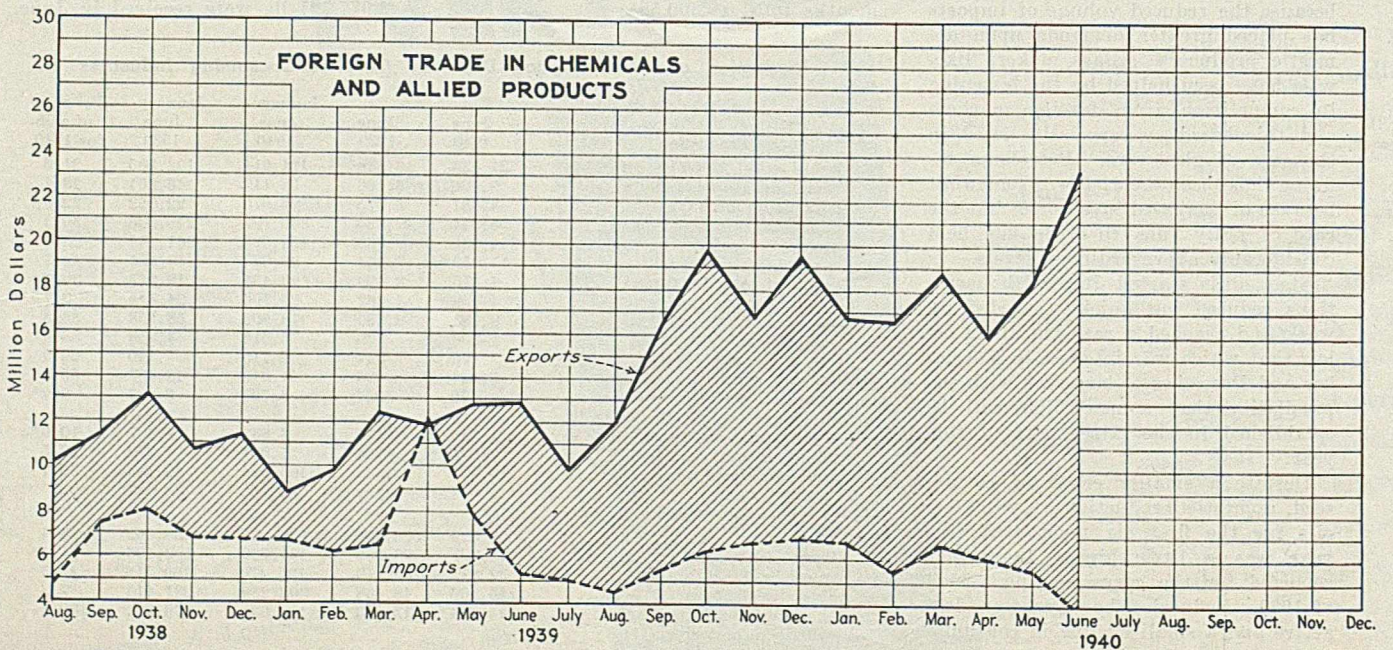
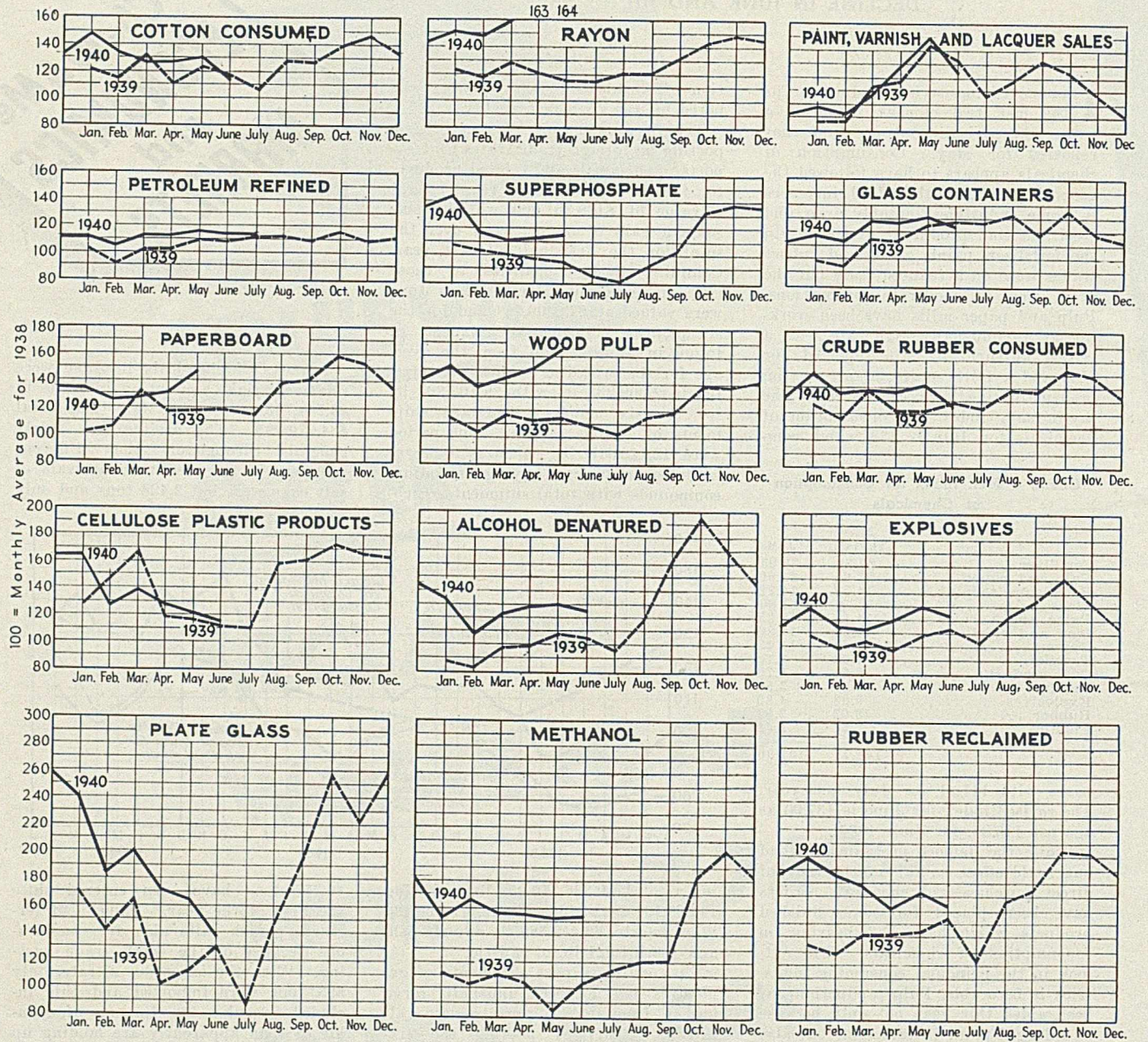
40,377 tons have been entered since the first of the year. Imports of fertilizer potash salts also are conspicuous because of the small trade passing. With the exception nitrate, only 893 tons were imported and this included no sulphate. Imports of cyanide of soda apparently are holding up as 3,977,791 lb. were received in June.

Production and Consumption Data for Chemical-Consuming Industries

	June 1940	June 1939	January-June 1940	January-June 1939	Per cent of gain for 1940
Production					
Alcohol, ethyl, 1,000 pr. gal.	21,423	16,838	124,614	102,505	21.6
Alcohol, denatured, 1,000 wi. gal.	9,706	8,166	58,119	45,264	28.4
Ammonia liquor, 1,000 lb.	4,381	3,875	26,970	22,022	22.5
Ammonium sulphate, tons	58,514	42,380	340,707	249,906	36.3
Automobiles, sales, no.	344,636	309,738	2,428,528	1,961,989	23.8
Benzol, 1,000 gal.	11,052	7,466	62,086	43,567	42.5
Byproduct coke, 1,000 tons	4,375	3,079	25,451	18,217	39.7
Glass containers, 1,000 gr.	4,429	4,662	26,706	24,345	9.7
Plate glass, 1,000 sq. ft.	9,783	9,289	78,605	58,758	33.8
Window glass, 1,000 boxes	908	720	6,618	4,853	36.4
Methanol, crude, 1,000 gal.	426	344	2,715	2,140	26.9
Methanol, synthetic, 1,000 gal.	3,426	2,295	21,019	13,487	55.9
Nitrocellulose plastics, 1,000 lb.	770	957	5,767	6,397	9.9*
Cellulose acetate plastics, 1,000 lb.					
Sheets, rods, and tubes, 1,000 lb.	634	446	3,939	4,407	10.6*
Molding material, 1,000 lb.	871	795	5,967	4,872	22.5
Rubber reclaimed, tons	16,631	14,848	108,524	82,183	32.1
Consumption					
Cotton, bales	556,529	578,436	3,836,022	3,538,365	8.4
Silk, bales	17,307	26,256	131,720	192,106	31.4*
Explosives, 1,000 lb.	32,877	30,210	195,470	169,516	15.3
Rubber, crude, tons	46,506	48,438	303,230	281,415	7.8
Rubber reclaimed, tons	15,844	13,669	100,036	76,842	30.2

* Per cent of decline.

Production and Consumption Trends



HERE'S THE RECORD OF BECKMAN ACHIEVEMENTS

✓ The first portable glass electrode pH meter—transforming the glass electrode from a laboratory curiosity into a practical working tool—was a Beckman instrument. It was this development that paved the way for the great present-day advancements in pH measurement and control.

✓ The self-balancing electronic potentiometer circuit was another important Beckman development . . . and is still available *exclusively* in Beckman equipment.

✓ The first *internally shielded electrode system* was Beckman developed. This advancement is of particular importance to industrial users for it permits electrodes to be used *anywhere*—in grounded flow lines, vats and tanks—at remote distances from the meter—without danger of electrostatic interference.

✓ The first *completely automatic glass electrode pH indicator, recorder and controller* was pioneered by Beckman. Operating on 115 v AC, this instrument made automatic process control accurate, convenient, *practical* . . . and is today widely used by industries in all parts of the world.

✓ The *only High Temperature Glass Electrode* available today is a Beckman development . . . perfected after a long period of research work in which an entirely new type of electrode glass was produced. Designed for continuous operation at temperatures to 100° C. (212° F.) this electrode is rapidly assuming great importance in industrial processes

✓ The most recent product of Beckman research—the Beckman High pH Electrode—greatly minimizes or completely eliminates sodium corrections when high pH values are measured in the presence of sodium ions. This important development extends the usefulness and accuracy of the glass electrode to many new industries where alkaline solutions in combination with sodium ions have heretofore presented difficulties.

Continuous research maintains Beckman Leadership!

ONLY

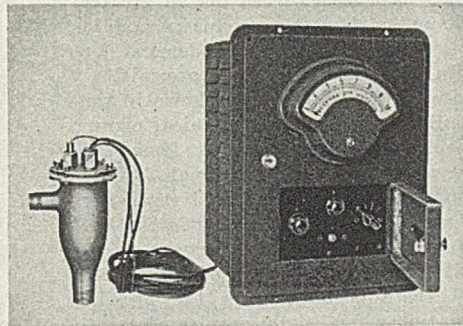
Beckman pH EQUIPMENT Has ALL THE MODERN ADVANCEMENTS!

The science of pH control has advanced with tremendous strides in the past few years . . . *due, principally, to the far-reaching pH developments of the Beckman research staff.* The introduction of Beckman Glass Electrode Equipment freed industry from the limitations and errors of antimony and quinhydrone instruments. Continued advancements have firmly established Beckman Glass Electrode Instruments as the most accurate—and by far the most adaptable pH control equipment for *all* types of industrial and laboratory applications.

Such important developments as Beckman High Temperature Glass Electrodes for *continuous* service in boiling liquids . . . and Beckman High pH Electrodes that minimize sodium errors in highly alkaline solutions . . . are only two of the many advancements available *exclusively* in Beckman Equipment.

When you buy pH equipment, buy *modern* equipment . . . specify **BECKMAN!**

THE BECKMAN AUTOMATIC pH INDICATOR



is the instrument for control of large scale industrial processes. Operating on 115 v AC current, it gives a *continuous visual indication* of pH on a large easily-read dial. Used with ANY standard potentiometric recorder or controller, it also provides a permanent *written Record* and *completely automatic pH Control*.

This is the most advanced pH instrument available today. It has all the famous Beckman developments such as Sealed and Shielded Glass Electrodes. . . . Automatic Temperature Compensation . . . Full Alternating Current Operation (no batteries) with built-in voltage regulation . . . use of Beckman High Temperature and High pH Electrodes for difficult conditions . . . etc. Write for Bulletin 16 which gives complete details on this outstanding instrument!

THE BECKMAN INDUSTRIAL pH METER

is particularly designed for portable plant and field use. Simple to operate, it incorporates a unique Null-Type Electronic Potentiometer Circuit that gives *instant* pH readings at the touch of a button. Also features *Continuous pH Indication* . . . Rugged Shielded Glass Electrodes that can be used at remote distances from the instrument . . . and many other important developments. Ask for Bulletin 21 which describes this instrument!



THE BECKMAN LABORATORY pH METER

is unequalled for all types of research and laboratory pH investigations. It features Sealed Glass Electrodes . . . Continuous (non-ballistic) indication of circuit unbalance . . . Built-in temperature compensation . . . Direct millivolt readings for Oxidation-Reduction measurements. A wide range of special electrodes is available to meet every research problem. Ask for Bulletin 31 which describes this instrument!



LET US HELP YOU! If you use aqueous solutions *anywhere* in your plant, chances are that Beckman pH Control will help you do the job better . . . *for less.* Without obligation to you, our research staff will be glad to make recommendations to fit your problem. When writing please give sufficient details to permit a comprehensive recommendation.

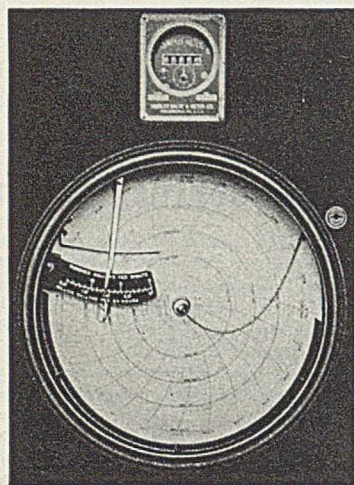
NATIONAL TECHNICAL LABORATORIES, South Pasadena, California

BECKMAN pH EQUIPMENT

SAVINGS THROUGH *Scientific* PROCESS CONTROL

SIMPLEX METERS

THE UTMOST IN ACCURACY



THE accuracy of plant flow metering equipment is of prime importance if economical operation of all functions is to be obtained. Hand in hand with these requirements, however, must go low maintenance costs and simplicity of testing methods.

Simplex flowmeters combine in their design these functions. Let Simplex instruments aid you in solving your flow measuring and control problems.

Write for Data

SIMPLEX VALVE & METER CO.

68th and Upland Streets

PHILADELPHIA, PA.

District Offices in Principal Cities

STEADY CONTRACT DELIVERIES AND FIRM PRICE TONE FEATURE MARKET FOR CHEMICALS

WITH very few exceptions, the market for chemicals has moved along in a routine way in the last month. Withdrawals against contracts have gone forward in good volume with some of the consuming industries feeling the effects of seasonal influences and others going contrary to the ordinary summer course. Most chemicals are holding a steady price position with third quarter quotations being a repetition of those which prevailed for earlier delivery. Foreign trade has been a factor in chemical activity in two ways. In the first place export buying has continued on a high level and secondly, the drop in imports has encouraged larger production at home. This import condition is true not only for chemicals but also in the case of many finished products which have been turned out in greater volume by domestic producers and in consequence has increased demand for chemicals and other raw materials.

Some interest has been shown in the possible reactions upon chemical manufacture which may result from the carrying out of the national defence program. This has referred especially to the possibility of priorities in the delivery of chemicals. Such possibility, however, is regarded as remote and there is nothing in the present situation which would require the allocation or establishment of priorities in the delivery of chemicals as ample supplies will be available for industry.

Vegetable oils continue in an unsatisfactory position from a price standpoint. China wood oil is affected by conditions at primary points and remains high in price with the use of substitute oils somewhat general. Other vegetable oils are selling at relatively low prices. Linseed oil has worked into an anomalous position. For some time domestic seed has been offered below the parity of Argentine seed and crushing plants along the seaboard have been adversely affected. Not only has it cost more to produce oil

in eastern mills but the loss in export trade in oil-cake has further added to the cost of oil not only because of the drop in oil-cake values but also because of the loss in drawback of duties which is customary on exports of cake made from imported seed. As the new crop of seed in the northwest promises to be larger than usual this year, the

Production and Sales of Crude Coal-Tar Products

Tar ¹	1938	1939
Production.....gal.	419,579,649	554,406,216
Sales.....gal.	302,321,022	344,534,382
Sales value.....	\$14,904,501	\$16,585,734
Light oil and derivatives:		
Crude light oil		
Production.....gal.	123,649,078	170,993,376
Sales.....gal.	9,588,332	9,397,726
Sales value.....	\$811,496	\$730,591
Benzol (except motor benzol)		
Production.....gal.	17,744,657	30,470,459
Sales.....gal.	17,175,742	26,627,639
Sales value.....	\$2,317,420	\$3,617,953
Motor benzol		
Production.....gal.	61,902,752	86,245,584
Sales.....gal.	61,221,485	81,671,632
Sales value.....	\$6,064,326	\$7,678,770
Toluol, crude and refined		
Production.....gal.	16,089,570	24,355,116
Sales.....gal.	15,588,155	24,683,051
Sales value.....	\$3,521,188	\$4,952,453
Solvent naphtha, crude and refined		
Production.....gal.	5,483,040	7,468,386
Sales.....gal.	4,834,644	7,093,186
Sales value.....	\$1,009,035	\$1,355,079
Xylol ²		
Production.....gal.	2,900,243	4,089,090
Sales.....gal.	2,732,697	4,393,400
Sales value.....	\$677,311	\$1,018,589
Other light oil products		
Production.....gal.	10,384,138	6,684,622
Sales.....gal.	6,461,307	4,562,135
Sales value.....	\$852,646	\$443,469
Naphthalene, crude ⁴		
Production.....lb.	53,584,209	104,085,593
Sales.....lb.	50,692,750	87,836,963
Sales value.....	\$979,039	\$1,517,240
Creosote oil		
Production.....gal.	88,066,812	110,241,843
Sales.....gal.	88,712,723	101,486,998
Sales value.....	\$10,820,307	\$12,384,939
Tars, crude and refined ²		
Production.....gal.	24,784,189	33,957,602
Sales.....gal.	23,639,190	32,258,215
Sales value.....	\$1,594,746	\$2,181,744
Tars, road ²		
Production.....gal.	144,061,551	149,835,943
Sales.....gal.	144,023,479	137,690,311
Sales value.....	\$12,004,996	\$11,191,316
Other distillates ⁵		
Production.....gal.	27,677,529	42,680,447
Sales.....gal.	7,178,525	10,740,339
Sales value.....	\$1,180,015	\$1,542,251
Pitch of tar		
Production.....tons	447,168	568,153
Sales.....tons	230,225	306,457
Sales value.....	\$3,357,663	\$4,358,507
Pitch of tar coke ²		
Production.....tons	80,436	90,124
Sales.....tons	63,749	81,443
Sales value.....	\$763,905	\$1,016,351

CHEM & MET.

Weighted Index of CHEMICAL PRICES

Base=100 for 1937

This month	98.63
Last month	98.60
August, 1939	96.96
August, 1938	99.54

Some of the chemicals of lesser tonnage fluctuate in price but the more important commodities are steady with third-quarter deliveries passing at the former contract levels. Quicksilver and its derivatives are among the items for which lower prices went into effect.

¹ Data for coke ovens reported to Bureau of Mines, and for tar refineries and others, to the United States Tariff Commission, unless otherwise noted.

² Reported to United States Tariff Commission only.

³ Reported to Bureau of Mines only.

⁴ Includes refined naphthalene reported to Bureau of Mines.

⁵ Includes crude tar acids reported to the United States Tariff Commission, and phenol, sodium phenolate and certain other products reported to Bureau of Mines.

advantage may continue with western mills and it is possible that crushing activities in the eastern section of the country may be curtailed.

Chlorate of potash which still is in limited supply in this country figured in the June imports with arrivals of 184,352 lb. and a six-month import total of 3,352,636 lb. is given although this figure includes imports of perchlorate.

Formal hearings are being held this month (they began Aug. 8) regarding the elaborate new and amended set of regulations for transportation of explosives and other dangerous articles. Under the leadership of Manufacturing Chemists Association, numerous tentative revisions of these rules have been recommended in anticipation of these formal hearings. The Commission is still open to recommendations and suggestions from the industry in order that further improvements may be made on the requirements for containers and shipping rules for commodities of potential hazard in transportation.

Appointment of a technologic committee by the National Academy of Sciences to review projects for recovery of manganese from low-grade domestic ore gives some assurance that the Government won't be started on any wild-goose chases.

The committee will sift all suggested processes, concentrating and metallurgical alike, both from a technological and an engineering standpoint, and make recommendations to the National Research Council and the Minerals Division of the defense commission. Upon its findings may depend in large part what disposition the President makes of the \$2,000,000 Congress gave him for construction of pilot plants to operate by the electrochemical "or other" processes—a fund from which Representative Schrugham of Nevada hopes to get a manganese plant at Boulder Dam—as well as the direction and scope of other governmental aid.

Chairman of this sifting committee is Dr. Clyde Williams, director, Battelle Memorial Institute, Columbus, O. A. C. Fieldner, chief of the technological branch of the Bureau of Mines, is secretary.

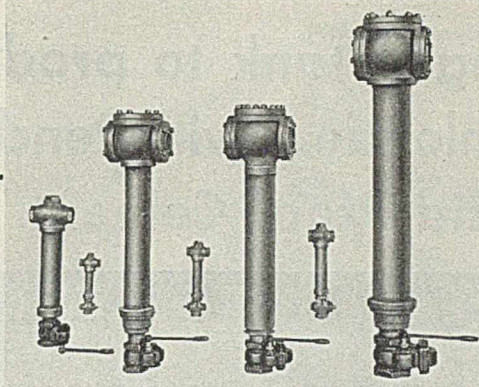
CHEM & MET.

Weighted Index of Prices for OILS & FATS

Base=100 for 1937

This month	68.24
Last month	73.37
August, 1939	66.80
August, 1938	79.37

The price curve for oils and fats continued downward with considerable inter-commodity competition. Tallow has sold for soap-making account, but the declining market has checked buying interest.



SPRACO SELF-CLEANING STRAINERS

Spraco strainers are made with a cylindrical strainer basket of perforated copper, the combined area of the perforations being approximately 10 times the cross sectional area of the supply line. Special strainer cylinders with wire mesh inserts furnished where such protection is required by particular operating conditions. Stock sizes range from 1/2" to 6" units. Larger sizes made to order.

Write for
"SELF-CLEANING STRAINER BULLETIN"

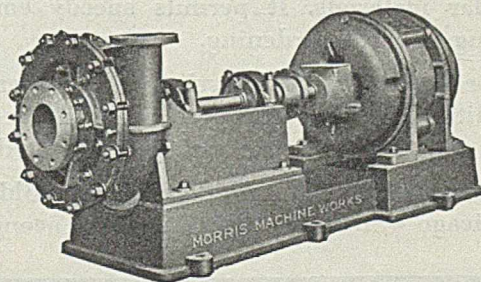
SPRAY ENGINEERING COMPANY
115 Central St., Somerville, Mass.



MORRIS

CENTRIFUGAL PUMPS

**Since
1864,
specialists
in
pumps
for
handling
abrasive,
corrosive,
and
pulpy
mixtures**



This Morris Slurry and Sludge Pump is one of the 10 different Morris designs for handling various kinds of abrasive mixtures. For clear water, corrosive liquids, and pulpy materials, too, Morris can supply an exactly suitable design for every requirement.

Bulletins on request

MORRIS MACHINE WORKS . . . Baldwinsville, N. Y.

Representatives in principal cities Export Office, 30 Church St., New York City

Building a tank to produce ferric chloride...with Penchlor Acid-Proof Cement



THIS TANK, lined with acid-proof brick in a rubber-lined steel shell, is almost ready to go into service manufacturing ferric chloride in the Wyandotte plant of Pennsylvania Salt Mfg. Co. It is 16' x 8' x 4', jointed with Penchlor Acid-Proof Cement*, and every square inch of its lining must withstand the most punishing chemical conditions.

Both ferrous and ferric chloride at temperatures up to 205°F. will be in contact with the Penchlor Acid-Proof Cement. Harder still, the service is intermittent, for this is a batch process in which the tank is periodically filled and emptied.

A similar tank in service for more than five years shows absolutely no evidence of attack... the Penchlor Acid-Proof Cement jointing is like new. This cement is inert to all acids except hydrofluoric. It adheres strongly to brick, steel, glass, carbon, lead, rubber, and similar materials. It permits speedy construction, being quick-setting and self-hardening.

For other types of service, where thermal shock and abrasive conditions are severe, there is Asplit Cement*—a synthetic resin with a setting time that is easily controlled by temperature.

Pennsylvania Salt Mfg. Co., Widener Bldg., Phila., Pa.—New York • Chicago • St. Louis • Pittsburgh • Tacoma • Wyandotte.



Write for **FREE TEST KIT**. You can prove for yourself the outstanding properties of these acid-proof cements, and make a convincing comparison with the product you are now using, by means of the free Test Kit supplied on request. Write us today, on your business letterhead.

*Fully protected by existing patents.

PENNSYLVANIA SALT
MANUFACTURING COMPANY
Chemicals

Nomographic Charts

—for Density Corrections and Physical Data on Heavy Chemicals



A set of nine charts for heavy chemicals such as Sulphuric Acid, Oleum, Nitric Acid, Hydrochloric Acid, Phosphoric Acid, Soda Ash Solutions, Potassium Carbonate Solutions and Aqua Ammonia, together with an article on graphical calculation of mixed acids, and a transparent straight edge to use as a guide with the charts.

These charts were prepared for "Chem. & Met." by Prof. Ernst Berl, Research Professor at Carnegie Institute of Technology. Price . . 75¢

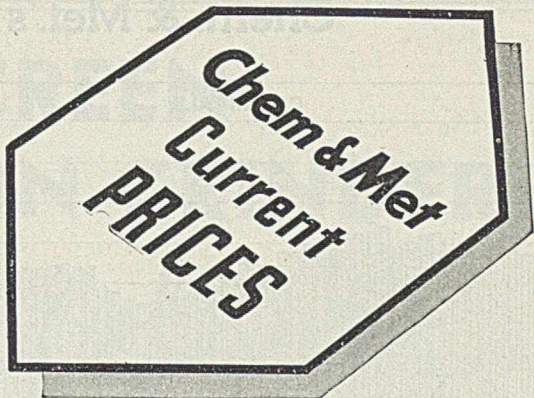


**CHEMICAL & METALLURGICAL
ENGINEERING**

330 West 42d Street,
New York, N. Y.

INDUSTRIAL CHEMICALS

	Current Price	Last Month	Last Year
Acetone, drums, lb.	\$0.074-\$0.08	\$0.074-\$0.08	\$0.054-\$0.064
Acid, acetic, 28%, bbl., cwt.	2.23 - 2.48	2.23 - 2.48	2.23 - 2.48
Glacial 99%, drums.	8.43 - 8.68	8.43 - 8.68	8.43 - 8.68
U. S. P. reagent.	10.25 - 10.50	10.25 - 10.50	10.25 - 10.50
Boric, bbl., ton.	106.00-111.00	106.00-111.00	106.00-111.00
Citric, kegs, lb.	.20 - .23	.20 - .23	.20 - .23
Formic, c'ys., lb.	.104 - .11	.104 - .11	.104 - .11
Gallic, tech., bbl., lb.	.90 - 1.00	.90 - 1.00	.70 - .75
Hydrofluoric 30% drums, lb.	.08 - .084	.08 - .084	.07 - .074
Lactic, 44%, tech., light, bbl., lb.	.064 - .064	.064 - .064	.064 - .064
Muriatic, 18%, tanks, cwt.	1.05 - .	1.05 - .	1.05 - .
Nitric, 36°, carboys, lb.	.05 - .054	.05 - .054	.05 - .054
Oleum, tanks, wks., ton.	18.50 - 20.00	18.50 - .	18.50 - 20.00
Oxalic, crystals, bbl., lb.	.104 - .12	.104 - .12	.104 - .12
Phosphoric, tech., c'ys., lb.	.074 - .084	.074 - .084	.074 - .084
Sulphuric, 60°, tanks, ton.	13.00 - .	13.00 - .	13.00 - .
Sulphuric, 66°, tanks, ton.	16.50 - .	16.50 - .	16.50 - .
Tannic, tech., bbl., lb.	.54 - .56	.54 - .56	.40 - .45
Tartaric, powd., bbl., lb.	.394 - .	.394 - .	.274 - .
Tungstic, bbl., lb.	nom. - .	nom. - .	2.35 - .
Alcohol, amyl.	. - .	. - .	. - .
From Pentane, tanks, lb.	.101 - .	.101 - .	.101 - .
Alcohol, Butyl, tanks, lb.	.09 - .	.09 - .	.07 - .
Alcohol, Ethyl, 190 p'f., bbl., gal.	5.98 - .	5.98 - .	4.54 - .
Denatured, 190 proof.	. - .	. - .	. - .
No. 1 special, bbl., gal. wks.	.294 - .	.294 - .	.264 - .
Alum, ammonia, lump, bbl., lb.	.034 - .04	.034 - .04	.034 - .04
Potash, lump, bbl., lb.	.034 - .04	.034 - .04	.034 - .04
Aluminum sulphate, com. bags, cwt.	1.15 - 1.40	1.15 - 1.40	1.15 - 1.40
Iron free, bg., cwt.	1.60 - 1.70	1.60 - 1.70	1.30 - 1.55
Aqua ammonia, 26°, drums, lb., tanks, lb.	.024 - .03	.024 - .03	.02 - .03
Ammonia, anhydrous, cyl., lb., tanks, lb.	.16 - .	.16 - .	.154 - .16
Ammonium carbonate, powd. tech., casks, lb.	.09 - .12	.09 - .12	.08 - .12
Sulphate, wks., cwt.	1.40 - .	1.40 - .	1.40 - .
Amylacetate tech., from pentane, tanks, lb.	.114 - .	.114 - .	.104 - .104
Antimony Oxide, bbl., lb.	.13 - .	.13 - .	.10 - .
Arsenic, white, powd., bbl., lb.	.034 - .034	.03 - .034	.03 - .034
Red, powd., kegs, lb.	.17 - .18	.17 - .18	.154 - .16
Barium carbonate, bbl., ton.	52.50 - 57.50	52.50 - 57.50	52.50 - 57.50
Chloride, bbl., ton.	79.00 - 81.00	79.00 - 81.00	79.00 - 81.00
Nitrate, casks, lb.	.084 - .10	.084 - .10	.07 - .08
Blanc fixe, dry, bbl., lb.	.034 - .04	.034 - .04	.034 - .04
Bleaching powder, f. o. b., wks., drums, cwt.	2.00 - 2.10	2.00 - 2.10	2.00 - 2.10
Borax, gran., bags, ton.	43.00 - .	43.00 - .	48.00 - 51.00
Bromine, cs., lb.	.30 - .32	.30 - .32	.30 - .32
Calcium acetate, bags.	1.90 - .	1.90 - .	1.65 - .
Arsenate, dr., lb.	.064 - .064	.064 - .064	.064 - .07
Carbide drums, lb.	.044 - .05	.044 - .05	.05 - .06
Chloride, fused, dr., del., ton.	19.00 - 24.50	19.00 - 24.50	21.50 - 24.50
flake, dr., del., ton.	20.50 - 25.00	20.50 - 25.00	23.00 - 25.00
Phosphate, bbl., lb.	.074 - .08	.074 - .08	.074 - .08
Carbon bisulphide, drums, lb.	.05 - .06	.05 - .06	.05 - .06
Tetrachloride drums, lb.	.044 - .054	.044 - .054	.044 - .054
Chlorine, liquid, tanks, wks., lb.	1.75 - .	1.75 - .	1.75 - .
Cylinders.	.054 - .06	.054 - .06	.054 - .06
Cobalt oxide, cans, lb.	1.84 - 1.87	1.84 - 1.87	1.67 - 1.70
Coppers, bgs., f. o. b., wks., ton.	18.00 - 19.00	18.00 - 19.00	15.00 - 16.00
Copper carbonate, bbl., lb.	10 - .164	10 - .164	10 - .16
Sulphate, bbl., cwt.	4.45 - 4.70	4.60 - 4.85	4.25 - 4.60
Cream of tartar, bbl., lb.	.344 - .	.344 - .	.22 - .
Diethylene glycol, dr., lb.	.22 - .23	.22 - .23	.22 - .23
Epsom salt, dom., tech., bbl., cwt.	1.80 - 2.00	1.80 - 2.00	1.80 - 2.00
Ethyl acetate, drums, lb.	.07 - .	.07 - .	.064 - .
Formaldehyde, 40%, bbl., lb.	.054 - .06	.054 - .064	.054 - .064
Furfural, tanks, lb.	.09 - .	.09 - .	.09 - .
Fusel oil, ref. drums, lb.	.16 - .17	.16 - .17	.124 - .14
Glaubers salt, bags, cwt.	.95 - 1.00	.95 - 1.00	.95 - 1.00
Glycerine, c.p., drums, extra, lb.	.124 - .	.124 - .	.124 - .
Lead:			
White, basic carbonate, dry casks, lb.	.07 - .	.07 - .	.07 - .
White, basic sulphate, sk., lb.	.064 - .	.064 - .	.064 - .
Red, dry, sk., lb.	.074 - .	.074 - .	.0735 - .
Lead acetate, white crys., bbl., lb.	.11 - .12	.11 - .12	.10 - .11
Lead arsenate, powd., bag, lb.	.084 - .11	.084 - .11	.10 - .104
Lime, chem., bulk, ton.	8.50 - .	8.50 - .	8.50 - .
Litharge, p'wd., sk., lb.	.064 - .	.064 - .	.064 - .
Lithophone, bags, lb.	.036 - .04	.036 - .04	.04 - .044
Magnesium carb., tech., bags, lb.	.064 - .064	.064 - .064	.06 - .064



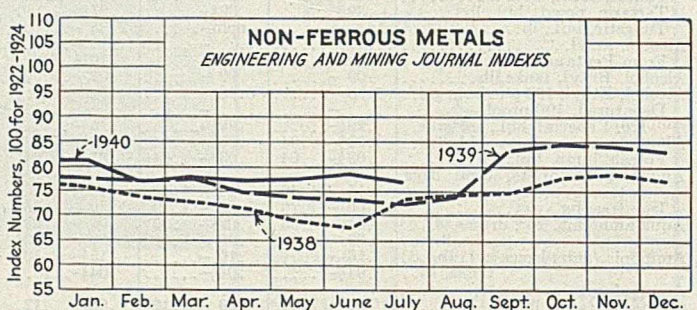
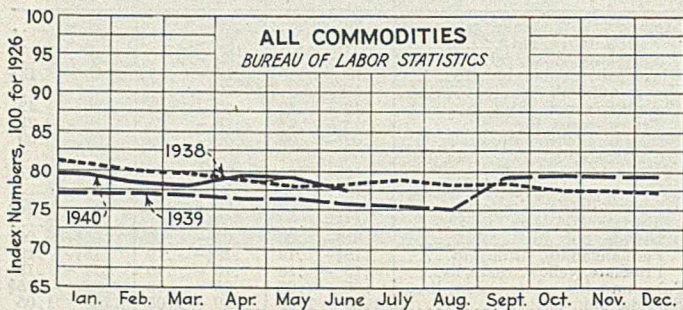
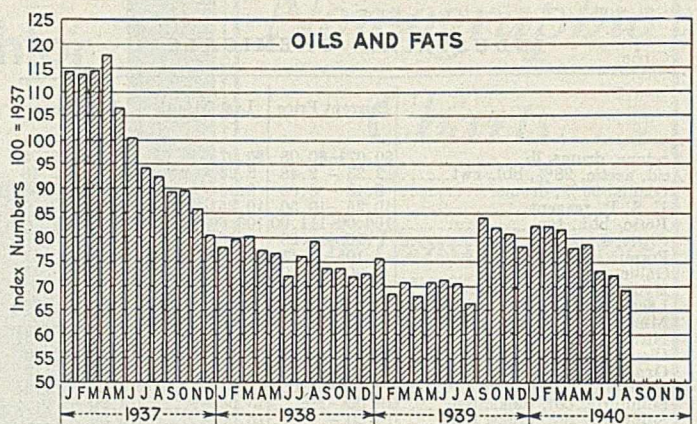
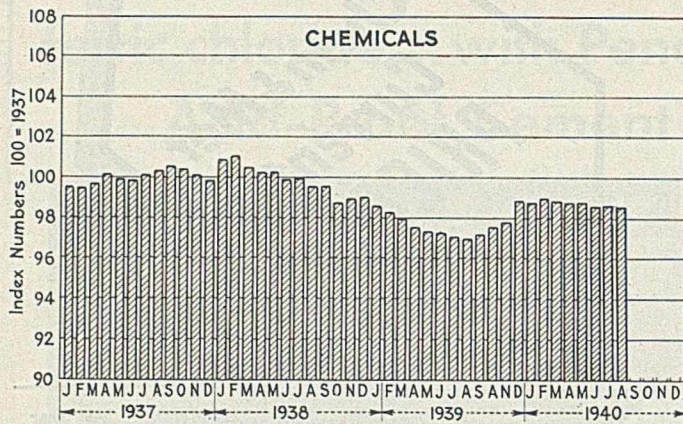
	Current Price	Last Month	Last Year
Methanol, 95%, tanks, gal.	.29 - .	.29 - .	.31 - .
97%, tanks, gal.	.30 - .	.30 - .	.32 - .
Synthetic, tanks, gal.	.30 - .	.30 - .	.33 - .
Nickel salt, double, bbl., lb.	.13 - .134	.13 - .134	.13 - .134
Orange mineral, csk., lb.	.104 - .	.104 - .	.104 - .
Phosphorus, red, cases, lb.	.40 - .42	.40 - .42	.40 - .42
Yellow, cases, lb.	.18 - .25	.18 - .25	.18 - .25
Potassium bichromate, casks, lb.	.084 - .09	.084 - .09	.084 - .09
Carbonate, 80-85%, calc. csk., lb.	.064 - .07	.064 - .07	.064 - .07
Chlorate, powd., lb.	.10 - .12	.10 - .12	.094 - .
Hydroxide (caustic potash) dr., lb.	.07 - .074	.07 - .074	.07 - .074
Muriate, 80% bgs., unit.	.534 - .	.534 - .	.534 - .
Nitrate, bbl., lb.	.054 - .06	.054 - .06	.054 - .06
Pernanganate, drums, lb.	.184 - .19	.184 - .19	.184 - .19
Prussiate, yellow, casks, lb.	.15 - .16	.15 - .16	.14 - .15
Sal ammoniac, white, casks, lb.	.05 - .06	.05 - .06	.05 - .054
Salsoda, bbl., cwt.	1.00 - 1.05	1.00 - 1.05	1.00 - 1.05
Salt cake, bulk, ton.	23.00 - .	23.00 - .	13.00 - 15.00
Soda ash, light, 58%, bags, contract, cwt.	1.05 - .	1.05 - .	1.05 - .
Dense, bags, cwt.	1.10 - .	1.10 - .	1.10 - .
Soda, caustic, 76%, solid, drums, cwt.	2.30 - 3.00	2.30 - 3.00	2.30 - 3.00
Acetate, works, bbl., lb.	.04 - .05	.04 - .05	.04 - .05
Bicarbonate, bbl., cwt.	1.70 - 2.00	1.70 - 2.00	1.70 - 2.00
Bichromate, casks, lb.	.064 - .07	.064 - .07	.064 - .07
Bisulphate, bulk, ton.	16.00 - 17.00	15.00 - 16.00	15.00 - 16.00
Bisulphite, bbl., lb.	.03 - .04	.03 - .04	.034 - .04
Chlorate, kegs, lb.	.064 - .064	.064 - .064	.064 - .064
Cyanide, cases, dom., lb.	.14 - .15	.14 - .15	.14 - .15
Fluoride, bbl., lb.	.07 - .08	.07 - .08	.074 - .08
Hyposulphite, bbl., cwt.	2.40 - 2.50	2.40 - 2.50	2.40 - 2.50
Metasilicate, bbl., cwt.	2.35 - 2.40	2.35 - 2.40	2.20 - 3.20
Nitrate, bulk, cwt.	1.45 - .	1.45 - .	1.45 - .
Nitrite, casks, lb.	.064 - .07	.064 - .07	.064 - .07
Phosphate, tribasic, bags, lb.	2.25 - .	2.25 - .	2.10 - .
Prussiate, yel. drums, lb.	.104 - .11	.104 - .11	.094 - .10
Silicate (40° dr.) wks., cwt.	.80 - .85	.80 - .85	.80 - .85
Sulphide, fused, 60-62%, dr., lb.	.024 - .034	.024 - .03	.024 - .03
Sulphite, crys., bbl., lb.	.024 - .024	.024 - .024	.024 - .024
Sulphur, crude at mine, bulk, ton.	16.00 - .	16.00 - .	18.00 - .
Chloride, dr., lb.	.03 - .04	.03 - .04	.03 - .04
Dioxide, cyl., lb.	.07 - .08	.07 - .08	.07 - .074
Flour, bag, cwt.	1.60 - 3.00	1.60 - 3.00	1.60 - 3.00
Tin Oxide, bbl., lb.	.51 - .	.51 - .	.52 - .
Crystals, bbl., lb.	.394 - .	.414 - .	.38 - .
Zinc chloride, gran., bbl., lb.	.05 - .06	.05 - .06	.05 - .06
Carbonate, bbl., lb.	.14 - .15	.14 - .15	.14 - .15
Cyanide, dr., lb.	.33 - .35	.33 - .35	.33 - .35
Dust, bbl., lb.	.084 - .	.084 - .	.084 - .
Zinc oxide, lead free, bag., lb.	.064 - .	.064 - .	.064 - .
5% lead sulphate, bags, lb.	.064 - .	.064 - .	.064 - .
Sulphate, bbl., cwt.	3.05 - 3.25	2.75 - 3.00	2.75 - 3.00

OILS AND FATS

	Current Price	Last Month	Last Year
Castor oil, 3 bbl., lb.	\$0.114-\$0.12	\$0.114-\$0.12	\$0.084-\$0.10
Chinawood oil, bbl., lb.	.25 - .	.25 - .	.22 - .
Coconut oil, Ceylon, tank, N. Y., lb.	.024 - .	.034 - .	.024 - .
Corn oil crude, tanks (f. o. b. mill), lb.	.05 - .	.054 - .	.05 - .
Cottonseed oil, crude (f. o. b. mill), tanks, lb.	.044 - .	.054 - .	.044 - .
Linseed oil, raw car lots, bbl., lb.	.088 - .	.094 - .	.087 - .
Palm, casks, lb.	.034 - .	.044 - .	.034 - .
Peanut oil, crude, tanks (mill), lb.	.054 - .	.054 - .	.054 - .
Rapeseed oil, refined, bbl., gal.	1.10 - .	1.05 - .	.81 - .
Soya bean, tank, lb.	.044 - .	.044 - .	.044 - .
Sulphur (olive foots), bbl., lb.	.084 - .	.09 - .	.064 - .
Cod, Newfoundland, bbl., gal.	nom. - .	nom. - .	.32 - .
Menhaden, light pressed, bbl., lb. Crude, tanks (f. o. b. factory), gal.	.067 - .	.074 - .	.056 - .
Grease, yellow, loose, lb.	.35 - .	.33 - .	.24 - .
Oleo stearine, lb.	.034 - .	.04 - .	.04 - .
Oleo oil, No. 1.	.054 - .	.06 - .	.054 - .
Red oil, distilled, d.p. bbl., lb.	.064 - .	.064 - .	.074 - .
Tallow extra, loose, lb.	.034 - .	.044 - .	.044 - .

The accompanying prices refer to round lots in the New York market. Where it is the trade custom to sell f.o.b. works, quotations are given on that basis and are so designated. Prices are corrected to August 12

Chem. & Met.'s Weighted Price Indexes



Coal-Tar Products

	Current Price	Last Month	Last Year
Alpha-naphthol, crude bbl., lb.	\$0.52 - \$0.55	\$0.52 - \$0.55	\$0.52 - \$0.55
Alpha-naphthylamine, bbl., lb.	.32 - .34	.32 - .34	.32 - .34
Aniline oil, drums, extra, lb.	.15 - .16	.15 - .16	.15 - .16
Aniline, salts, bbl., lb.	.22 - .24	.22 - .24	.22 - .24
Benzaldehyde, U.S.P., dr., lb.	.85 - .95	.85 - .95	.85 - .95
Benzidine base, bbl., lb.	.70 - .75	.70 - .75	.70 - .75
Benzoic acid, U.S.P., kgs., lb.	.54 - .56	.54 - .56	.54 - .56
Benzyl chloride, tech., dr., lb.	.23 - .25	.23 - .25	.23 - .25
Benzol, 90%, tanks, works, gal.	.15 - .16	.16 - .18	.16 - .18
Beta-naphthol, tech., drums, lb.	.23 - .24	.23 - .24	.23 - .24
Cresol, U.S.P., dr., lb.	.09 - .10	.09 - .10	.10 - .11
Cresylic acid, dr., wks., gal.	.58 - .60	.58 - .60	.69 - .71
Diethylaniline, dr., lb.	.40 - .45	.40 - .45	.40 - .45
Dinitrophenol, bbl., lb.	.23 - .25	.23 - .25	.23 - .25
Dinitrotoluol, bbl., lb.	.15 - .16	.15 - .16	.15 - .16
Dip oil, 15%, dr., gal.	.23 - .25	.23 - .25	.23 - .25
Diphenylamine, bbl., lb.	.25 - .27	.32 - .36	.32 - .36
H-acid, bbl., lb.	.45 - .50	.45 - .55	.50 - .55
Naphthalene, flake, bbl., lb.	.07 - .07	.06 - .07	.05 - .06
Nitrobenzene, dr., lb.	.08 - .09	.08 - .09	.08 - .09
Para-nitraniline, bbl., lb.	.47 - .49	.47 - .49	.47 - .49
Phenol, U.S.P., drums lb.	.13 - .14	.13 - .14	.14 - .15
Picric acid, bbl., lb.	.35 - .40	.35 - .40	.35 - .40
Pyridine, dr., gal.	1.70 - 1.80	1.70 - 1.80	1.55 - 1.60
Resorcinol, tech., kegs, lb.	.75 - .80	.75 - .80	.75 - .80
Salicylic acid, tech., bbl., lb.	.33 - .40	.33 - .40	.33 - .40
Solvent naphtha, w.w., tanks, gal.	.27 - .27	.27 - .27	.26 - .26
Tolidine, bbl., lb.	.86 - .88	.86 - .88	.86 - .88
Toluol, drums, works, gal.	.30 - .30	.30 - .30	.27 - .27
Xylol, com, tanks, gal.	.26 - .26	.27 - .27	.26 - .26

Miscellaneous

	Current Price	Last Month	Last Year
Barytes, grd., white, bbl., ton	\$22.00-\$25.00	\$22.00-\$25.00	\$22.00-\$25.00
Casein, tech., bbl., lb.	.11 - .13	.12 - .13	.09 - .11
China clay, dom., f.o.b. mine, ton	8.00 - 20.00	5.00 - 20.00	8.00 - 20.00
Dry colors			
Carbon gas, black (wks.), lb.	.028 - .30	.028 - .30	.02 - .30
Prussian blue, bbl., lb.	.36 - .37	.36 - .37	.36 - .37
Ultramarine blue, bbl., lb.	.11 - .26	.11 - .26	.10 - .26
Chrome green, bbl., lb.	.21 - .30	.028 - .30	.21 - .27
Carmine red, tins, lb.	4.85 - 5.00	4.85 - 5.00	4.00 - 4.40
Para toner, lb.	.75 - .80	.75 - .80	.75 - .80
Vermilion, English, bbl., lb.	nom.	nom.	1.57 - 1.58
Chrome yellow, C.P., bbl., lb.	.14 - .15	.14 - .15	.14 - .15
Feldspar, No. 1 (f.o.b. N.C.), ton	6.50 - 7.50	6.50 - 7.50	6.50 - 7.50
Graphite, Ceylon, lump, bbl., lb.	.06 - .06	.06 - .06	.06 - .06
Gum copal Congo, bags, lb.	.08 - .30	.08 - .30	.06 - .30
Manila, bags, lb.	.09 - .15	.09 - .14	.09 - .14
Damar, Batavia, cases, lb.	.10 - .22	.10 - .20	.08 - .24
Kauri, cases, lb.	.18 - .60	.18 - .60	.18 - .60
Kieselguhr (f.o.b. N.Y.), ton	50.00 - 55.00	50.00 - 55.00	50.00 - 55.00
Magnesite, calc. ton	50.00 - .00	50.00 - .00	50.00 - .00
Pumice stone, lump, bbl., lb.	.05 - .07	.05 - .08	.05 - .07
Imported casks, lb.	.03 - .04	.03 - .04	.03 - .04
Rosin H., 100 lb.	2.22 - .00	.00 - .00	.00 - .00
Turpentine, gal.	.33 - .32	.32 - .30	.30 - .30
Shellac, orange, fine, bags, lb.	.26 - .26	.26 - .26	.19 - .19
Bleached, bonded, bags, lb.	.25 - .25	.25 - .25	.18 - .18
T. N. Bags, lb.	.14 - .13	.13 - .10	.10 - .10
Soapstone (f.o.b. Vt.), bags, ton	10.00 - 12.00	10.00 - 12.00	10.00 - 12.00
Talc. 200 mesh (f.o.b. Vt.), ton	8.00 - 8.50	8.00 - 8.50	8.00 - 8.50
300 mesh (f.o.b. Ga.), ton	7.50 - 10.00	7.50 - 10.00	7.50 - 11.00
225 mesh (f.o.b. N.Y.), ton	13.75 - .00	13.75 - .00	13.75 - .00

Industrial Notes

SEMET-SOLVEY Co., New York, has acquired control of the Wilputte Coke Oven Corp. Louis Wilputte and his staff will be associated with the purchasing company.

THE MEDART Co., St. Louis, has purchased the entire wood pulley stock of the Reeves Pulley Co. which discontinued the manufacture of wood split pulleys as of July 1.

PITTSBURGH EQUITABLE METER Co., Pittsburgh, and its subsidiary the Merco Nordstrom Valve Co., are serving their mid-west customers with completely equipped field service trucks operating out of Chicago and Tulsa.

AMERICAN ASPHALT PAINT Co., Chicago, and the MARIETTA PAINT AND COLOR Co., Marietta, Ohio, have been consolidated under the name of the AMERICAN-MARIETTA Co.

BAKELITE CORP. and HALOWAX CORP., New York, have moved their offices from 247 Park Ave. to 30 East 42d St.

GLOBE STEEL TUBES Co., Milwaukee, has appointed Neal E. Boeckler assistant manager of sales at St. Louis; Gilbert H. Krohn, sales agent at Chicago; and Clarence A. Schroeder, manager of sales at Milwaukee.

AUDUBON WIRE CLOTH CORP., Philadelphia, has appointed H. W. Paret, Jr., Bessemer Bldg., Pittsburgh, as sales representative in western Pennsylvania, eastern Ohio, and West Virginia.

MANNING, MAXWELL & MOORE, INC., Bridgeport, Conn., has changed the name of its Ashcroft American gauge division to Ashcroft gauge division.

ANSBACHER-S-EGLE CORP., Rosebank, S. I.,

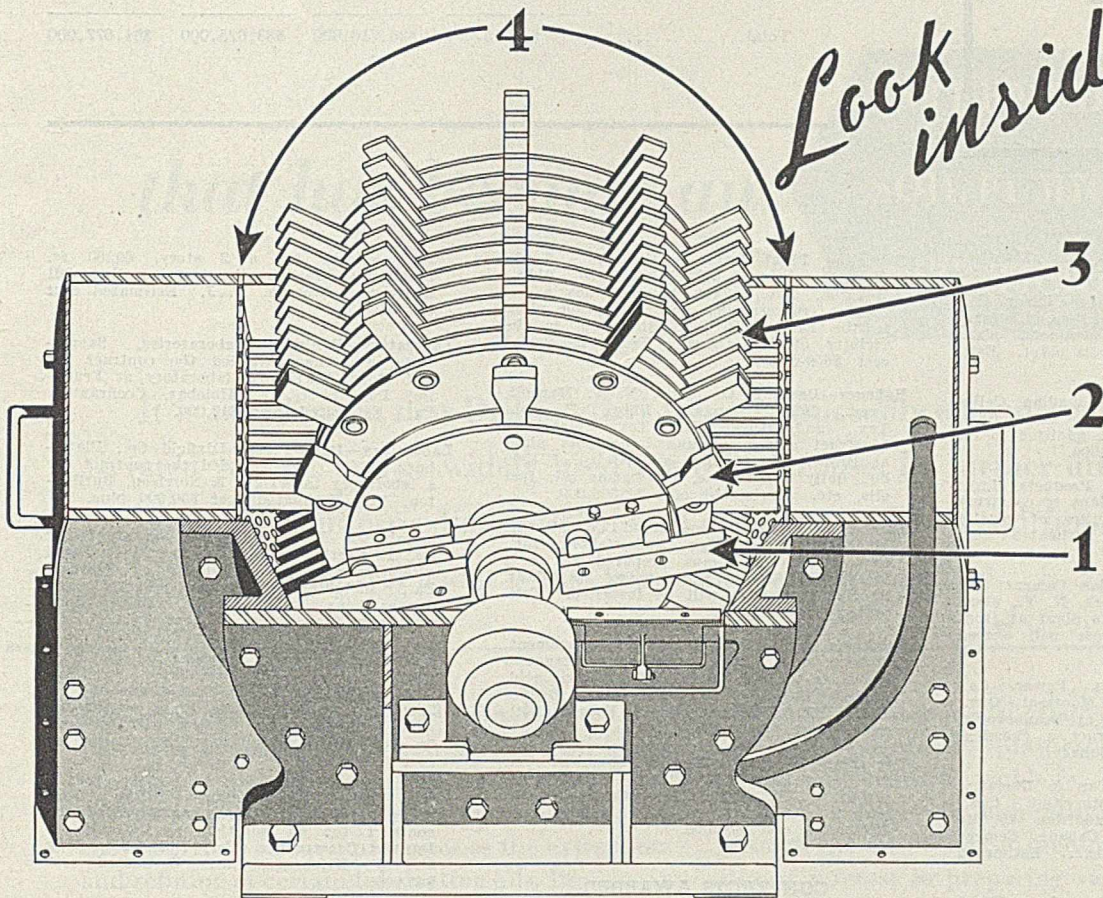
N. Y., has opened an office at 820 South Clinton St., Chicago with H. M. Cotey in charge.

THE STROOCK & WITTENBERG CORP., New York, has appointed J. A. Burns as its sales representative in the Pittsburgh district with headquarters in the Vandergrift Bldg.

PENNSYLVANIA SALT MFG. Co., Philadelphia, has appointed H. M. Ellsworth advertising manager to succeed Miss I. J. Denney who resigned on July 1.

THE ZIALITE CORP., Mt. Vernon, N. Y., has moved to Worcester, Mass., to take better advantage of the services of its technical director, Dr. Ernest D. Wilson who was recently appointed head of the department of chemical engineering and chemistry at Worcester Polytechnic Institute.

PRATER DUAL SCREEN TRIPLE REDUCTION GRINDERS



1. Breaker Bars break up the material with short, powerful blows.
2. The crushers combine cutting and crushing action and distribute the material for final grinding.
3. Selected types of fast flying hammers are used solely for final grinding and reduction to size.
4. Dual Screens increase screen capacity to 70 per cent of the grinding area.

Prater Dual Screen Triple Reduction Grinders are impact grinders—but impact grinders of an entirely different type.

The material is fed from the side through three successive stages of breaking, crushing or cutting, and final grinding to size. The instant the

material is ground to size the screen area is available to sift it out. The result is greater capacity, closer control of grain size, and lower power cost—the guaranteed basis on which every Prater Processing Unit is installed. The dual screen mill is only one of the many types of grinders that Prater builds.

PRATER PULVERIZER COMPANY
1801 SOUTH 55TH AVENUE, CHICAGO, ILL.

PROCESSING EQUIPMENT

Eastern Representatives:
BROWN & SITES COMPANY
30 CHURCH STREET, NEW YORK CITY

Chem & Met New CONSTRUCTION

PROPOSED WORK

Asbestos Products Plant—Philip Carey Co., Ltd., Lennoxville, Que., Can., manufacturer of asbestos and asphalt products, plans to construct an addition to its plant. Estimated cost \$50,000.

Cellucotton Products Plant—Canadian Cellucotton Products, Ltd., Niagara Falls, Ont., Can., plans to construct an addition to its plant. Estimated cost \$50,000.

Cellulose Plant—Gordon Fox Products, Ltd., Wallaceburg, Ont., Can., plans to construct a plant for the manufacture of plastic cellulose coatings, etc. Estimated cost \$40,000.

Cement Plant—Universal Atlas Cement Co., 135 East 42nd St., New York, N. Y., plans to construct additions to its plant at Hudson, N. Y. Estimated cost will exceed \$100,000.

Chemical Plant—Beauharnois Power Co., Ltd., 107 Craig St., W., Montreal, Que., Can., has purchased a site at Beauharnois, Que., and plans to construct a chemical plant. Estimated cost \$250,000.

Chemical Plant—Dominion Tar & Chemical Co., 14 Morse St., Toronto, Ont., Can., plans to construct an addition to its plant. W. E. Kinney, Canada Cement Bldg., Montreal, Que., Engr. Estimated cost \$60,000.

Chemical Plant—Refining Co., Inc., 30-30 Northern Blvd., Long Island City, N. Y., and New Mexico, has purchased a site on North Tryon St., Charlotte, N. C., and will construct a building to be used as a research laboratory and demonstration plant for its vegetable oil processes. B. H. Thurman, address above, Pres. J. N. Pease & Co., Johnston Bldg., Charlotte, N. C., Archt.

Chemical Plant—Stevens Chemical Products Co., Ltd., R. W. Brown, Gen. Mgr., 790 Coxwell St., Toronto, Ont., Can., plans to construct a plant for the manufacture of chemicals, compounds, etc. Estimated cost \$50,000.

Chemical Research Building—Sherwin-Williams Co., paint manufacturers, East 115th St. and South Cottage Grove Ave., Chicago, Ill., will soon receive bids for a 1 story, 100x300 ft. chemical research building at Calumet, Ill.

Crude Oil Refinery—Manville Crude Oil Co., Manville, Wyo., contemplates the construction of a refinery at Fort Pierre, S. D. Estimated cost \$50,000.

Cyanamid Plant—North American Cyanamid, Ltd., Fourth St., Niagara Falls, Ont., Can., will soon receive bids for the construction of a plant in Stamford Twp., Niagara Falls. Estimated cost \$3,000,000.

Patent Medicine Plant—Carter Products, Inc., 52 Park Pl., New York, N. Y., is having plans prepared by Albert Kahn, Inc., Archt., New Center Bldg., Detroit, Mich., for a 1 story plant at New Brunswick, N. J. Estimated cost \$500,000.

Plant—Southern Alkali Corp., c/o O. N. Stevens, Vice Pres., Corpus Christi, Tex., plans to enlarge its plant at Corpus Christi.

Recycling Plant—Davis & Co., Inc., N. V. Hansell, Pres., 1322 Commerce Bldg., Houston, Tex., plans to construct a recycling, repressuring and absorption plant in the Rincon Field of Starr Co. in the vicinity of Rio Grande, Tex. Estimated cost \$650,000.

Refinery—Davis & Co., Inc., N. V. Hansell, Pres., 1322 Commerce Bldg., Houston, Tex., and Brownsville, Tex., plans to construct a refinery and byproducts plant at Brownsville to have a capacity of 1500 bbl. daily of gasoline, lubricating oil, fuel oils, etc. Estimated cost \$2,500,000.

Soda Ash Plant—Brunner-Mond Co., C. K. MacFetridge, Gen. Mgr., Amherstburg, Ont., Can., is having plans prepared for a 1 story, 50x100 ft. addition to its plant. Special equipment will be installed. Estimated cost \$45,000.

Sulphuric Acid Plant—Dominion Government, Ottawa, Ont., Can., plans to construct a plant for the manufacture of sulphuric acid. Nichols Chemical Co., Ltd., 1111 Beaver Hall Hill, Montreal, Que., Engr. Estimated cost \$1,000,000.

Tar Plant—Northern Tar & Chemical Co., Ltd., c/o Donald A. Thompson, 42 Lansdowne St., Winnipeg, Man., Can., plans to construct a plant at Port Arthur, Ont. Estimated cost \$50,000.

CONTRACTS AWARDED

Acetone Refinery—Vegetable Oil Products Co., 410 South Avalon Blvd., Wilmington, Calif., has awarded the contract for a refinery to Associated Piping & Engineering Co., 2332 East 38th St., Los Angeles. Estimated cost \$40,000.

Carbide Plant—Pacific Carbide & Alloys Co., North Columbia Blvd. at Hurst St., Portland, Ore., has awarded the contract for a carbide plant to L. H. Hoffman Co., 715 SW Columbia Bldg., Portland. Estimated cost \$250,000.

Cement Plant—Lone Star Cement Co., Santa Fe Bldg., Dallas, Tex., has awarded the contract for a cement manufacturing plant at Houston, Tex., to Tellepson Construction Co., 3900 Clay St., Houston. Estimated cost \$40,000.

Chemical Plant—Aridye Corp., Fair Lawn, N. J., has awarded the contract for a chemical manufacturing plant at Rock Hill, S. C., to Rock Hill Lumber Co., Rock Hill, S. C. Estimated cost \$40,000.

Chemical Plant—E. I. du Pont de Nemours & Co., National Ammonia Division, 1530 East Hancock St., Detroit, Mich., has awarded the contract for alterations to its chemical plant, also warehouse and office building, to Reisdorf & Brewer, 23 Rhode Island Ave., Highland Park, Mich. Estimated cost \$40,000.

Chemical Plant—Monsanto Chemical Co., Worcester St., Indian Orchard, Mass., has awarded the contract for a plant for the manufacture of resinox phenolic plastic moulding materials to J. R. Roy & Sons, 21 Silver St., Springfield, Mass. Estimated cost \$250,000.

Glass Factory—Scientific Glass Co., 49 Ackerman St., Bloomfield, N. J., has awarded

	Current Projects		Cumulative 1940	
	Proposed Work	Contracts	Proposed Work	Contracts
New England.....		\$350,000	\$280,000	\$788,000
Middle Atlantic.....	\$600,000	180,000	8,850,000	7,720,000
South.....	40,000	40,000	12,455,000	32,685,000
Middle West.....	40,000	25,215,000	7,190,000	3,880,000
West of Mississippi.....	3,240,000	140,000	24,255,000	16,296,000
Far West.....		290,000	4,990,000	2,148,000
Canada.....	4,595,000	495,000	25,605,000	1,160,000
Total.....	\$8,515,000	\$26,710,000	\$83,625,000	\$64,677,000

the contract for a 2 story, 60x80 ft. factory to Becker Construction Co., 361 Grove St., Newark, N. J. Estimated cost \$50,000.

Laboratory—Baldwin Laboratories, Saegertown, Pa., has awarded the contract for a 1 story, 55x150 ft. laboratory at Franklin, Pa., to G. F. Holobar, Cochranton, Pa. Estimated cost \$40,000.

Laboratory—Berst-Forster-Dixfield Co., Plattsburg, N. Y., has awarded the contract for a laboratory to Wright & Norrison, Burlington, Vt. Estimated cost \$50,000 plus.

Mineral Oil Refinery—Royal Manufacturing Co., 19 North First Av., Duquesne, Pa., will alter its mineral oil refinery at Warren, Pa., including laboratory, barrel and burner houses, etc. Work will be done with own forces.

Oil Refinery—Phoenix Refining Co., c/o Raymond Russell, 4527 Sommerset St., San Antonio, Tex., will construct a gasoline refinery in the Long Lake Field at Cayuga near Palestine, Tex. Work will be done by day labor and subcontracts. Estimated cost \$100,000.

Paper Mill—Alliance Paper Mills, Ltd., Georgetown, Ont., Can., has awarded the contract for an addition to its mill to Dunker Construction Co., Ltd., 251 King St., W. Kitchener, Ont. Estimated cost \$45,000.

Petroleum Development—Gulf Refining Co., Gulf Bldg., Pittsburgh, Pa., has awarded the contract for developing petroleum producing area in Ottawa Co., Mich., to Robert W. Atha, Mt. Pleasant, Mich. Estimated cost will exceed \$25,000.

Plant—Canadian Industries, Ltd., 1135 Beaver Hall Hill, Montreal, Que., Can., manufacturer of fertilizers, paints, varnishes, etc., has awarded the contract for a plant at Shawinigan Falls, Que., to Fraser-Brace Engineering Co., Ltd., 107 Craig St., W., Montreal. Estimated cost \$150,000.

Salt Manufacturing Plant—Neepawa Salt, Ltd., Neepawa, Man., Can., has awarded the contract for a plant consisting of six buildings to Carter-Halls-Aldinger, Ltd., Royal Bank Bldg., Winnipeg. Estimated cost \$300,000.

Soybean Plant—Old Forts Mills, Inc., Milling Co., P. Turner, Pres., North Grand and George Sts., Marion, O., will rebuild its soybean processing plant recently damaged by fire, by day labor. Estimated cost including equipment \$150,000.

Soap Factory—Oxford Soap Co., c/o Buck & Buck, Engrs., 650 Main St., Hartford, Conn., has awarded the contract for a 3 story, 74x115 ft. soap factory and a 1 story, 120x150 ft. warehouse at Manchester, Conn., to Bartlett-Brainard Co., 16 Van Dyke Ave., Hartford. Estimated cost \$100,000.

Smokeless Powder Plant—U. S. War Department, Washington, D. C., will construct a smokeless powder plant to have a daily capacity of 200,000 lb., at Jeffersonville, Ind. Work will be done by separate contracts under supervision of E. I. du Pont de Nemours & Co., Du Pont Bldg., Wilmington, Del. Estimated cost \$25,000,000.