objects and institutions thus invented were determined by the unguided operation of the principle of cause and effect or were regulated by conflict, competition, and the selection they brought in their train. Gradually however, and with increasing intensity in the last few years, man has become aware of the necessity for intelligent, purposeful regulation of these relationships. The interdependence of men in a world neighborhood makes necessary a new pattern of thought. The Age of Invention is even now giving way to the Age of Planning. . . . It is the responsibility of the scientist to make the machinery of planning consistent with the structure of the democratic society. A democratic form of coordinated control must be developed in the transition from the political state to the social service state. . . ."

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REPORTS

INDUSTRIAL RESEARCH IN THE UNITED STATES IN 1940[1]

THE total expenditure for basic production research in the United States in 1940 was probably $220,000,000. A nation-wide study was started by the Air Hygiene Foundation in attempting to reduce the estimated $900,000,000 a year lost to the industries by workers absent because of illness. The speed-up of production increases the hazards which result in many types of accidents and maladies. In a non-explosive coal-mining process a tube placed in a hole drilled in a vein expands when oil under high pressure is pumped into it. The Bureau of Mines reported on the hydrogenation of low-rank coals from the West. A satisfactory substitute for mica is needed and "Alsifilm" is being tried in lieu of mica splittings. A procedure of exploring for metal-bearing ores is based on the observation that plants growing over an ore body contain more of the metal in their tissues than plants from other places. American clays have displaced imported clays for many uses. "Duraglass" is a stronger bottle glass produced by automatic control; figured wire glass is made with chromium-plated wire. Valuable increases were reported in the light transmission of optical systems produced by suitable chemical treatment, such as with 1 per cent. nitric acid solution, to form low refractive index surface films; by following this process with a baking operation the glass surface is made much more durable. "Vycor" laboratory ware, which is 96 per cent. silica glass, is practically shockproof thermally; "Pyrex" highway reflecting markers have been pronounced successful by New York State engineers. Several new laboratories for powdered metals research were established. "Plast-Iron," a pure iron powder, was announced. The National Bureau of Standards studied the corrosion of metals used in aircraft. The casting of rods and tubes from molten metal is now performed continuously; wire is made by a process of slitting sheets instead of drawing metal through dies. The reduction of iron ores under pressure by carbon monoxide and the desulfurization of pig iron with calcium carbide were investigated. The output of information on all aspects of welding has continued. Uranium-nickel steels appear to be quite corrosion-resistant; silver-bearing 18/8 stainless steel is much more resistant to chloride solutions than the original alloy. The use of polonium in standard electrode alloys was found to improve the starting performance of spark plugs. Tellurium is employed in a new electric lamp. By an electrolytic process both plating with indium and its production in commercial quantities are possible. It is expected electrorefining of tin will attract more attention in the future. By the middle of 1942 the production of aluminum ingots will have expanded to 250 per cent. of the 1939 level. Advances were made in the knowledge of beryllium-aluminum and beryllium-magnesium alloys. Magnesium production was 13 million pounds in 1940 and will be doubled by the spring of 1942.

New processes were introduced for the stabilization of iodine in iodized carriers. A molten mixture of salts consisting of sodium nitrite and sodium and potassium nitrates is a heating and cooling liquid for industrial processes requiring high temperatures but where direct heating with an open flame is either dangerous or impracticable. The net cost of research in the field of synthetic organic chemicals was about 3½ per cent. of sales. Nitromethane, nitroethane, 1-nitropropane and 2-nitropropane are being manufactured commercially, and later on nitroparaffins with longer carbon chains will be available. Over 80 recently commercialized esters of polyhydric alcohols and their ethers were reported. Normal octanol and normal decanol are now available in quantity; the manufacture of adipic acid was started. The production of guanidine salts was markedly improved. Levulinic acid was made commercially. New non-volatile, water-soluble compounds, offered under the designation "Carbowax," are recommended for the paper and textile industries and as metal-working

[1] Abstract of a paper prepared for the *News Edition* of the American Chemical Society, published in the issue of January 10.

aids. Sulfathiazole, sulfadiazine and sulfaguanidine are new members of the sulfanilamide family. Drug manufacturers are reported to be studying hydroponics for growing drug plants now produced only in the Orient and for raising the drug content of plants. The four regional laboratories of the U. S. Department of Agriculture were made ready for occupancy. Potassium metaphosphate was described as a potential high-analysis fertilizer material. Better extraction of cottonseed oil is being studied; means are being sought to produce furfural from cottonseed hulls and to use the residual lignin for the production of a plastic. Glues for plywood from cotton and soybean proteins are being developed. Colchicine continued to get attention as an inductor of polyploidy in plants. Applied in the form of a solution containing as little as 1 part in 100 million parts of water, vitamin B_1 is reported to have displayed potentiality in horticulture. "Parmone" is a "liquid hormone spray" containing naphthalene acetic acid, for use in delaying the dropping of fruit from trees until they are ready to harvest. Bactericidal irradiation was put to wider use and the characteristics of the "Sterilamp" were reported. Food dehydration is being studied broadly. There has been considerable activity in research on food antioxidation. A new "synthetic" sausage casing consists of collagen; cholesterol is being produced commercially from beef spinal cords. The growth of research effort in the petroleum industry has been rapid, having expanded 539 per cent. in eleven years and having risen from seventh largest to second largest. The National Advisory Committee for Aeronautics selected Cleveland as the site for the Government's $8,400,000 airplane-engine research laboratory. Geochemical prospecting for underground oil was developed further. The tendency in motor fuels is toward the production of single hydrocarbons or a group of three or four in order that the combustion in automotive engines may be precisely controlled. The new "Polyform" process combining polymerization with cracking was disclosed. At least 10 petroleum refineries are using bauxite for bleaching paraffinic oils. Naphthenic acids extracted from lubricating oil fractions became commercially available. Development of new treatments for lumber is particularly important because much timber now cut is second-growth, which may have a large proportion of sapwood, thus making it more susceptible to staining. Urea is being used as an aid in seasoning lumber; wood can be easily bent by treatment with urea. Lignin has been referred to as the "greatest economic waste in the world to-day," and if ways can be found to hydrogenate lignin cheaply it may become the source of a whole new series of organic compounds. Newsprint was produced from southern yellow pine at Herty, Texas; the U. S. Forest Products Laboratory prepared newsprint by mixing unbleached semi-chemical pulp from southern gum trees with groundwood pulp from southern pine, and at Syracuse University newsprint was made from red pine. "Velo" cold-set ink and nickel ink were described; isophorone is used in improved inks, stencil pastes and roll-coating finishes. Research is in progress on the production of writing paper from low-grade cotton; paper made from cotton burs and stalks is under test in Texas. The U. S. Institute for Textile Research published the results of a broad program of textile-drying investigation; the U. S. Department of Agriculture contributed a new process for sterilizing textile fibers. Uses for cotton discussed by the National Cotton Council, which is supporting extensive investigation at Mellon Institute, included bale coverings, stabilizing road cuts and fills, protecting tree seedlings and beehives, bags for peanuts and fertilizers, and plastics.

"Vinyon" is being utilized in making a variety of felts. The production was announced of "Vinyon" yarn of 74 per cent. greater tensile strength than previously available. Thirty-six mills were licensed to make nylon hosiery and plans were approved for a second plant for the manufacture of nylon yarn at Martinsville, Va., with full operation scheduled for the spring of 1942. Dot patterns are being applied electrostatically on dress goods. The United States now manufactures 96 per cent. of its dyes. Dehydrated castor oil is displaying potentialities in the manufacture of quick-drying paint and varnish; tung oil is being deodorized. Road performance and life studies of low-pressure tires have shown a doubling of mileage since 1927, gains effected through research in materials, design and construction. Electrically conductive rubber is being commercialized. In so-called rubber synthesis researchers are not building a replica of nature's product but are shaping specific molecules to meet particular needs. About 2,000 tons of synthetic rubber were produced in this country during 1939, and around 11,000 tons were made in 1940; plans call for the production of at least 20,000 tons of rubber substitutes by the fall of 1941. A new process deep-draws sheets of cellulose acetate into various shapes. Outdoor furniture is made of woven extruded cellulose acetate-butyrate molding composition. The use of ethyl cellulose, benzyl cellulose, as well as "Vinylite" in commercial floor coverings, has been reported. A training monoplane was built with phenolic-impregnated spruce plywood; the Army Air Corps evolved a Bellanca "plastic plane" whose wings are formed plywood, bonded with a self-setting resin. Tractor seats molded from a soybean protein-formaldehyde plastic are in production. The output of "Vinylite" resins was increased several times and will

be tripled by a new plant. Calendered "Vinylite" sheets have applications as rubber and leather successors, particularly in articles of attire. The development of collapsible tubes formed of vinyl sheet material was reported. "Saran," a vinylidene-chloride thermoplastic resin, is employed in the manufacture of synthetic rattan. The production of melamine resins ("Melamac"), especially for laminating and surface coatings, was announced.

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SPECIAL ARTICLES

COMPLEMENT-FIXATION IN ENCEPHALITIS AND RABIES VIRUS INFECTIONS

THE use of brain extracts as an antigen in the complement-fixation test presents considerable difficulties on account of the anti-complementary and non-specific effects involved.[1] Mainly for this reason the test has remained unsatisfactory as a specific method for diagnosing central nervous system virus infections, especially when no other source of antigen than the infected brain is available.

A technique has now been devised, however, by which the disturbing variables have been largely removed or controlled. The main features of the procedure consist in (*a*) preparing the antigens from a heavy brain emulsion by repeated freezing and thawing and centrifugation in the angle head centrifuge; (*b*) inactivating the sera at the proper temperature according to the animal species.

Diluted guinea pig serum constitutes the complement. In each test it is titrated in duplicate in the presence of the antigens, and also in saline. One set of tubes is incubated for one half hour at 37° C., the other at icebox temperature 18 hours before addition of the hemolytic system. The former set at 37° C. determines the amount of complement to use in the later specific test and the latter set at icebox temperature, run with the specific test, indicates the validity of the result by showing the actual amount of free complement present in the system at the time the sensitized blood cells are added. This double titration discloses that some preparations, especially crude brain emulsions, when merely centrifuged in the horizontal centrifuge, show no anti-complementary effect following incubation at 37° C. but do have a strong inhibitory effect when kept in the cold for 18 hours. Thus they are unsuitable as antigens. Antigens prepared as described above, however, usually exhibit no anti-complementary effect until after at least 3 months' aging. The titre of the complement in the presence of antigen is the same as in saline at 37° C. and often even better. Two full units of complement in saline are used in the final specific reaction—an amount equivalent to 2, sometimes 2½ units in the presence of antigen at 37° C. The result of the titration of complement at icebox temperature usually parallels that at 37° C.; besides it gives more exact information on the inhibitory effect of the antigen than the usual antigen control.

TABLE I

EFFECT OF HEATING AT DIFFERENT TEMPERATURES FOR PERIODS OF 20 MINUTES ON THE SPECIFIC AND NON-SPECIFIC COMPLEMENT-FIXING POWER OF SEVERAL NORMAL AND IMMUNE SERA

Sera	56°		60°		65°	
	Homologous antigen	Heterologous antigen or normal brain	Homologous antigen	Heterologous antigen or normal brain	Homologous antigen	Heterologous antigen or normal brain
Rabies immune, Rabbit No. 1	*1/128	1/16	1/128	1/16	1/128	0
" " " No. 2	1/32	1/32	–	–	1/32	0
Eastern equine encephalomyelitis, Rabbit No. 3	1/96	1/24	–	–	1/48	0
Normal, Rabbit No. 4	–	1/16	–	1/16	–	0
Rabies immune, Guinea pig No. 1	1/12	0	1/6	–	1/3	–
" " " No. 2	1/96	0	–	–	1/24	–
Rabies immune, Mouse (pooled sera)	1/24	1/6	1/12	0	–	–

* 1/128 = Highest dilution at which serum gave a 2+ or better reaction.
0 = No reaction in any of the tubes, the first dilution being usually 1/3 or 1/4.
– = Not tested.

Infected mouse or dog brains have constituted the antigens. A suspension of infected brain is made up in ten times its weight with diluent consisting of 0.85 per cent. saline containing 2 per cent. inactivated normal guinea pig serum. This suspension remains in the icebox 14 to 20 hours and is then spun in a horizontal centrifuge at 2,500 r.p.m. for 30 minutes. The supernatant is removed, frozen and thawed five times in a dry ice-alcohol mixture, and spun in a Swedish angle centrifuge for 1 hour. The supernatant is again removed and, after the addition of 1/10,000 merthiolate, is stored in the icebox.

Sheep red blood cells plus anti-sheep hemolysin constitute the hemolytic system. The hemolysin is

[1] B. F. Howitt, *Jour. Immunol.*, 33: 235, 1937.