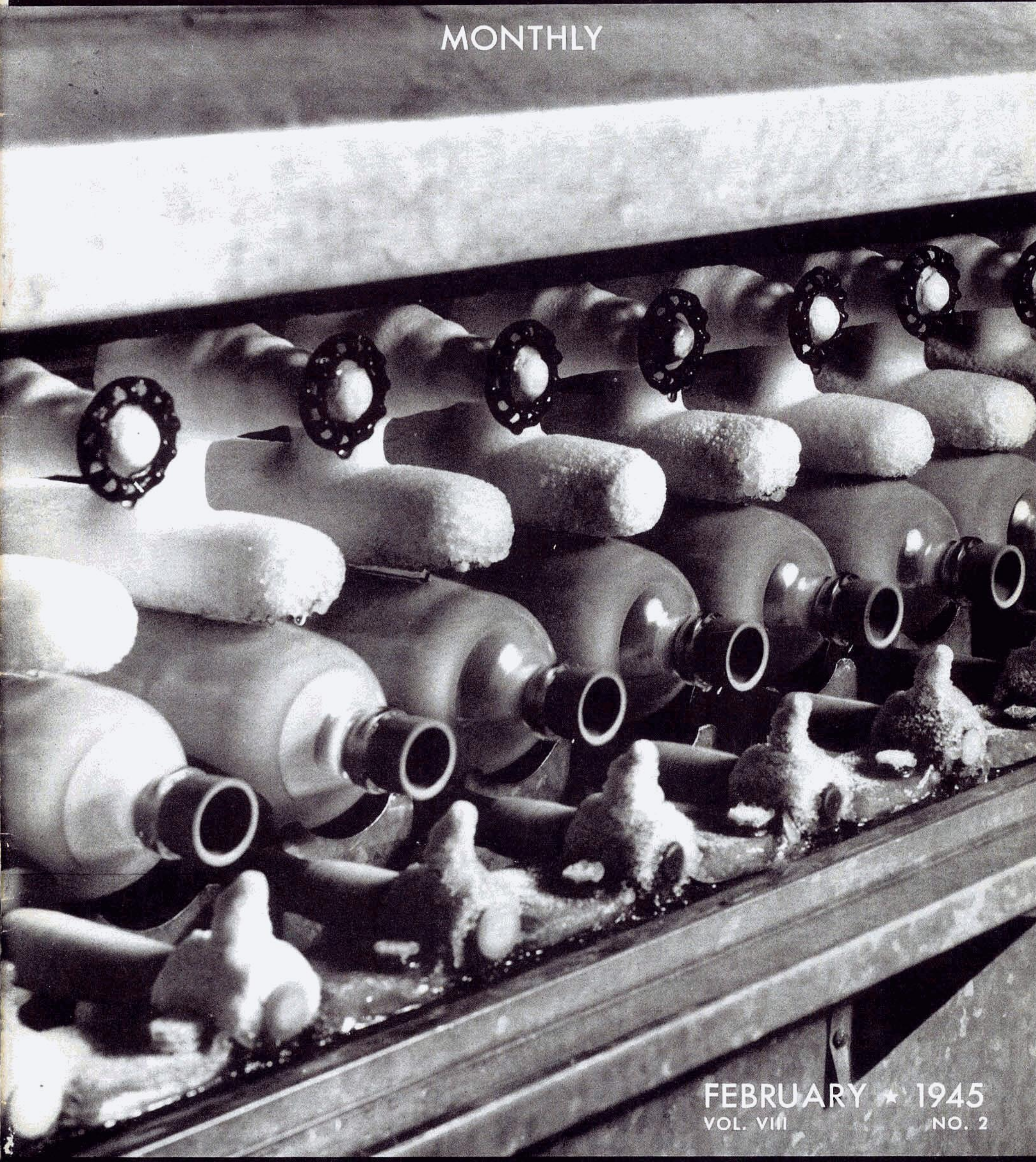
ENGINEERING AND SCIENCE

MONTHLY



FEBRUARY ★ 1945
VOL. VIII NO. 2

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Gun crew officers, in helmets and flash gear, keep careful watch following an attack on their carrier. Action took place in the Southwest Pacific. Officer at right is relaying observations by telephone.

There's still a tough war to win

—and the armed forces need vast amounts of telephone and electronic equipment.

THE telephone and radio on ships and planes have made a vast change in naval warfare.

Our Navy has more of these things than any other navy in the world. The battleship Wisconsin alone has enough telephones to serve a city of 10,000.

A great part of this naval equipment comes from the Western Electric Company, manufacturing branch of the Bell System.

That helps to explain why we here at home are short of telephones and switchboards.

BELL TELEPHONE SYSTEM

BY-LINES

HOWARD M. WINEGARDEN

Dr. Winegarden received all of his formal training at the California Institute of Technology, completing his Ph.D. degree in 1931. Since 1923 he has been connected with the research department at Cutter Laboratories, Berkeley, Calif. He maintained his connection with this firm while completing his higher degrees. For the last 15 years he has been Director of Research at Cutter Laboratories, manufacturers of biological and pharmaceutical products.

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ERNEST C. WATSON

Professor Watson received his Ph.B. degree from Lafayette College, Easton, Pa., in 1914, and was associated with the University of Chicago in the physics department prior to coming to the California Institute of Technology in 1919. He is now professor of physics at the Institute.

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PAUL H. HAMMOND

Paul H. Hammond received his B.S. degree at California Institute of Technology in 1936. He served as heating engineer for Southern California Gas Company of Los Angeles, Calif., until 1940 at which time he became affiliated with the Holly Heating and Manufacturing Company. As assistant general manager, he has been in charge of purchasing, priorities and personnel.

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COVER ILLUSTRATION

Equipment for rapid freezing or "shelling" of liquid plasma. Refrigerant flows over rotating bottles. See article pages 4 to 8.

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ENGINEERING AND SCIENCE

Monthly

The Truth Shall Make You Free

CONTENTS FOR FEBRUARY, 1945

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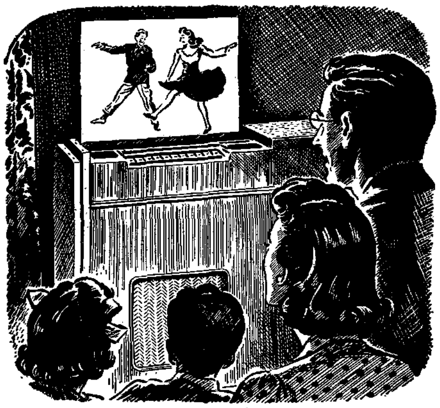
ENGINEERING AND SCIENCE MONTHLY

Edited at California Institute of Technology

General Electric answers your questions about

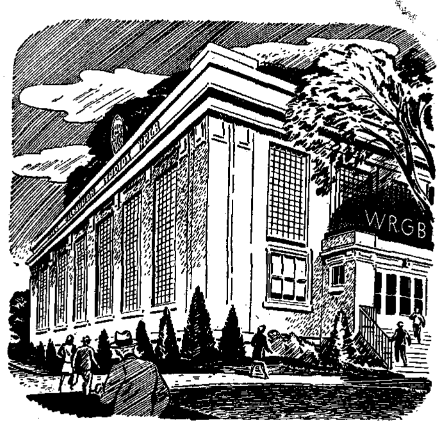
TELEVISION



Q. What will sets cost after the war?
A. It is expected that set prices will begin around $200, unless there are unforeseen changes in manufacturing costs. Higher priced models will also receive regular radio programs, and in addition FM and international shortwave programs. Perhaps larger and more expensive sets will include built-in phonographs with automatic record changers.

Q. How big will television pictures be?
A. Even small television sets will probably have screens about 8 by 10 inches. (That's as big as the finest of pre-war sets.) In more expensive television sets, screens will be as large as 18 by 24 inches. Some sets may project pictures on the wall like home movies. Naturally, pictures will be even clearer than those produced by pre-war sets.

Q. What kind of shows will we see?
A. All kinds. For example: (1) Studio stage shows—dancers, vaudeville, plays, opera, musicians, famous people. (2) Movies can be broadcast to you by television. (3) On-the-spot pick-up of sports events, parades, news happenings. G.E. has already produced over 900 television shows over its station, WRGB, in Schenectady.



Q. Where can television be seen now?
A. Nine television stations are operating today—in Chicago, Los Angeles, New York, Philadelphia, and Schenectady. Twenty-two million people—about one-fifth of all who enjoy electric service—live in areas served by these stations. Applications for more than 80 new television stations have been filed with the Federal Communications Commission.

Q. Will there be television networks?
A. Because television waves are practically limited by the horizon, networks will be accomplished by relay stations connecting large cities. General Electric set up the first network five years ago, and has developed new tubes that make relaying practical. G-E station WRGB, since 1939, has been a laboratory for engineering and programming.

Q. What is G. E.'s part in television?
A. Back in 1928, a General Electric engineer, Dr. E. F. W. Alexanderson, gave the first public demonstration. Before the war, G. E. was manufacturing both television transmitters and home receivers. It will again build both after Victory. Should you visit Schenectady, you are invited to WRGB's studio to see a television show put on the air.

TELEVISION, another example of G-E research

Developments by General Electric scientists and engineers, working for our armed forces in such new fields as electronics, of which television is an example, will help to bring you new products and services in the peace years to follow. *General Electric Company, Schenectady, N. Y.*

FOR VICTORY BUY AND HOLD WAR BONDS

Hear the General Electric radio program: "The G-E All-Girl Orchestra," Sunday 10 p.m. EWT, NBC—"The World Today" news, every weekday 6:45 p.m. EWT, CBS.

GENERAL ELECTRIC

952-623-211

ENGINEERING AND SCIENCE
Monthly

Vol. VIII, No. 2 February, 1945

The Month in Focus

Veteran Education

The act of Congress which provides for the education or continued education of returning veterans is arousing increased attention as ever-growing numbers of discharged service men are resuming participation in academic life. The situation already has presented many delicate problems, and it is obvious the act must be administered with care. The opportunity of a free education in institutions of higher learning may stimulate many to enter into college courses, but unless proper guidance and counsel is provided for these individuals, more harm than good may come from the program.

In some institutions, the existence of barriers such as entrance examinations may greatly reduce the assimilation of individuals into courses for which they do not have aptitude. However, the number of institutions which require entrance examinations is relatively small and is restricted principally to a few technical colleges. It may profit a man to pursue courses in liberal arts without definite objectives from the standpoint of general improvement of intellect, but increased earning power may not be effected by such a procedure. By proper counselling, the individual may be directed toward courses which will provide training in a specific field for which he has an aptitude and which will qualify him to secure certain types of positions. At the same time he may be given greater familiarity with the subjects of general interest.

The colleges are not the only ones who can be of assistance to the returning veteran. There are many who will profit most by becoming skilled in some trade. During the period of the war, a relatively small number of young men will have been trained in the civilian trades to replace the older men. Industry can do much for itself and the veteran by providing a certain amount of training along these lines. Industry can also play an important part in the training of those who elect to pursue college courses by cooperating with the colleges. There is some indication already that there may be a closer cooperation in this field than before the war. After all, the colleges train individuals in fundamentals which serve as the foundation upon which industry must build the training of its employees in the specific skills.

Whether the training is to be in a trade, a profession or an art, guidance is necessary to prevent disappointments and failures. These of course will occur regardless of the effectiveness of counselling, but certainly with guidance, the score should be better.

War or Postwar

While one does not wish to appear pessimistic, he cannot help being disappointed in the over-confidence shown by a large number of individuals in this country during the past six months. Victories such as the recent Russian advances in Germany and American conquests in the Philippines have led to a distinct feeling of complacency and unfortunately to much over-confidence. These remarks are directed specifically to those technical people who are thinking more about postwar than about present activities. Possibly such direction is unjust, for the lead is, in many cases, taken by officials who may plant the germ of complacency. However, a reserve of fuel by which high pressure steam can be produced up to the finish, may get the job done sooner than if the fuel tank runs dry and operations must stop until more fuel can be obtained.

A runner who passes all contestants prior to crossing the finish line has not won the race; he must give all the strength he has to assure a win. Continued concentrated effort on the part of the civilian worker in his contribution to the war, be it money or labor, will assist in reducing the suffering and loss of life as well as the expenditure of material goods.

Blood for the Arteries of War

At the risk of seeming repetitious it is desirable to emphasize again the dramatic and vital role that human blood is playing in the winning of the war and the saving of our wounded fighting men. The annals of World War II are filled with actual examples of men who have survived fire and explosion to walk and fight again only because of prompt and adequate supply of whole blood or blood plasma at the battle front. Timely and interesting as Dr. Winegarden's article on the processing and use of blood in this issue is, we hope its most important effect will be to help insure an increased supply of this basic commodity of life at its source, the civilian blood donor. Let it be made available neither in too little quantity nor too late.

HUMAN BLOOD: Life Saver 1 in World War II

By HOWARD M. WINEGARDEN

THE use of human blood in the practice of medicine dates back many centuries. Successful blood transfusions probably were first performed in the middle of the seventeenth century. In some instances the blood of animals was employed, but such a procedure frequently resulted in serious reactions; transfusions of human blood were more successful. Even these were subject to two serious drawbacks; namely, the technical difficulties related to the actual transfer of blood from one individual to another, and reactions resulting from the use of the wrong type of human blood.

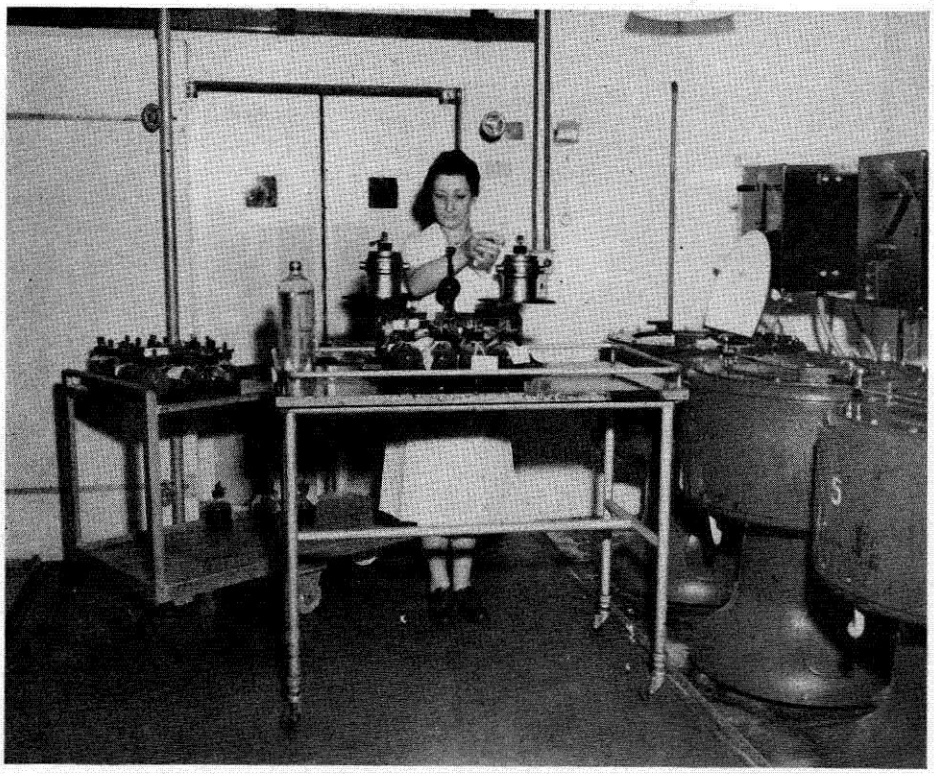
Foremost among the technical difficulties of transfusions was that caused by the inherent tendency of the blood to clot outside of the body. To remedy this handicap, removal of the fibrin from blood by mechanical defibrination methods was first employed; it was nearly a century later, in 1914, that sodium citrate was introduced by Hustin as an anti-coagulant for blood. The epochal experiments of Landsteiner in 1900 on agglutinating substances in human blood led to its separation into four types and removed the other serious drawback to transfusion. Now it became a comparatively simple laboratory procedure to determine the proper blood donor for a given patient.

BLOOD TRANSFUSIONS UNDER WAR CONDITIONS

The complicating factors related to the use of human blood in military medicine were strikingly illustrated by its almost complete absence during the Civil and Spanish American Wars. It has been pointed out that the Surgeon General's History of the Civil War records but two blood transfusions; even 35 years later, during the war with Spain, blood transfusions were apparently not used in military medical practice. During World War I there were extensive developments in blood transfusion techniques. The use of blood directly was almost universal since storage of the material in blood banks had not been developed.

In recent years the maintenance of stores of sterile, typed bloods has proved of tremendous value in civilian medical practice. However, such blood preparations deteriorate rapidly and are good for only a few weeks at best, even when kept under ideal cold storage conditions. This instability of stored blood is a great handicap to military medicine, so numerous products have been prepared from human blood to meet the emergencies of war.

The composition of blood may be roughly classified under two divisions; namely, (1) the plasma or fluid portion, and (2) the cellular constituents, including red corpuscles, white corpuscles, and blood platelets. The prevention and treatment of shock resulting from severe wounds and burns under combat conditions are, of course, now a major problem in military medicine. It has been found that the plasma portion of the blood is just as effective as whole blood in the prevention and treatment of shock, except in those cases where a tremendous loss of blood occurs and the red blood cell concentration falls low enough to produce a fatal anemia with anoxia. Since fatal shock almost always occurs *before* this level is reached, the primary problem in most cases is one of preventing and treating shock. Plasma and similar human blood products are excellent for this purpose. Military experience emphasizes the fact that there is little loss of red cells in severe burns; rather there may be a severe loss of plasma from the circulating blood with an increase in hemoglobin concentration. Consequently, plasma rather than whole blood appears to be indicated for this condition.



AT LEFT:

FIG. 1: Balancing the load in cups before centrifuging the blood to separate the plasma from cellular constituents.

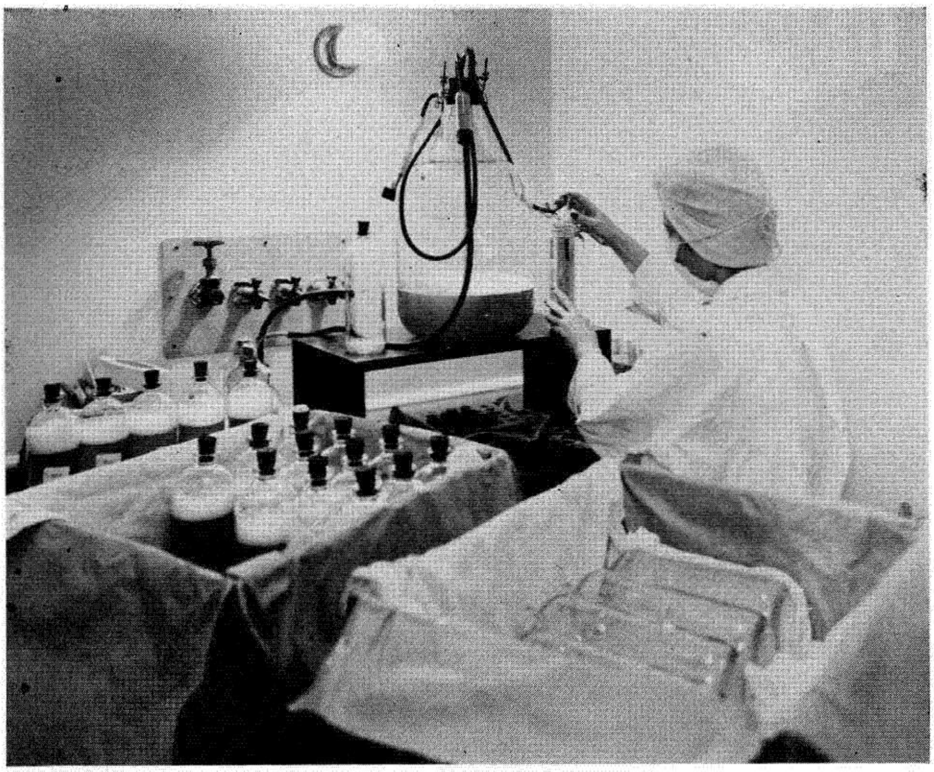


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FIG. 2: Dispensing pooled plasma into final glass containers.

The use of plasma in place of blood for the treatment of shock has substantially removed one of the major technical difficulties associated with transfusion, namely, the necessity of typing bloods in order to select proper material, since blood type incompatibilities are largely associated with the cellular constituents. In practice, a considerable number of plasmas from bleedings of various types are pooled before processing, diluting the substances present which might in some cases give untoward reactions. Consequently, this pooled material may be freely used in the field without testing for blood type.

Plasma prepared from citrated blood and serum from clotted blood are standard preparations that have been widely used in the present world conflict. While these products are far more stable than whole blood, they are too labile to be ideal for medical practice in the military field. As a result, two additional products have been prepared from human plasma: dried plasma and albumin.

BLOOD COLLECTION

Blood collections by the American Red Cross at various bleeding centers throughout the United States are made in sterile assemblies previously prepared at the processing laboratory. A typical bleeding unit consists of a bottle containing a small amount of sodium citrate solution, stoppered with a special rubber closure. This assembly includes a two-holed rubber stopper fitted with two small stainless steel cylinders with rubber tubing attachments. A small cotton filter is attached to the end of one of the rubber tubes, while the other one is fitted with a bleeding needle shielded with a small test tube to help maintain sterility during transportation and temporary storage, before use at the bleeding center. Each complete bleeding assembly is sterilized with steam in a pressure autoclave. These sterile collecting assemblies, prepared at various processing laboratories throughout the country, are shipped in special refrigeration boxes to the Red Cross bleeding centers. In practice, it is, of course, not necessary to keep the sodium citrate solution cold, and the refrigeration boxes are iced only during their return trip from the bleeding center to the processing laboratory.

After the desired amount of blood has been obtained from the donor, small spring clamps are placed over the two rubber tubes, the longer of which is then cut off close to the rubber stopper. The blood remaining in this tube is subsequently drained into the test tube which has served as a shield for the bleeding needle. The test tube sample of blood is stoppered and shipped back to the processing laboratories with the bleeding; it serves for necessary serological tests. The bleeding bottle proper is placed in a standard refrigerated box.

These refrigerated boxes are expressed immediately to the processing laboratory and the bleedings stored in a cold room pending completion of serological tests. Samples for these tests are checked, recorded, and delivered to biological control departments. Any bleedings which prove to be unsatisfactory by such tests are removed so that they cannot cause contamination in the pools.

SEPARATION OF PLASMA

After the bleedings have satisfactorily passed the serological tests, they are ready for the separation of plasma from the cellular constituents. Although the cells of citrated blood will settle quite well on standing, it is common practice to centrifuge the material in order to speed up the rate of settling. This treatment also increases the plasma yield. Cup-type centrifuges are used and these are refrigerated to keep the blood cold during the process. Since they are operated at maximum speed and are run almost continuously, it is necessary to balance the load in the cups very carefully (see *Fig. 1*). A centrifuging period of about an hour gives an excellent packing of the cells. Any tendency for the red blood cells to hemolyze and yield red plasma is minimized by refrigeration during the shipment of the blood, as well as during subsequent storage and separation of the plasma. After the bottles have been centrifuged, they are

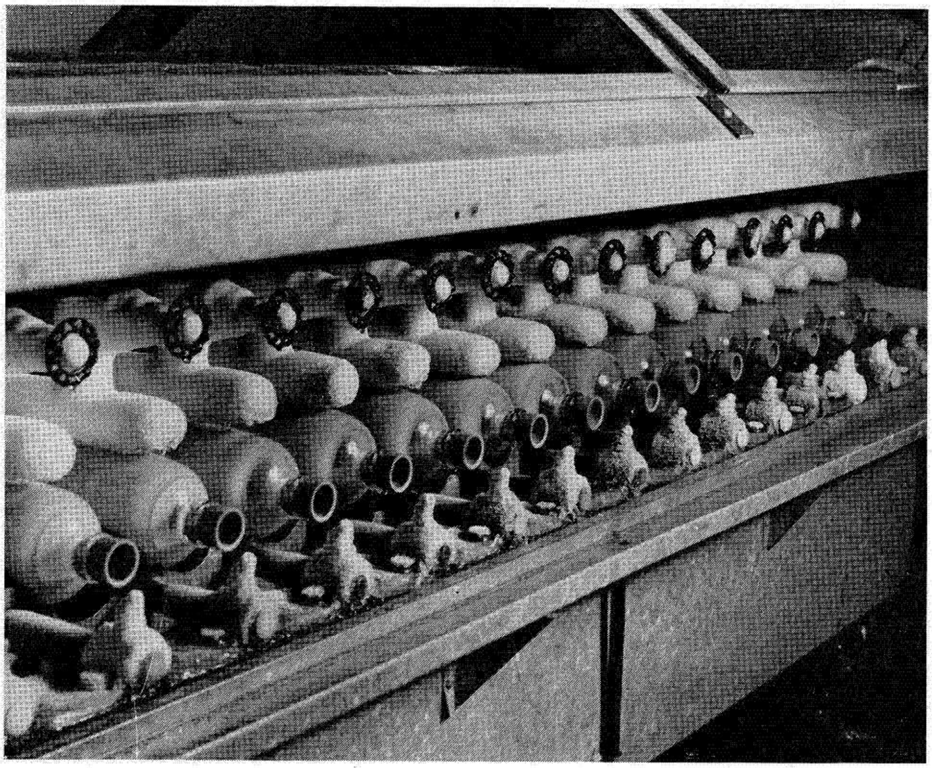

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FIG. 3: Equipment for rapid freezing or "shelling" of liquid plasma. Refrigerant flows over rotating bottles.

very carefully removed in order not to disturb the cells and are placed in the cold room to await pooling.

PLASMA POOLING

To eliminate traces of blood type incompatibilities, plasma representing from 50 to 55 bleedings is mixed in a large pooling bottle. This process allows the plasma to be administered readily and safely to a person of any blood type without undue reaction, which is very important in emergency battlefield treatment. The pooling operations and the filling of final containers are carried out in special air-conditioned rooms (see *Fig. 2*). The air entering these rooms is not only filtered through the best available equipment, but is treated with ultra-violet light in order to further reduce the bacterial count. The flow of filtered air is maintained at a sufficient rate to represent a complete change every three minutes. Moreover, the rooms are frequently flooded with steam between pooling operations. Strict aseptic precautions are observed throughout all operations, and only specially trained technicians dressed as for surgery are allowed in these rooms.

In the pooling process the supernatant plasma is drawn off by vacuum through a closed system into a large pooling bottle with the aid of a special-design aspirating spoon. The pooling bottle is then shaken vigorously to insure thorough mixing of the plasma. Two samples for sterility testing are taken immediately from each bottle and are sent to biological control departments. A bacterial preservative is then added to the pooled plasma, and a third sample of 50 *cc* is taken in one of the standard final containers. This is then carried through the entire plasma processing procedure along with the regular material, including freezing and drying, and is used as a check on the sterility of the plasma pool represented.

FREEZING OF LIQUID PLASMA

The pooled plasma is now dispensed into final glass containers—tall, cylindrical bottles with an overall capacity of about 750 *cc*. Approximately 550 *cc* of the plasma (equivalent to two Red Cross bleedings) are added to each of these bottles. The plasma is now ready for rapid freezing or "shelling." This is accomplished either by rotating the bottles in a low temperature bath containing a freezing mixture or by flowing the chilled refrigerant over the bottles as they are rotated (see *Fig. 3*). Ideally, the material should be frozen as a uniform shell on the sides of the bottle with a hollow core clear through the center. In practice it is found that the plasma tends to freeze in the neck of the bottle, so that local application of heat from a small steam coil is frequently resorted to in order to prevent this freezing. It may also be necessary to warm the bottom of the container while it is rotating to prevent too heavy a deposit of frozen plasma there. If the frozen plasma is not properly proportioned in the bottle during shelling, irregularities in the drying cycle occur, slowing down the process and occasionally injuring some of the material.

The proper quick freezing or "shelling" of the plasma called for the development of equipment, since no stock machinery was available. Various modifications of the types of shelling equipment have been developed throughout the industry; the two described above represent those most commonly used. A third ingenious device consists basically of rotating spindles on which the bottles of plasma are mounted. The speed of rotation of these spindles is such as to cause the plasma to form a rather uniform layer against the inside of the bottle, due to centrifugal action. These bottles maintained at proper rotation are then refrigerated and subjected to a blast of very cold air which causes the plasma to freeze quickly. A hollow core in the center of the bottle naturally results from the above procedure, although the force of gravity causes the layer of frozen plasma to be thicker at the bottom of the bottle than at the top.

It is essential in all these "shelling" procedures that the necks of the bottles be kept completely clear of frozen plasma in order to facilitate subsequent rapid drying in vacuo. Considerable experimentation and adjustment of

AT RIGHT:

FIG. 4: Rubber stoppering of dried plasma bottles as they are removed from the desiccation trays.

the equipment are necessary to produce a fully satisfactory frozen plasma. Following freezing of the material, the bottles are stored in a cold room at −20 degrees Centigrade.

DRYING OF FROZEN PLASMA

Several types of equipment are commonly used for drying the frozen plasma. Since the product must be kept substantially free from bacterial contamination throughout, the equipment and procedure requirements are rigorous. Two sources of vacuum are commonly employed; namely, (1) mechanical pumps, and (2) multiple stage steam ejectors. When the high vacuum mechanical pumps are used, it is necessary to have an effective condenser for cooling the water as it evaporates from the frozen plasma. These condensers must be maintained at a low temperature (−40 to −60 degrees Centigrade) in order to collect the greater part of the water vapor and protect the pump from overload.

In the case of the steam ejector type of vacuum equipment, the capacity of the system is large enough to handle, without aid of a refrigerated condensing unit, the water vapor given off. A multiple stage ejector producing a vacuum of around 100 microns under no load is usually employed. Jet condensers with barometric legs and a large cooling tower complete the major pieces of equipment required for the steam ejector vacuum assembly. In practice, a vapor pressure range of 500 microns down to about 100 microns is employed during the drying cycle.

The desiccating chambers for this equipment essentially consist of vacuum cabinets of various sizes and designs. Multiple small units may be used. These are manifolded to the main vacuum line—or one or two very large vacuum chambers may be used. In either case it is necessary to gradually supply carefully controlled heat to all bottles of frozen plasma. This may be accomplished either with the aid of electrically heated plates or with hollow shelves whose temperature is regulated by the circulation of thermostatically controlled hot water. The problems of heat flow under these high vacuum conditions are rather extensive, and they require a great deal of engineering design and subsequent alterations on a trial and error basis.

An alternative method of drying the frozen plasma consists in mounting the bottles on individual vacuum lines. Such an assembly has been termed the "Christmas tree," with the main vacuum line representing the trunk, the large feeder lines corresponding to the branches of the tree, and lines for individual bottles corresponding to the tips of the tree branches. This type of device can be moved from one room to another, since higher temperatures are required at the latter stages of drying. A flow of heat through the frozen plasma results from warm air around the outside of each of the bottles. This system has one serious drawback—the breaking of one container will temporarily destroy the vacuum of the entire system, not only slowing up the process but possibly resulting in a denaturation of some of the partially dried plasma.

At the start of the drying run, the temperature of the plasma is well below freezing (−20 to −30 degrees Centigrade). It is gradually increased as the moisture content is lowered, and in the final drying stages a temperature as high as 50 degrees Centrigrade may be employed in order to yield material containing less than one per cent water. It is essential to keep the final water content very low in order to have maximum stability in the dried plasma. Drying from the frozen state minimizes the tendency to denaturation of the sensitive proteins present, and the properly dried final material has such a stability that it may be kept without refrigeration for years and still be fully satisfactory for clinical use.

PACKAGING OF DRIED PLASMA

After drying is completed, the containers are removed from the vacuum chamber with full aseptic precautions. (See *Fig. 4*). The containers are closed with sterile rubber stoppers by a crew of specially trained workers, also

AT LEFT:

FIG. 5: A marine of the Fourth Division on Saipan receiving blood plasma—almost as soon as he was wounded. The process takes from eight to 15 minutes and prepares the wounded man for removal to the operating hospital.

dressed as for surgery. The stoppered bottles are then taken to a hand-operated special vacuum machine which removes the stopper momentarily, evacuates most of the air from the container, and replaces the stopper. The hood of the sterile stopper is immediately turned down to protect the edge of the bottle, and next the outside of the stopper and the neck of the bottle are given a protective adhesive coating to assist in maintaining high vacuum until the plasma is used.

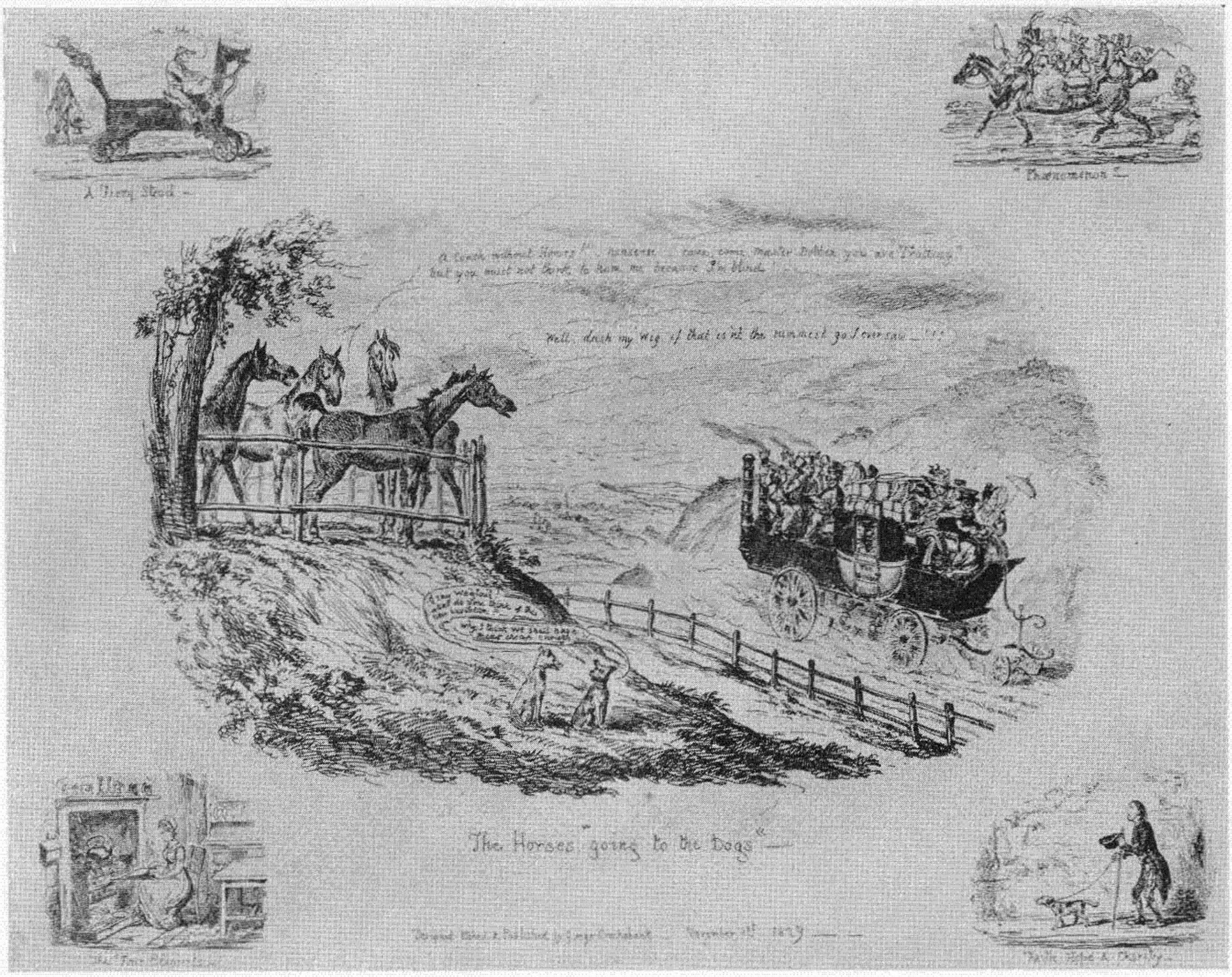
Representative samples of the final packaged containers are then subjected to rigorous tests to insure a sterile product. Safety tests in laboratory animals are also made. The dried plasma, now ready for final packaging operations, is placed in a can which is evacuated, flooded with nitrogen and hermetically sealed. It is believed that the presence of an inert gas like nitrogen will materially prolong the life of the rubber stopper and will also tend to minimize deterioration of the dried plasma if a possible leak in the vacuum of the bottles occurs. A bottle of sterile diluting fluid (distilled water containing a small amount of citric acid), identical in size with the plasma container, is supplied along with the bottle of dried plasma. These two with the injection equipment constitute the complete outfit. Because of the porous consistency of the plasma and the fact that it has not been appreciably denatured during drying, solution is very rapid when the diluting fluid is added to the evacuated plasma bottle. It is possible, in expert hands, to bring this about in less than a minute, and thus an effective preparation is ready for almost immediate administration in the field.

These plasma kits are placed in a waterproofed bag before sealing, and are packaged twelve to a carton. The waterproofed bag enables the cartons to float in case an emergency necessitates dumping the plasma before the ship reaches shore. The cartons thus packed are then bound with tin strips and are ready for shipment.

OTHER HUMAN BLOOD PRODUCTS

Mention should be made of some of the other human blood products that have been developed in connection with the Red Cross blood program. The albumin fraction of the plasma, constituting about 60 per cent of the total protein present, has been found to be an excellent substitute for blood in the prevention or treatment of shock, and is now being used by the armed forces. It may be separated in a highly purified form from human plasma by chemical fractionation in the cold (about -5 degrees Centigrade) with the aid of alcohol. The product so obtained is dried in trays from the frozen state to remove the residual alcohol. It is then dissolved in water containing a small amount of $NaCl$ and a preservative, and is ready for final filtration and filling. A sufficient amount of dissolving fluid is used to yield a solution with a final concentration of 25 per cent albumin. Since it is not practical to carry on the process under completely sterile conditions, the final solution is rendered sterile by being passed through one of the standard bacteriological filters. It is necessary, of course, to adjust the pH of the final product to about neutrality in order to insure stability and harmlessness on injection. The 25 per cent albumin solution is dispensed in 100 *cc* amounts in special hard glass containers. It has a pleasing yellow-green color, is crystal clear, and is remarkably stable even at tropical temperatures. This stability allows it to be freely used in military operations where space is at a premium and refrigeration may not be available. The 100 *cc* vial of albumin is packaged in a tin can along with the required administration equipment. Since it is dispensed as a liquid, no immediate diluting fluid is needed; so the space required is very small. One vial of albumin solution is approximately equal to two human bleedings in terms of shock-preventing properties.

(Continued on Page 12)



Caricature of the first journey by automobile, by George Cruickshank (1792-1878).

REPRODUCTIONS OF PRINTS, DRAWINGS AND PAINTINGS OF INTEREST IN THE HISTORY OF SCIENCE AND ENGINEERING

I—The First Journey by Automobile[1]

By E. C. WATSON

IN historical studies good caricatures are often of real value as well as of considerable interest. From them the student may learn what questions, ideas, events, and incidents occupied public attention, and what was the popular reaction to them. From them the historian may judge of the true inwardness of a situation, be it political, social or scientific. Good caricatures reflect and comment upon life as it was actually lived, and portray not only what the persons caricatured "were like to look at, but also what manner of men they were."

About 1830 great interest in steam carriages developed in England. This was due in large measure to the work of Sir Goldsworthy Gurney (1793-1875), whose steam coach, patented in 1827, is accurately portrayed in the rare and little known caricature by George Cruickshank (1792-1878), which is here reproduced. In 1829 the coach of Gurney accomplished, with a number of stops, the trip from London to Bath, the first journey of any length to be made by an automobile. The feat and something of the popular reaction to it is preserved for us in this amusing contemporary print.

Other caricatures of this kind, as well as serious prints of the steam coaches of Gurney, Church, Hancock, and others, will appear later in this series of historical reproductions, and further details of the coaches themselves and of the early history of mechanical road vehicles will accompany them.

[1]Reprinted with a few revisions from *The American Physics Teacher*, *6*, 112 (1938)

A. J. STAMM VISITS CAMPUS

Dr. A. J. Stamm, '21, chief chemist, Forest Products Laboratories, Madison, Wisconsin, spoke before a group of West Coast lumbermen at Seaside, Oregon, in January. Dr. Stamm subsequently visited Los Angeles in connection with business and personal matters.

Dr. and Mrs. Stamm have two daughters, 11 and 7, and one son, 3 years old.

Dr. Stamm regretted that lack of time made it impossible to see many of his friends in the West. He asked Bob Hare, '21, Dick Stencil, '21, and Ray Ager, '22, with whom he visited briefly, to extend his greetings to his other friends.

Government Controls in Industry

By PAUL HAMMOND

ENGINEERING, production, and economics are closely related to any controls which may be placed upon industry. It is recognized that engineering is very much concerned with the field of economics. This article by Paul Hammond should be of interest to engineers and scientists. Statements and opinions advanced are to be understood as individual expressions of the author, and not those of the staff of Engineering and Science or of the Association.

—*EDITOR.*

WHILE there can be little disagreement with the broad objectives of speedy and orderly reconversion following the war, maintenance of high levels of employment and production, and rigid controls against inflation, the specific regulatory measures issued to implement these goals often are highly controversial. The cooking and heating appliance manufacturing industry, perhaps more than any other, has been the experimental laboratory in which theories of control have been tested. Some of these specific controls differ so strikingly from the broad policy statements of the War Production Board and Office of Price Administration as to be startling in their implications to one not acquainted in detail with their provisions.

LIMITATION ORDER

The customary limitation order issued by the War Production Board concerned itself with the prohibited uses of an item; simplification and standardization of lines; and elimination of critical materials or components in the manufacture of a product. There could be no fundamental doubt as to the necessity of these basic controls in a wartime economy. L23c, the Limitation Order regulating the stove industry, however, introduced two additional theories of control which, in one form or another, have remained controversial since their inception. These were a "concentration of industry" program and what Maury Maverick, chairman of the Smaller War Plants Corporation, has termed the "grandfather clause" policy.

Concentration of industry may best be explained in terms of an actual example. A clear case could be made against the manufacture of civilian automobiles and a limitation order issued preventing their production. Such a limitation order would be uniform in its effect throughout the industry, and all members of the industry would be required to convert to direct war production. In the case of stoves, however, limited production was deemed essential for the army cantonment program and for war housing. The question then became one of how this limited production should be allocated and by whom.

The customary solution would be the issuing of a limitation order permitting manufacture for the specific uses considered essential. Those companies who could secure this business would then be permitted the continuity of production afforded by this limited production. This would normally be supplemented by other war work and some companies would be forced to complete conversion for other types of work. This would be a uniform regulation imposed throughout the industry, and while the effects would differ greatly they would follow relatively conventional economic lines. The companies remaining in production would be determined by price, quality, and delivery.

Concentration of industry through this process might not be the most effective means of securing maximum overall war production. Larger companies would probably have machinery and facilities more suitable for quick conversion. A company removed from major war production centers would not be in competition for available labor with other critical programs. In the case of the stove industry, it was decided to concentrate the industry by regulation on the basis of size and available labor. L23c, the stove limitation order, classified all stove manufacturers as "A," "B," or "C" producers. "A" producers were manufacturers with an annual base period sales volume of over $2,000,000; "B" producers those with a volume of under $2,000,000, located in specific "critical" production areas; "C" producers those with a volume of under $2,000,000, not in these areas. Only "C" producers were permitted to make stoves. As originally issued this was a highly inflexible and arbitrary ruling. For example, all small Los Angeles companies were required to cease production as "B" manufacturers. Such companies located in adjoining Pasadena or Glendale could have continued manufacturing as "C" producers.

This order was highly unpopular in the industry. In July, 1943, this policy was slightly liberalized in that the arbitrary city designation was dropped and the Group I Critical Labor Shortage Areas as determined from time to time by the War Manpower Commission were substituted. Class "C" producers would be given authorized schedules up to 100 per cent of their base period production before making authorizations to "B" and "A" producers. However, it was June 20 of this year before the idea of classes of producers was dropped from the order.

As reconversion became more imminent the problem of concentration of industry in a slightly different form again became highly controversial. Several industry groups felt that no reconversion should be permitted in that industry until such time as all members of the industry were ready for the resumption of civilian production. In other words, no one should resume production of radios, for example, until all 1941 radio producers were set to begin civilian manufacturing. The effects of this proposal upon our speedy reconversion would have been disastrous.

However, the experiments on concentrations of industry had been pretty well worked out in the stove industry and the things that could and could not be done rather definitely determined. No hard and fast rules were arbitrarily laid down as in the early experiments. In Priorities Regulation No. 25, the "Spot Authorization Plan" covering resumption of civilian production, the following general considerations of policy are outlined: (1) It must not interfere with war production. (2) Labor and facilities must be available and not required for more essential purposes. Thus a flexible plan has been determined that will permit an orderly and partial transition from a wartime to peacetime economy.

FROZEN COMPETITION

In the meantime the word "producer" had become the center of another controversy closely associated with the concentration of industry. After concentrating the stove industry so thoroughly by regulation the companies frozen out felt it only fair that their relative competitive position be also frozen by regulation. As a result they secured in 1943 a regulation that only a producer manufacturing stoves during the base period of July 1, 1940, to June 30, 1941, could manufacture stoves. The rationing of stoves for civilian use by the O.P.A. had also become a firm program and as a result it was further determined that a manufacturer could produce only in those fuel types produced during the base period for this purpose.

Written into the stove limitation order this so-called "grandfather clause" policy became a subject of violent controversy in the W.P.B. and various industry groups. In effect it was a regulation freezing business to what it was before the war. The argument was not limited to the stove industry. To many business men this appeared an ideal means of insuring their place in their industry after the war. The idea of newcomers usurping their place while they engaged in war production was a compelling argument for the regulation.

The assumption was made that the large companies would be held longest in war production. Many smaller companies, including the "war babies," would be seeking an item to produce with the drop-off of their war production. This search would naturally lead to those fields where the major producers were still in war work. The business secured would be at the expense of these established companies, who would return to civilian production to find new and firmly entrenched competitors.

Reasonable as this position seems, it could hardly be justified if we have as a goal an expanding economy with maintenance of full employment, greatly augmented production, and the smoothest possible transition from war to peacetime production. The conflict over this policy was one of the major causes of the recent dissension in the W.P.B. The restrictions against new producers were deleted from the stove order on August 29, 1944, and in the order issued October 23, 1944, the following excerpt is quoted "Applications from persons who have not previously been engaged in the production of stoves, burner valves, or thermostats will be accepted and processed on the same basis as all other applications."

This little publicized but highly significant W.P.B. control in the stove industry has apparently been discounted. The effect is of importance to all industry. It has been determined that within the limits of available materials and relative degree of essentiality, the W.P.B. will give individual companies freedom of choice to produce what they wish and will not try to preserve the prewar status quo or protect the prewar competitive position of any company. This is particularly significant to small companies who are already feeling the effect of cutbacks in war production. It augurs well for an expanding competitive economy that will of its own force go far to break monopolistic control.

PRICING POLICY

In October the O.P.A. issued a memorandum on the subject of "Our Pricing Objectives in the Reconversion Period." One of the objectives of this policy as given by Chester Bowles, the Administrator, was: "It must encourage maximum production. It must not stand in the way of the manufacturer's desire to produce to the limit of his capacity. This means prices which yield good profits for business, large or small, on the basis of high volume of production."

The stove industry prices are controlled by M.P.R. 64. On August 11, 1944, Amendment No. 1 to this order was issued and, despite strong industry protest and the above statement of O.P.A. policy, the following section governs reconversion pricing for this industry.

Section 10. Application for adjustment.

(a). Any manufacturer subject to this regulation may apply to the Office of Price Administration, Washington, D. C., for an adjustment of his maximum price for a particular stove or stoves. An adjustment may be granted if it appears that:

1. The manufacturer's ceiling price is below his total cost to make and sell the stove; and

2. The manufacturer's entire stove operation is being conducted at a loss or will be at a loss within 90 days; and

3. The loss of the manufacturer's production of that stove would result in higher prices to consumers for the same or substantially the same stove.

(b). Any adjustment, if granted, will not be greater than the lower of the following amounts:

1. An amount sufficient to eliminate the loss incurred in making and selling the stove.

2. An amount sufficient to bring the maximum prices established by this regulation for sales of competitive manufacturers' comparable stoves to the same class of purchaser and on the same terms and conditions of sale.

The economic implications of such a pricing policy might be summarized by stating that this regulation assumes the profit motive should have no place in reconversion. Some manufacturers find their whole stove production program operating at a loss, while many will find a loss incurred on certain models. In no case could an adjustment be made which would do more than provide a recovery of costs with no margin of profit.

From the O.P.A. viewpoint the following facts may have been the governing considerations. The prices of stoves had previously been set by this regulation at 112 per cent of the lowest price quoted to each class of purchaser during the period January 15 to June 1, 1941. It should be pointed out, however, that this does not necessarily represent a relative 12 per cent price increase above ceiling, as the generally applicable ceilings are March, 1942, prices. As most prices were materially increased during that period of some 14 months, this theoretical price adjustment was thus far less than it would at first appear in relation to other products.

However, the price of stoves clearly affects the cost of living and it might be contended, therefore, that any increase in the price of stoves would tend to increase living costs, be against the "hold the line" order, and be inflationary in character. Nevertheless, the provisions of the Emergency Price Control Act direct the Administrator to make adjustments for such relative factors as general increases in costs of production and distribution and general increases or decreases in profits. There have been sharp increases in production costs for the stove industry. Since January, 1942, labor costs have risen by as much as 30 per cent and material costs increased from 5 per cent to 15 per cent, depending on the type of product.

O.P.A. has indicated that a distinction will be made in reconversion pricing between products that have been continuously in production during the war and those whose production has been completely suspended. Thus it appears that existing ceilings will be applied in the stove industry, regardless of whether the particular manufacturer had continuity of production or not. This application would theoretically be based on the assumption that if some manufacturers have been able to produce under existing ceilings, then all companies should do so. It ignores the fact that some companies have let their war production "carry" their stove manufacturing to retain the competitive advantage of continuity. While such practice may be justified in wartime, it could not continue during the reconversion period.

From the stove industry viewpoint this was a definite threat to its reconversion and if similar regulations were issued for other industry, it would hurt all reconversion activity. A program permitting limited civilian production had been written into L23c on June 20, 1944. A company producing stoves for civilian use would thus be conforming with W.P.B. policy as outlined under the "Spot Authorization Plan." Such a company would have available excess capacity *not required in war production.* They would have *labor available*, the use of which would not interfere with labor requirements for war production in that area. They would furthermore be producing a scarce and essential civilian item—a fact that the O.P.A. has recognized for over a year, as proved by its distribution of stoves under a rationing program. Thus when Amendment 1 to MPR 64 was issued on August 11, 1944, the O.P.A. must have been fully aware that this was a pricing policy to be applied in an industry where an approved reconversion plan was in operation.

PROFITS

This must then be considered as a reconversion pricing policy and examined in the light of its probable effect in the stove industry. This industry has been largely engaged in war production. As war contracts terminate, each company must consider its re-entry into the stove business in the light of this price regulation. Unless established ceilings are high enough to provide a profit, the best the manufacturer can hope for is a break-even operation and that only if he can meet the prices of his lowest competitor. Two probabilities suggest themselves.

A large percentage of the average manufacturer's output is in "low cost" production of low-profit, large-volume items. These are in contrast to slower-selling, higher-priced, larger-profit models. Under stringent price control, the low-cost production would be discontinued and, as a severe consumer shortage exists, the higher priced models would be sold exclusively. The entire O.P.A. policy is thus circumvented as overall cost to the consumer is increased as a result of the attempt to control profits.

Not all manufacturers will be able to realize a profit even on their most profitable models. Such companies might, in view of this no-profit order, decide to enter an entirely new field. This would, in the first place, retard the manufacturer's reconversion, as presumably retooling, altered plant layout, engineering design, sales policies, and a host of incidental problems would prevent his speedy resumption of full-scale operations. Such a delay is generally considered to be the most likely cause of a serious unemployment problem following the war. In the second place, the loss of any considerable portion of the stove manufacturing capacity would prolong the present shortage, make normal competitive pricing more difficult to attain, and finally threaten a definite hardship to the civilian population, as cooking and heating equipment is essential to health and comfort.

Since a manufacturer faced with this specific problem would surely choose one of these two courses of action in preference to continued operations at a loss or at the best on a break-even basis, it is difficult to see how either O.P.A. or overall government policies can be realized through such pricing regulations. It is to be hoped that once again the experience gained in the operations of reconversion pricing in the stove industry will guide the way to a more effective and workable control to insure high levels of production and employment.

Human Blood

(Continued from Page 8)

Other products which have been obtained from human plasma and show real value include: (1) immune globulin used to control epidemics of measles and scarlet fever, and (2) thrombin used with foams prepared from human fibrin. These foams or sponge-like preparations, together with thrombin solutions, are of special value in brain surgery for the control of bleeding and may be left in place following the operation, since they are ultimately absorbed.

One of the most recent and important developments is found in the special anticoagulant solutions for preservation of whole blood. Solutions of this type have been prepared which now make it possible to send blood transfusions directly from this country to all the battle areas (thanks to modern air transportation). It is necessary, of course, to carefully type these whole blood preparations so that the patient is sure to receive the right kind of material. These whole blood units are of great value in the treatment of those casualties where extremely heavy losses of blood have occurred.

FIELD RESULTS

Reports from the South Pacific and other fighting fronts describe the use of plasma and albumin on the battlefields. Casualties are given transfusions at aid stations a few hundred yards from the firing line, some 10 to 30 minutes after being wounded (see *Fig. 5*). The process, taking from eight to 15 minutes, prepares the wounded men for transportation by litter back to the operating hospitals, by restoring the bulk and balance in the blood stream and counteracting the effects of shock. Navy Medical Corps men say that the tins of plasma are as easily handled and transported as cans of food, since they are protected from weather and breakage and are not affected by extreme temperatures. Some seriously wounded men receive as many as five or eight injections in a few days. Nearly half the injured soldiers need plasma injections, and most of these require more than one dose. The total number of plasma injections about equals the total number of wounded men, say doctors at the fighting front. In the South Pacific transfusions from fit men on the spot are risky because of the prevalence of malaria.

American military surgeons have emphasized the low mortality rate among wounded men in this war. One of the most important factors responsible for this fact undoubtedly is human plasma which has been made available through the voluntary blood donations of millions of patriotic Americans under the direction of the American Red Cross. Truly, human blood has been "Life Saver 1 in World War II."

C. I. T. NEWS

ADMISSION OF VETERANS TO C.I.T.

THE policy of admission of veterans who wish to pursue courses of study at the California Institute of Technology has recently been established. This policy is directed principally to those who are seeking entrance for the degree of Bachelor of Science in Engineering or Science. Those who wish to continue their studies in pursuit of graduate degrees will be held to the usual requirements of the Graduate School. The details for the establishment of special refresher courses for men who have their B.S. degree have not been completed. Recently a questionnaire was sent to graduates of the Institute to determine how many were interested in such courses and the subject matter desired. The result of this questionnaire will assist in the formulation of a policy.

Two forms of leaves of absence have been granted to students. Those men whose education was interrupted because of induction into the armed services have been given a leave of absence for the duration of the war or until discharged from the service. In some cases, special leaves of absence have been granted which require the passing of certain examinations to re-enter the Institute. Students who left the Institute to enter into an occupation have been granted a leave of absence for one year which must be renewed each year.

In order to offer assistance to veterans who decide to resume college work, the Institute will provide refresher courses in mathematics, physics and chemistry at the freshman and sophomore levels, if the demand warrants. Veterans who have not previously attended the Institute may take the transfer examinations before or after taking the refresher courses offered. If they choose to take the examination without taking the refresher course and fail, they may, if their record warrants it, be admitted to refresher courses and be given another opportunity to take the transfer examination. The refresher courses carry no academic credit, and while taking any refresher course, a student will be required to carry a load of at least 15 semester units unless permitted to do otherwise.

It is recognized that veterans transferring to the Institute at the sophomore or junior level may not have had all courses required of regular Institute freshmen or sophomores. Such veteran transfers will be governed by the following regulations: With the exception of requirements in mathematics, physics, and English composition, and in addition chemistry for science majors, the Institute curriculum requirements of the first two years will be waived provided that (a) the transfer student has 32 acceptable college credits if a sophomore, or 64 if a junior; the acceptability of such credits to be judged by the engineering or science course committees for engineers or scientists respectively; (b) he has satisfied all of the prerequisites of his option prior to the level at which he enters according to a list of such prerequisites selected from the curricula of the first two years at the Institute and certified to the Registrar by the head of each option; (c) if he is allowed credit for any courses of the year in which he enters or subsequent years, he may be required to complete his program by including such Institute courses of the year or years prior to his admission for which he may not have credit, as his adviser shall think wise. In any such requirement, courses prerequisite to the work in his option shall take precedence; (d) any department may prescribe the electives to be taken by the transfer student in its own department if it considers that his previous preparation has been lacking in a field under its jurisdiction. (For example, a transfer who had had no history might be required to take courses in history as his senior humanities elective.)

After the Institute returns to its normal schedule, examinations for freshman admission will be held in March. However, as a further accommodation to returning veterans who wish to enter the Institute 20 places in the first complete freshman class of 160 will be reserved for veterans for a period to be determined by the Admissions Committee, but not to extend beyond July 15. This is an extension of two months beyond the normal date of accepting applications for admission.

The Institute does not give correspondence courses. The courses given by the United States Armed Forces Institute at Madison, Wisconsin, are recommended for subjects at the high school level required for fulfillment of the Institute entrance requirements. Any subject required for admission and satisfactorily completed through A.F.I. will be given entrance credit. In addition, an applicant must pass the entrance examinations in mathematics, physics, chemistry, and English.

Subjects at the college level taken to fulfill the requirements of the Institute first or second year, may be taken through any of the colleges cooperating with the A.F.I. providing the cooperating college will itself grant credit toward its own bachelor degree for such courses, and providing also that the subject does not involve laboratory work. The courses given by the University of California Extension Division, Berkeley, California, are recommended. To simplify selection, there are listed below the subjects of the first two years at the California Institute of Technology which it is believed can be adequately covered by the correspondence method, and the corresponding University of California Extension Division course number and title.

Courses which may be taken under the University of California Extension Division with California Institute equivalents:

Title	*U.C. No.*	*Semester Hours*	*C.I.T. Equivalent*
FRESHMAN YEAR			
Plane Analytical Geometry	XB 3a	3	Ma 1 a, b
Differential Calculus	XB 3b	3	
First Year Reading and Composition	XB 1a	3	En 1 a, b
First Year Reading and Composition	XB 1b	3	
History of Western Europe to 1500 A.D.	XB 4a	3	H 1 a, b
History of Western Europe 1500-1933	XB 4b	3	
Machine Drawing	XB 6	3	D 1 a, b
SOPHOMORE YEAR			
Integral Calculus	XB 4a	3	Ma 2 a, b
Solid Analytical Geometry and Integral Calculus (Cond.)	XB 4b	3	
Descriptive Geometry (Not required for science majors)	XB 2	3	D 2
Elements of Economics	XB 1a	3	Ec 2
History of the United States to 1920 (As this course is only 3 units, credit can be given for H 2a only.)	X17 a, b	3	H 2a

Application for Extension Division courses should be made directly to the A.F.I. at Madison, Wisconsin. Credit for freshman and sophomore mathematics courses is further tested by a California Institute of Technology examination taken at the time the applicant is ready to enter.

Applicants planning to enter the Electrical or Mechanical Engineering option may take in addition "Differential Equations" *XB 110b* to fulfill the California Institute requirement *Ma 11*. All California Institute students are required to take third year English, *En 7ab* and a senior humanities elective. Credit for the former may be gained by taking "History of English Literature" *XB 47a* and *XB 47b;* and for the latter by taking "The English Bible as Literature" *XB 116*, "Shakespeare" *XB 117E*, "History of Philosophy" *XB 10a* and *XB 10b* for a total of six semester hours.

It is not possible for an applicant to gain sophomore or junior standing by taking correspondence courses alone. There is, however, a very real advantage in securing credit for some of the subjects of the first two years. A veteran may benefit from the lighter academic load he is thereby enabled to carry until such time as he may have readjusted himself to academic work. On the other hand, if he substitutes courses of the upperclass years, he will, in his senior year, have a place in his schedule for certain valuable courses of the first graduate year provided he can meet the prerequisites.

Credit is allowed for courses satisfactorily completed at any accredited college or junior college providing satisfactory grades have been earned and provided also that the subject matter sufficiently parallels the work given at the California Institute. No definite statement can be made concerning credit for college work until a transcript of record has been submitted to the Institute for evaluation. Credit for courses in mathematics, physics—and in chemistry for science majors—is further tested by an examination taken at the time the applicant wishes to enter.

The fact that the curriculum of the California Institute of Technology is concentrated on technical and scientific material for which there is no substitute does not make it possible to grant credit for military experience. Such experience together with most service courses, has been along very practical and specialized lines and for the most part is not the equivalent of the fundamental theory taught by the Institute or other technical institutions. However, each case will be considered on its own merits and credit will be allowed wherever it can be shown that an applicant can go on to more advanced work successfully.

INDIAN SCIENTISTS VISIT INSTITUTE

SIX distinguished Indian scientists making a six weeks' tour of the United States and Canada visited the Institute late in December. Their tour was for the purpose of acquainting themselves with the organization of science and technology in the United States to the end that they might better plan the future of India in the interests of its people. They were accompanied to Pasadena by a representative of the State Department, Frank S. Coan.

While quartered in Pasadena, they visited the Huntington Memorial Library and Art Gallery, the 200-inch telescope installation on Palomar, and the Mount Wilson Observatory, and devoted one entire day to inspecting the laboratories on the campus under guidance of Doctor Millikan.

One of the scientists, Professor S. K. Mitro, delivered a talk at the Institute's Physics Seminar on "Active Nitrogen."

Members of the party were:

Dr. Nazir Ahmad, O.B.E., M.Sc., Ph.D., Director, Indian Central Cotton Committee.

Sir Shanti Swarup Bhatnagar, Kt., O.B.E., D.Sc., F.R.S., Director, Scientific and Industrial Research, Government of India.

Sir Jnan Chandra Ghosh, Kt., M.Sc., D.Sc., Director, Indian Institute of Science, Bangalore.

Professor S. K. Mitra, D.Sc., M.B.E., Professor of Physics, Calcutta University.

Professor Meghnad Saha, D.Sc., F.R.S., Professor of Physics, Calcutta University.

Professor J. N. Mukherje, C.B.E., D.Sc., Professor of Chemistry, University College of Science, Calcutta.

AMERICAN PHYSICAL SOCIETY

THE regional meeting of the American Physical Society was held in Room 201, Bridge Laboratory, in an all-day session on Saturday, December 16. The morning session was devoted to a symposium on various aspects of the quantum theory, with invited papers from Paul S. Epstein, Hans Reichenbach and Raymond T. Birge.

Contributed papers were given at the afternoon session.

Following were the contributed papers:

"A Possible Cause of the Variability with Time of the Incoming Cosmic Rays at High Latitudes," by Robert A. Millikan, H. Victor Neher and William H. Pickering, California Institute; "Some Recent Investigations on Hydrodynamic Stability," by C. C. Lin, Guggenheim Laboratory, California Institute; "Pressure Flow of a Turbulent Fluid Between Two Parallel Infinite Planes," by P. Y. Chou, Guggenheim Laboratory, California Institute; "Frequency Elimination in Spirotron Systems for Accelerating Ions and Electrons," by L. E. Dodd, University of California at Los Angeles; "Minimum Conditions Necessary to Achieve the Velocity of Escape," by H. S. Seifert, California Institute; "The Relativistic Increase in Ionization of Cosmic-Ray Electrons," by Wayne E. Hazen, University of California; "The Diffusion Problem of Connected Events," by Donald A. Darling, California Institute; "Magnesium Ion Source of High Intensity Mass Spectrograph," by T. H. Pi, California Institute; "The Movement of Red Particles in a Turbulent Stream," by Hans Albert Einstein, California Institute; "The Rydberg Constants and the Value of e/m," by Chao-Wang Hsueh, California Institute.

Two papers were contributed on the supplementary program. They were "The Turbulent Jet," by P. Y. Chou, California Institute, and "Radio Direction Finding at a Wave-Length of 1.8 Meters," by W. H. Pickering, J. David and W. F. Hornyak, California Institute.

Don't forget Alumni Seminar
Tentative date, April 22.

JET PROPULSION PLANE

CAPTAIN Brian Sparks, '32, and four other specially selected aircraft engineers, guided the new jet-propulsion airplane from the drafting board to the initial flight from a secret test base. In September, 1941, when Captain Sparks was assistant to the Chief Design Engineer at Bell Aircraft Corporation, Larry Bell, president of the Buffalo firm, called him into his office and asked him if he would like to work on a very secret project. After indicating his willingness, and being sworn to secrecy, Captain Sparks discovered that the Army had requested Bell Aircraft to undertake the design of a jet-propulsion airplane to be powered by the jet engine developed in England by R.A.F. Group Captain Frank Whittle.

Bell gave Captain Sparks an address where he reported along with the four other engineers. Three weeks were spent in merely sketching different designs before they finally decided on the present design and began preliminary layout of the airplane. One engineer became structural designer; two others took over the layout and mechanical design; Captain Sparks became aerodynamic designer and pilot adviser, and the fifth member of the group became project engineer.

Another month of preliminary design of the airplane brought the project to the point where draftsmen, loftsmen, detailers, structural computers, and other specialists began to enter the picture. An abandoned Ford assembly plant in Buffalo was leased and from there on the staff began to increase.

The airplane was ready to fly by September, 1942, a record for almost any airplane of conventional type, let alone such a highly unorthodox type of aircraft. The first flight was made just a year after the design was begun.

One of the more serious difficulties in the design of the "squirt," as the plane is sometimes called, lay in the absence of propellers. The large amount of data whereby the control-surface design, stability and drag of the orthodox airplane are corrected for the effects of the propeller slipstream did not apply to the new plane, and Captain Sparks admits that much of the aerodynamics had to be based on theoretical considerations or simply the best guess which could be made. The extreme secrecy which surrounded the project permitted only the sketchiest of wind tunnel tests.

Early in the progress of the building of the airplane another Caltech alumnus, Robert M. Stanley, '35, chief test pilot of Bell Aircraft Corporation, was admitted to the secret factory and was instructed to set up a flight-test program. To maintain secrecy, the tests were to be conducted from an isolated spot in California. The test program called for the first flight on October 1, 1942. A group of Bell officials, Army Air Force officers, and aviation scientists and engineers had arrived to witness the test flight. The first flight lasted for 30 minutes, and reached an altitude of approximately 25 feet. Immediately after the first hop, Mr. Stanley took off again, going up 4000 feet, but because of the heat in the cockpit he landed to remove the hatch for better ventilation. On the third hop he reported that the speed was surprisingly high in level flight at 10,000 feet.

Mr. Stanley and his crew spent many weeks on a long grind of test flights. At the close of a full year of tests, during which time there had been no accidents, and numerous improvements had been made on the airplane, Larry Bell reported to General Arnold that the JP was ready. On January 6, 1944, the United States Army Air Forces and the British Air Ministry made a joint public announcement of the jet-propelled combat airplane.

When the Army Air Forces jet-propelled fighter flies into combat for the first time, Captain Brian Sparks, now chief techincal pilot for the American Export Airlines, Inc., and Robert Stanley will await the results with considerably more than passing interest.

A TECH MAN'S PALACE

Lloyd Goodmanson, '40, together with a group of Boeing engineers, solved the housing problem in a most unusual manner. The housing shortage, which has necessitated living in barracks, tents, and the like, and the consequent trials and tribulations there, is common talk. Little has been said of living "contentedly" in a palace as an alternative.

In answer to their plea for a big house, none other than a palace was available. Each of its 30 rooms follows the style of a different period. The rooms are ornamented with Chinese dynasty vases, brocade, carved marble, oriental rugs, antiques, art treasures, and other fabulous bric-a-brac. The expenses of home and grounds, as well as the chores, are equally divided among the men.

The problems of living in such grandeur are those that anyone might have who went home every night to an art gallery. If accidentally a piece of ornamentation falls to the floor, broken in many pieces, the one responsible has a considerable dent in his budget. In order to avoid such catastrophes the men tiptoe cautiously through the halls of "china" and over the costly oriental rugs.

The men have a self-imposed ban on smoking in the drawing room. They stand in an ante-room or adjourn to the basement where they can recklessly smoke, relax, and dream of the distant day when they too will become opulent.

DR. LOMBARD RECEIVES EMBLEM

Dr. Albert E. Lombard, Jr., noted aeronautical engineer, on leave from California Institute of Technology, has been awarded the Army emblem for exceptional civil service "in recognition of his outstanding contribution to the nation's war effort by assisting in the development of aircraft resources."

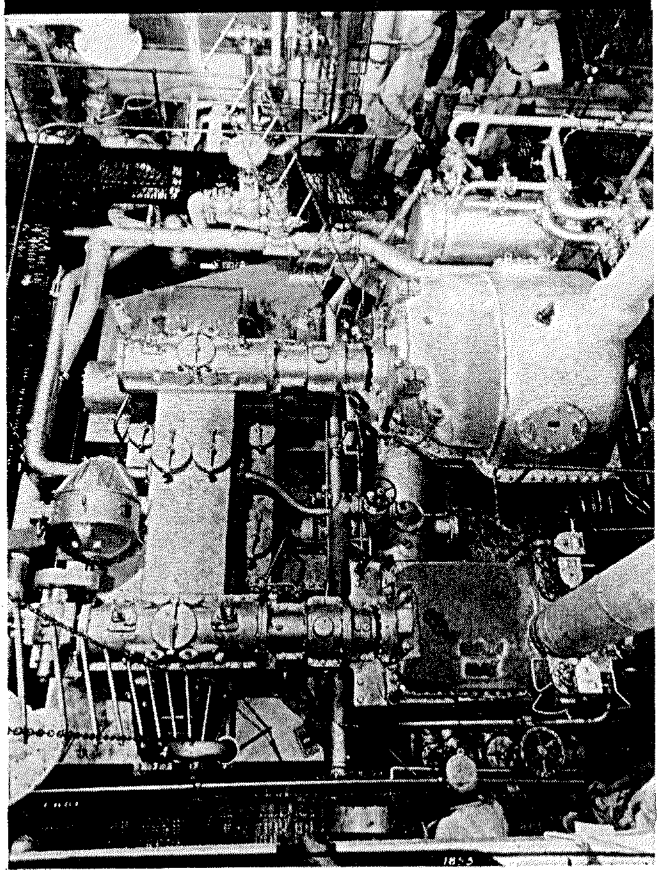
Dr. Lombard, special assistant to the director of the Aircraft Resources Control Office in Washington, was given leave from Caltech nearly four years ago to take his present work with the Army. Before going East he served as assistant professor of aeronautics and mechanical engineering.

For eight years after graduating from Caltech in 1928, Dr. Lombard was with the Curtiss-Wright Corporation in Buffalo and St. Louis as research and consulting engineer. He was responsible for the aerodynamics work on the famous Curtiss-Wright Commando, the plane now carrying supplies over the Himalayas.

Upon returning to Caltech, Dr. Lombard became a teaching fellow in applied mechanics and aeronautics, receiving his Ph.D. degree *cum laude* in aeronautical engineering in 1939.

"FIVE YEARS OF INDUSTRIAL RELATIONS"

The Industrial Relations Section California Institute of Technology, founded in 1939, has recently published a bulletin covering its activities. The publication includes a report for the period 1939-1944 as well as outlining plans for the future of the Section. Alumni of California Institute of Technology may secure copies of the bulletin by writing to the Industrial Relations Section of the Institute.



ATHLETICS

By H. Z. MUSSELMAN,
Director of Physical Education

SINCE the previous story in this publication was written, Caltech's basketball team has won three and lost five, making the record to date five victories and eight defeats.

Early in the season, Coach Carl Shy named his starting lineup of Hugh West and Stuart Bates forwards, Bernie Wagner center, Paul Nieto and John Schimenz at guards. However, shortly after the holidays, wholesale troubles descended on the squad. Wagner was transferred to Great Lakes, Nieto was declared ineligible and West was forced out with a badly strained knee. Both Nieto and West, who were the key men on the team, are lost for the season.

The revised lineup now includes Larry Collins and Jerry Schneider forwards, Bates at center and Jack Cardall and John Pryor at guards. Collins and Pryor were brought up from the B-squad and currently are the leading scorers.

In the first game after the holidays, Tech defeated Los Alamitos Naval Training Station 55-54. With the lead changing hands twice in the last minute of play, Paul Nieto tossed the winning basket from mid-floor as the gun sounded. In another close battle, Oxy was trimmed 44-43, with neither team having more than a three point advantage any time in the second half. Redlands proved an easy victim, falling before the Tech attack by a 55-31 score.

Games were dropped to U.C.L.A. 42-37, March Field 57-44, Pepperdine 52-44 and 45-33, and U.S.C. 42-36. In practically all of these defeats, the lack of height on the Tech team enabled the victors to score repeatedly on tip-in and rebound shots.

PERSONALS

1926

FIRST LIEUTENANT MANLEY EDWARDS, (U.S.A.), is now stationed with a signal service battalion in New Guinea.

LIEUTENANT-COLONEL STUART SEYMOUR, (U.S.A.), was transferred in December to Camp Livingston, La.

1928

DOUGLAS G. KINGMAN has been promoted to division superintendent, San Joaquin Division of the General Petroleum Corporation of California.

1929

LIEUTENANT-COMMANDER FRED WHEELER, chief engineer of the U.S.S. *Princeton* which was lost in the Philippine battle last fall, is back in the United States and has been assigned to the Marine Engineering Department, U. S. Naval Academy.

1931

LIEUTENANT RAY LABORY, (U.S. N.R.), has recently been assigned as transportation officer at the U. S. Naval Ammunition and Net Depot at Seal Beach, Calif.

1933

MAJOR ROBERT G. MacDONALD, after spending 26 months in the South Pacific theater, returned to the United States and was stationed at Fort Belvoir and Camp Sutton. He was then ordered to the Atlantic theater and now is battalion commander in an engineer regiment commanded by Lieutenant-Colonel Allan W. Dunn '29.

1935

LIEUTENANT BOB JONES, who is stationed with a Navy Degaussing Unit on a South Pacific island, claims it is too hot there to participate in sports except softball and ping pong.

BRADLEY H. YOUNG, maintenance engineer for Pan American-Grace Airways in Lima, Peru (author of "Rhumba Run," which appeared in *Engineering and Science* last September and October), is back in California for a brief period of time.

1937

JOHN P. SELBERG and wife sent out announcements introducing Nancy Lynn Selberg, November 15, 1944.

1939

LIEUTENANT (j.g.) WILLARD M. SNYDER, who has been an instructor at the Naval Training School, Meacham Field, Fort Worth, Texas, expects to be transferred soon to the Naval Air Transport Service in the Pacific.

1941

LIEUTENANT LARRY WIDDOES, (U.S.N.R.), has been transferred to the Naval Air Station at Whidby Island, Wash.

ALFRED SCHAFF, JR., co-pilot for Pan American-Grace Airways in Lima, Peru, returned to California for a two-month vacation after three years service in South America. He was accompanied by his wife and daughter.

DAVID S. WOOD and Miss Connie Simonsen have sent engagement announcements to their friends.

1942

LIEUTENANT (j.g.) TOM ELLIOTT, who has had a shore station in the Pacific area for over a year, frequently sees Tech men as they pass through. Among these have been Lieutenant Kenneth Schureman '42, (U.S.N.R.), *Ensign Ralph Willits* '43, Lieutenant Chuck Carstarphen '39, (U.S. N.R.), and Lieutenant Rube Snodgrass '41, (U.S.M.C.).

LIEUTENANT (j.g.) WARREN GILLETTE, LIEUTENANT GEORGE MEYER and ENSIGN PAUL McKIBBEN are in submarine service in the Pacific.

ENSIGN GEORGE LIND, having completed *his indoctrination work at the University* of Arizona, is a fire control officer aboard a battleship in the Southwest Pacific.

LIEUTENANT LANGDON HEDRICK is an engineering officer with an army bombing squadron in the Far East.

HENRY KREMERS, formerly with Lockheed Aircraft Corporation in the research department, now is associated with Gates Paper Company of Los Angeles, Calif.

WILLIAM LESTER ROGERS and Miss Sandra Alice Morrissey of San Marino, Calif., were united in marriage at a formal wedding ceremony in early January. Their new home is in Pasadena.

1943

WILLIAM FAIR is with Sperry Gyroscope Company as a *Navy technician.*

ENSIGN DAVID A. ELMER, who has been working on a Navy research project at Caltech, has been transferred to the industrial department of the Mare Island Navy Yard.

LIEUTENANT (j.g.) EVERETT MACARTNEY is finishing his submarine training and expects his craft soon to be assigned to active service.

ENSIGN CHUCK STRICKLAND is stationed aboard a carrier in the Pacific.

LIEUTENANT JOHN BUCHANAN, (U.S.A. Air Forces), is attached to an aviation engineer battalion at St. Petersburg, Fla., with duties of airport construction.

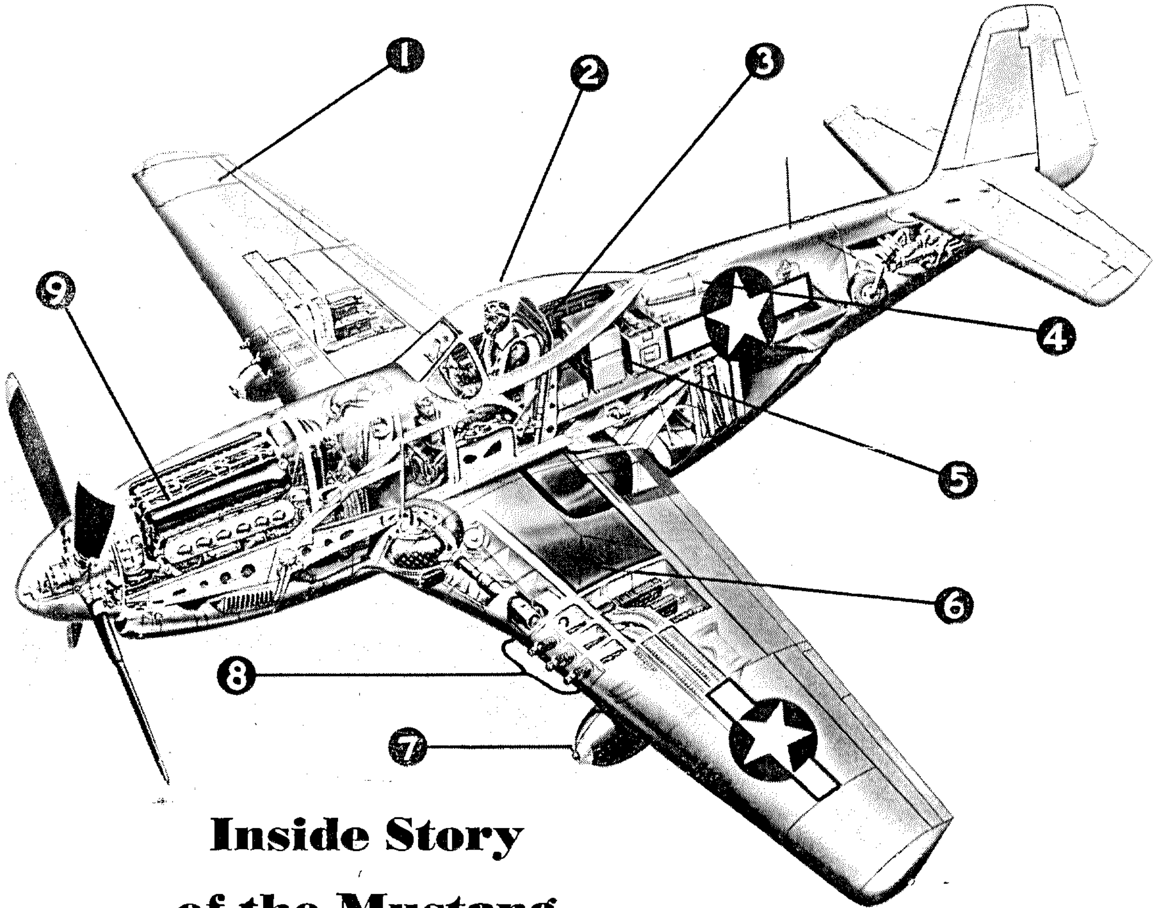
LIEUTENANT EDWIN JOHNSEN, (U.S.A. Air Forces), is also attached to an aviation engineer battalion at St. Petersburg, Fla., also with duties of airport construction.

1944

DOCTOR CHARLES T. BOEHNLEIN, formerly a professor of aeronautical engineering at the University of Minnesota, is now a lieutenant-commander in the Navy, assigned to teach at the Navy postgraduate school, *Annapolis, Md.*

SECOND LIEUTENANT STANLEY HOLDITCH is an instructor of an officers communications course at Chanute Field, Ill. His students are all pilots who have *flown out their missions overseas and* are being trained for ground crew jobs.

ENSIGN FRANKLIN OTIS BOOTH and Miss Barbara Hyde of Piedmont, Calif., were married in a formal ceremony early in January. Ensign Booth is stationed on Treasure Island in the mine sweeping service of the U. S. Naval Reserve.



Inside Story of the Mustang

Here are nine reasons why the P-51 Mustang is the most efficient, most deadly, most feared American fighter-plane in enemy skies:

1. REVOLUTIONARY DESIGN—laminar-flow super-speed wing.

2. NO BLIND SPOTS—full vision cockpit enclosure.

3. ARMOR PLATE—this bullet-proof seat back protects Mustang pilots.

4. FIGHTS EIGHT MILES UPSTAIRS—these tanks provide oxygen for pilot.

5. TWO-WAY RADIO—provides close coordination during missions.

6. SELF-SEALING GAS TANKS—an important safety factor in combat.

7. BOMB LOAD—1000 pounds under each wing.

8. DEADLY FIREPOWER—six .50 cal. machine guns, three in each wing.

9. SPEED—OVER 425 MPH—1520 HP supercharged engine and automatic, variable pitch propeller.

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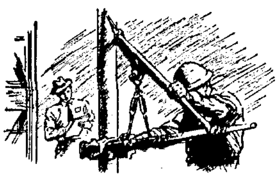
North American Aviation *Sets the Pace*

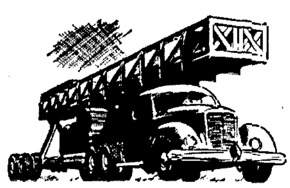
PLANES THAT MAKE HEADLINES... *the P-51 Mustang fighter (A-36 fighter-bomber), B-25 and PBJ Mitchell bomber, the AT-6 and SNJ Texan combat trainer. North American Aviation, Inc. Member, Aircraft War Production Council, Inc.*

Norm Tessner, 403 E. Center St., Anaheim, Calif.

Norm Tessner has a $35,000 kit of tools

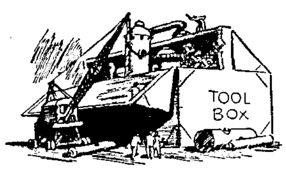


1 Norm Tessner is a Union Oil well puller. Like any other skilled workman, Norm has to have tools. The principal "tool" in his case is a portable rig which pulls the tubing and the pump out of the wells. Without that rig Norm simply couldn't practice his trade.



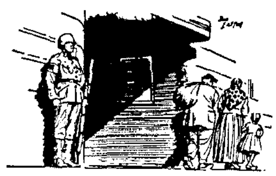
2 So in order to use his skill, Union first had to provide him with a portable derrick and machine that cost $35,000. At first glance this may seem like a lot of money. But it takes even more than that to provide working equipment *for each employee in the Union Oil Company.*

3 Of course, it only takes a $90 typewriter to provide the working equipment for a stenographer. But on the other hand, it takes a $4,000,000 refining unit to make jobs for just 25 stillmen. And if the company is going to function as a unit, one phase of the work is just as necessary as the other.



4 So the Union Oil stockholders have actually invested $39,504 (in refineries, ships, tools, rigs, oil lands, etc.) for *every one* of the 7,869 employees in the company. This figure shows how drastically the machine age has altered American life.

5 75 years ago almost any man could buy what simple tools he needed himself. Today, in many industries tools cost so much the *individual* simply cannot finance them. The answer is *multiple ownership*—pooling the money of a lot of people. (In Union's case, 31,375 stockholders have helped finance our equipment.)



6 Of course, some countries form these pools by *government ownership.* But in America we form them under legal agreements known as *corporations.* For that way, we can preserve the *freedom* of the individual, the *efficiency* of a free economy and that all-important human incentive—*competition.*

UNION OIL COMPANY
OF CALIFORNIA

This series, sponsored by the people of Union Oil Company, is dedicated to a discussion of how and why American business functions. We hope you'll feel free to send in any suggestions or criticisms you have to offer. Write: The President, Union Oil Company, Union Oil Bldg., Los Angeles 14, Calif.

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