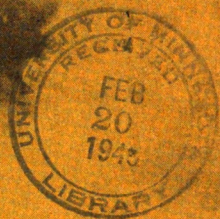


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CHEMICAL WARFARE BULLETIN



APRIL 1942



THE COVER PICTURE

Units of the First Cavalry Division stopped many tank attacks during maneuvers with the aid of smoke. Here, two bewildered tank crews are shown having successfully nosed through a dense screen. Maj. William W. Spurlock, Division Chemical Officer, discusses the subject in his article SMOKE SAVES THE DAY, which begins on page 67 of this issue.

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CHEMICAL WARFARE BULLETIN



A review of developments in the
application of chemicals
to military effort.

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A WORD TO HUNTSVILLE

**An Address Delivered
by Maj. Gen. William
N. Porter, Chief of the
Chemical Warfare Ser-
vice, to Employees of
Huntsville Arsenal,
Huntsville, Alabama,
Jan. 12, 1942.**



Fellow Soldiers: Six months ago it became my job to select a site for a new arsenal for the Chemical Warfare Service. After a most careful survey which took me into twenty-one states, it was decided that the \$50,000,000 project should be located on the broad acres on which we are gathered today.

The peaceful countryside through which I travelled then, on a quiet Sunday, is becoming, through your efforts, one of the most vital centers for the creation of weapons needed for our fighting men. As I travelled over it this morning you can well imagine the contrasts which rose in my mind -- cotton, corn, schools and houses have been replaced by busy offices, manufacturing plants, loading plants, workshops, warehouses and magazines. Miles of roads and miles of new railroad track cross and recross the 30,000 acres. More than half of our work is done and I am here to thank you for it.

THESE PREPARATIONS ARE NECESSARY

When this project was conceived we were at peace, but making these preparations is necessary to maintain that peace in a chaotic world. Today we are at war, and you and I are soldiers together. While we are working far from the sounds of battle in Huntsville or in Washington, other Americans -- your brothers, your sons and your neighbors -- are giving their lives to their country. Every day the casualty lists are coming in from the Far East, bringing the names of men who have given all for the American cause.

What you and I can do -- the very least we can do -- is to give this cause every ounce of our energy, every hour of the day that we can, and every minute of every hour. Our men in uniform in the Philippines are not making their brave fight for anything material. They are fighting for the preservation of America. They are not thinking of better jobs or personal ambitions. The sailors and soldiers and marines who are undergoing their terrible baptism of fire in the Pacific are doing so in the service of their country.

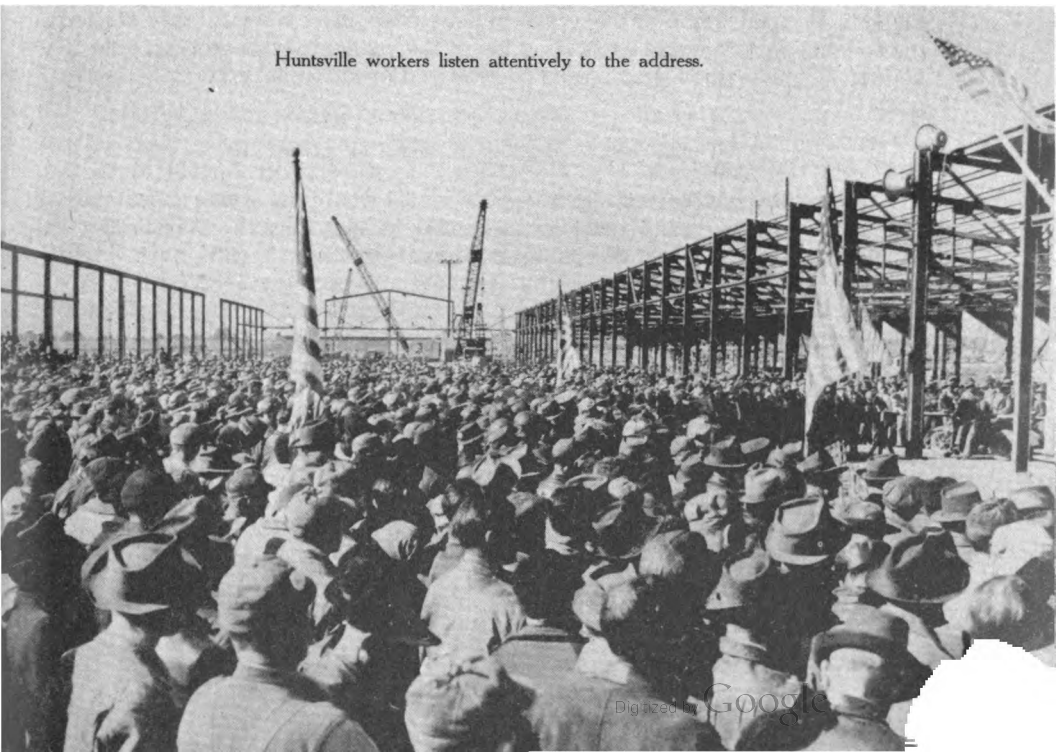
You, too, are fighting in the service of your country. You are the American soldiers of production. Together with our armed forces, you are in this thing all the way. You, and you principally, must pull us out of this critical situation. Without the whole-hearted cooperation of you men and women of construction and production, we of the armed forces are helpless.

An Army cannot fight without arms. It is your job to supply us with arms. If you give us the arms we need, we will win this war, and we will win it finally and decisively. The quicker you give them to us, the sooner we can do it. You, the soldiers of industry, must place the needs of our country above every other consideration. Those peoples in Europe who thought of themselves first, think no more. This shall not happen here. There can be only one result to the cooperative efforts of our soldiers of production and our soldiers of the firing line. The only outcome of that cooperation can be the defeat of the Nazis and the Japanese. Free America must and shall remain unconquered.

ONLY IN A DEMOCRACY CAN LABOR UNIONS EXIST

The year ahead is going to be a tough one. It will decide whether we are to continue here in America as a free people, or are to become a slave to providence. If we win, there will be greater freedom and opportunity for all of us. But if we lose, we will be permitted to exist only under such conditions as a foreign master will dictate. A conquered America would be a nation of 130,000,000 hungry people. Without liberty as we know it, there would be no more free labor unions in this country. Only in a democracy can labor unions exist.

Huntsville workers listen attentively to the address.



I am appealing to you today for speed and more speed, because I know that speed is the greatest weapon we have in this war. American production applied by American soldiers and sailors is the only thing our enemies fear. The faster we can produce, the sooner we will have them on the run. I must tell you frankly that so far in this war, the decision has been going against us. Our outnumbered troops have lost the first round at Manila. We can ill afford our losses at Pearl Harbor. The Japanese have taken a big toll of American lives, and we have not halted them yet. And I might add that victory is a long distance off.

AMERICA MUST BECOME THE ARSENAL OF DEMOCRACY

As Chief of the Chemical Warfare Service, I have come here today to tell you that in order to stem the Axis tide, we MUST have the chemicals and explosives that will be manufactured here. We need more and MORE chemicals, and we need them as fast as we can get them. We need them now. This is a war of production. Whichever side produces the most will eventually win. Our enemies have a big head start. They have been preparing for a showdown with us ever since the Armistice in 1918. For 24 years they have been piling up munitions and training men for an attack on us. The whole continent of Europe is the arsenal of Fascism. The whole continent of North America must become the arsenal of Democracy.

Today we have not yet reached that goal. Our war effort has been in progress for only a little more than a year. We must catch up with the Nazis and the Japanese and surpass their output. That's the only way we can win. It's a race against time.

At Huntsville I have seen that you are cooperating magnificently in that race. We in Washington are proud to announce to the world -- and we don't care who knows it -- that you are months ahead of schedule. We had planned to open some of these plants here next July. Now we have shifted the opening date forward to April. One of the reasons we have been able to do this has been your willingness to keep construction here going 24 hours of the day.

TODAY NO SCHEDULE IS FAST ENOUGH

The record is excellent. In normal times, I would say it was unbeatable. But we are at war; and today no schedule is fast enough. Personally I should like to see some of our plants here operating next month, or in early March. You men who are building our arsenal here are the FIRST LINE defenders of democracy. On your skill and on your speed depends the output which will win this war. Without you men who build -- men like Pop Swain out here -- there would be no arsenals at all. And without arsenals, there would be no production. You are the men who start the ball rolling.

Don't forget that after you've finished your jobs of construction the thousands of men and women who will make up the operating personnel of this arsenal must keep it rolling. You may be fitted for one of THOSE jobs -- look into it. Therefore, it is clear that the future of the country depends on what you can do at Huntsville, and on what millions like you can do at our other production plants. You have enlisted in America's victory Army of your own free will. You have volunteered, without coercion, to fight for freedom.

And here I would like to take the opportunity to thank the citizens of Huntsville for their fine cooperation. I would like to express my appreciation of the efforts of the Nashville, Chattanooga and St. Louis and Southern Railroads.

If you fail, the whole American way of life will fail with you. You know that if our production lags, we will lose the war. It is encouraging to report to you that in every engagement where our American-produced war materials have been used, they have proved superior to the enemy's. Our crack light and medium tanks are largely responsible for the route of the Nazis in Lybia.

INCENDIARY BOMBS HAVE PROVED THEIR VALUE

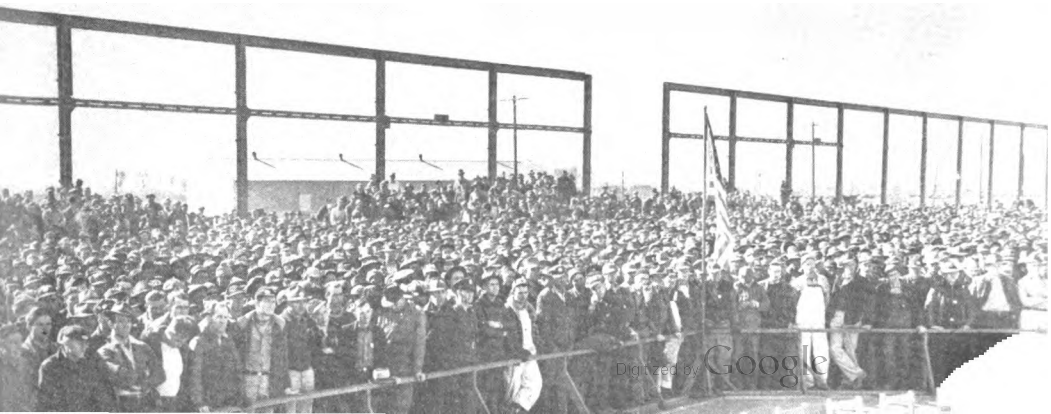
Our Kitty Hawk fighter planes are waging victorious battles in the skies over Europe. Almost nightly American-made bombers -- the Martins, the Liberators and the Flying Fortresses -- are dropping American-made bombs on the invasion ports of France and Norway, and on the industrial centers of Germany. Incendiary bombs of the type that are soon to be made here have already proved their value in the Far East, in North Africa and Europe. American chemicals, such as will be manufactured at Huntsville, are in the hands of every one of the United Nations, ready for use the minute they will be needed.

Lead and steel and chemicals are the only intellectual impulses that will make an impression on our enemies. The need for them is great. Production of them here in America is the only means we have for stopping Hitler in his tracks. In quality we have beaten our enemy at every turn. Our battle now is for quantity. Every gun or bomb or plane we turn out may help save thousands of American lives. Therefore, we must produce these guns and bombs and planes until it hurts.

NO PERSONAL AMBITION MUST STAND IN OUR WAY

No personal ambition, no petty considerations must stand in our way. This war goes beyond everything that is personal. Everybody must cooperate as a team with a single purpose. You have heard over and over

Another view of the large crowd of Huntsville employees listening to General Porter's address.



again about plant expansion. You know that the Government is expanding its production facilities as fast as it can. What you may not have thought of is that the swiftest path to expansion of production lies right within your individual powers. Every worker who drives four rivets in the time it normally takes to drive three is contributing to production expansion. Every construction worker who is hammering a dozen nails in the time it formerly took to drive six is expediting his production.

The service you are rendering yourselves and your country by speeding up your work is measurable only in human lives -- the lives of American fighting men. The faster we work the more American lives we will save. Never forget that this war is being fought on the work benches, the machines and the production lines -- as much as on the actual battle front. America has never lost a war, and we aren't going to lose this one.

All of us and all of our children have a stake in this fight. It is the right of the entire American people. We cannot, and I am confident, we will not, let ourselves and our countrymen down.

The Army knows it can depend on you.

The high-ranking Chemical Warfare officers accompany Lt. Col. A. Robert Ginsburgh, Chief of the War Department Bureau of Public Relations, in a visit to the Lincoln Mills during the Huntsville trip. Here Colonel Ginsburgh is addressing the Lincoln Mills workers. Seated, left to right, are Maj. Gen. William N. Porter, Brig. Gen. R. C. Ditto (Commanding General of the Huntsville Arsenal), and an officer of the Fourth Regional Civilian Defense Area.



SMOKE SAVES THE DAY

The First Cavalry Division Furnishes Some Vivid Examples of the Tactical Use of Smoke

by

***Lt. Col. William W. Spurlock,
Division Chemical Officer***



Due to the very limited amount of smoke munitions available to the First Cavalry Division for the August-September maneuvers last year, it was decided not to use smoke for screening river crossings and other similar problems of the entire Division, but to restrict its use largely to the most mobile elements, namely 91st Reconnaissance Squadron and Tank Pursuit Squadron.

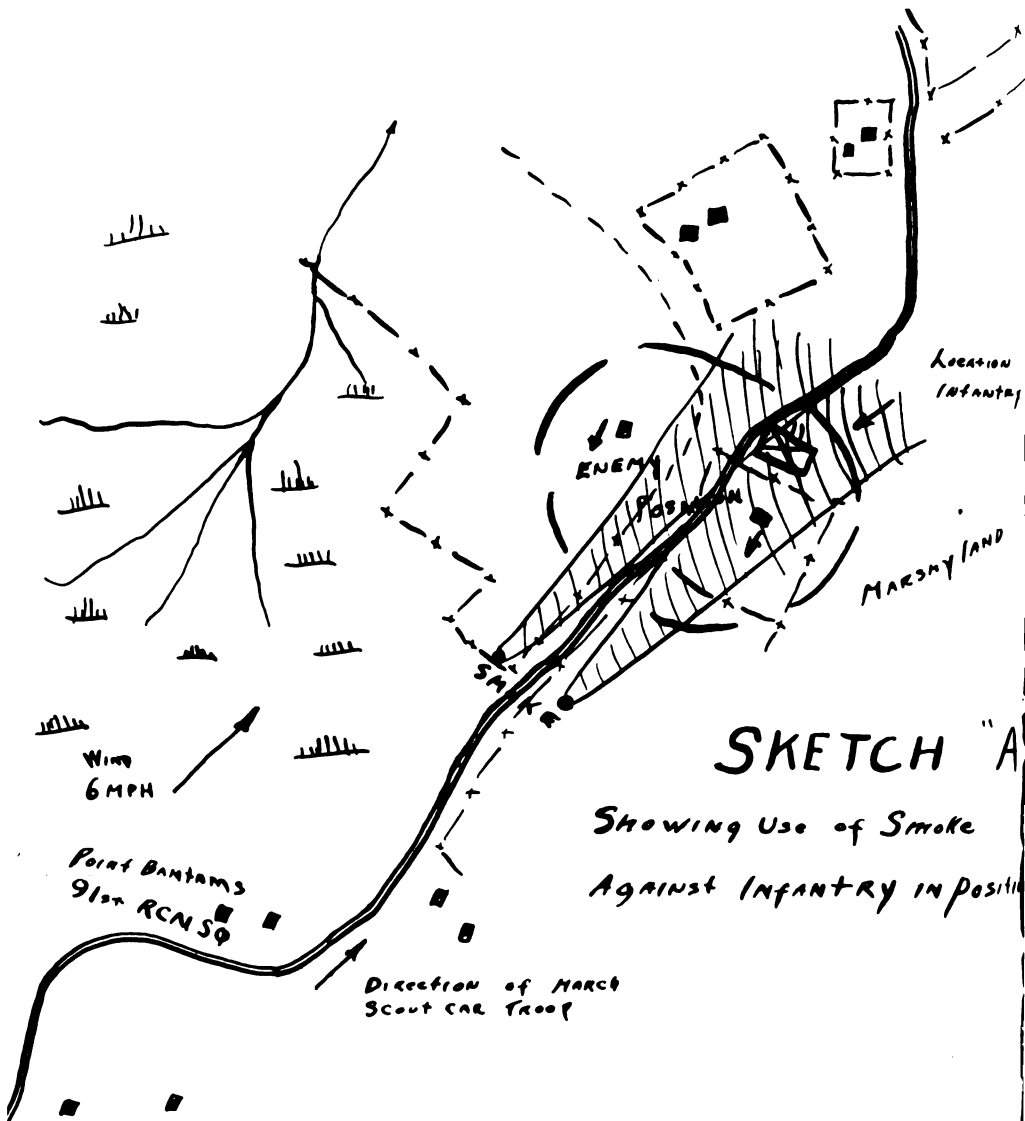
THE 91ST RECONNAISSANCE SQUADRON

The 91st Reconnaissance Squadron is made up of four motorized troops, two scout car troops of twenty cars each, one bantam troop of thirty-eight bantams, and one tank troop of thirteen tanks and three half-track scout cars. As the name implies, the primary mission is reconnaissance rather than combat. Frequently the squadron is far afield and split up into small detachments. A few smoke pots were carried in each vehicle to be used, primarily in delaying superior forces or as a means of escape. Some examples of these missions follow.

A. AGAINST ARMORED COLUMN. The squadron, far in advance of friendly forces was confronted by an armored column of immensely superior fire power. Withdrawal, at the same time delaying the enemy was the only course open.

Bridges on all side roads were demolished, forcing the enemy column to keep on the main highway, where they encountered frequent road blocks which were covered by smoke screens. Machine guns were set up in heavy timber alongside the road, and when the enemy dismounted from armored vehicles to remove road blocks, light machine guns were able to inflict heavy casualties and then escape through the smoke before the enemy, his vision completely cut off, could take effective action.

This same operation was repeated several times over a six mile road space, until all vehicles of the 91st Reconnaissance Squadron were assembled on the main road in advance of the enemy. The enemy consumed five



SKETCH "A"

Showing Use of Smoke
Against Infantry in Position

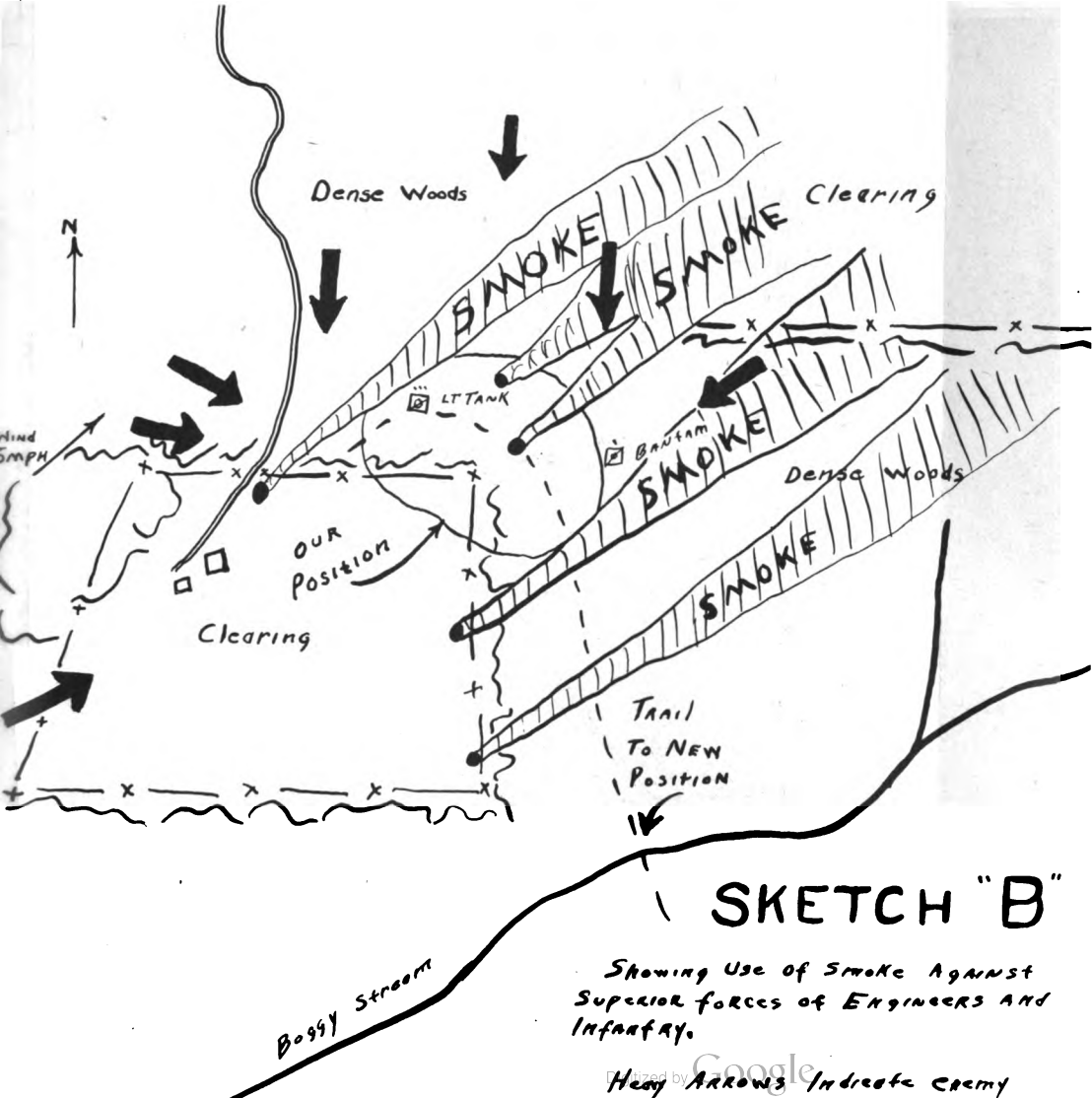
ADN G.O. SCOUT CARS
91st RCN SQ

and one-half hours in advancing six miles. Personnel casualties were ruled so heavy against him that a part of his tanks were lacking crews and hence inoperative for the remainder of the day. CN candles had been used in the first of these smoke screens. Since the enemy was without masks, they did not approach succeeding road blocks until the smoke had dispersed, thus allowing more time for construction of sturdier road blocks, which in turn caused greater delay.

B. AGAINST INFANTRY IN POSITION. (See sketch "A") A reinforced infantry battalion held the area directly astride a road which it was necessary for the Reconnaissance Troop, reinforced with a platoon of engineers,

to traverse. The wind was five to seven miles per hour, parallel to the road. Smoke pots were dropped from first two scout cars, on either side of the road, thus enveloping enemy, rendering aimed fire impossible. A movement of scout cars, launched as quickly as the screen became dense, produced such confusion that the infantry abandoned its mission to run out of the screen. The umpire ruled no casualties against the 91st Reconnaissance Squadron, other than four scout cars which had run over land mines. All other vehicles, with no personnel losses therefrom were allowed to pass through enemy area and continue on their mission.

C. AGAINST INFANTRY AND ENGINEERS. (See sketch "B") The 91st Reconnaissance Squadron (bantam troop of eight cars, tank troop of six tanks, squadron headquarters of three cars) was completely surrounded, our main body being twenty miles to the south. Wind, SW, six miles per hour. Enemy attacks were forming from the west, northwest, north and northeast. Smoke pots were ignited to the immediate west, and slightly

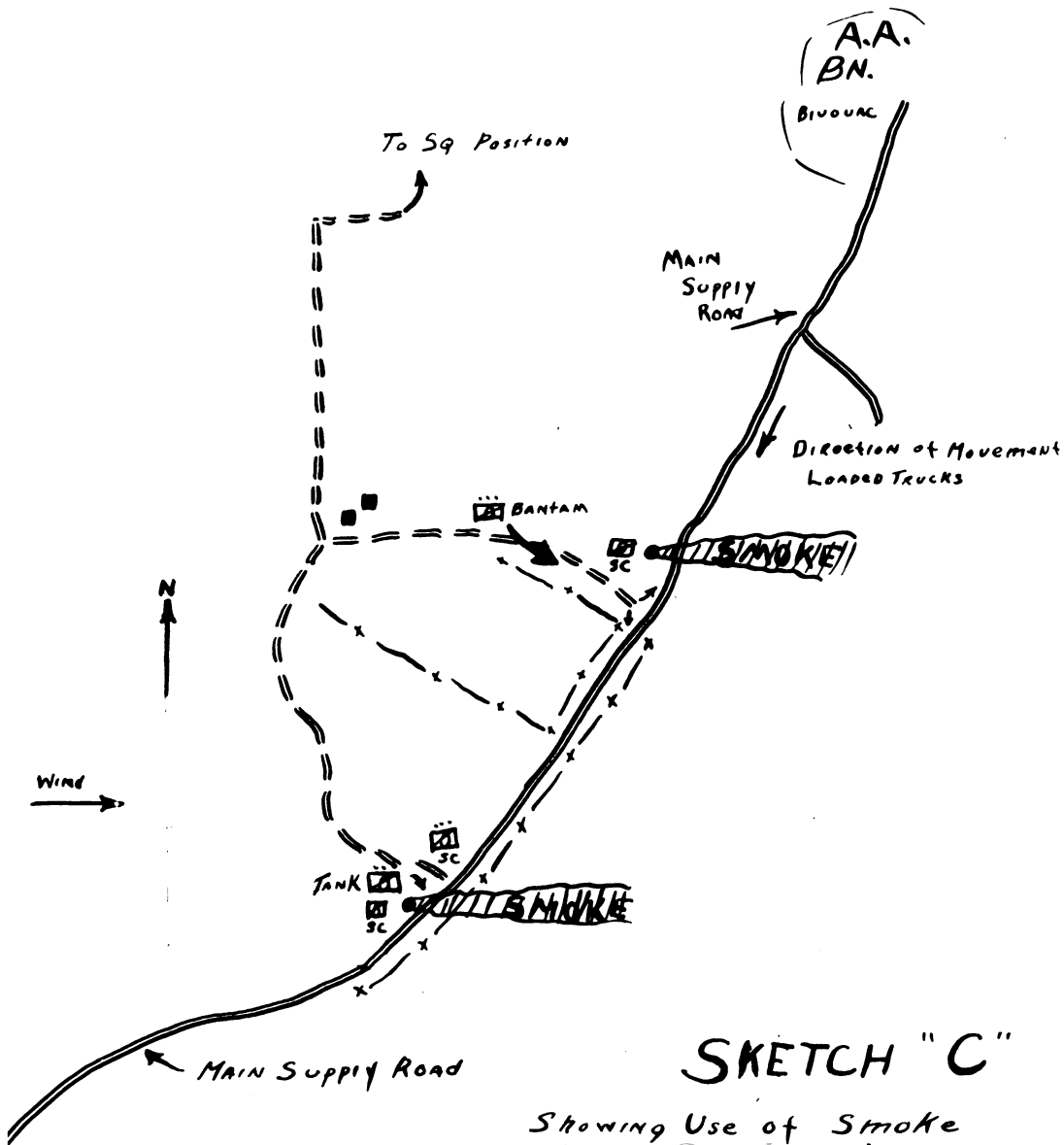


SKETCH "B"

Showing Use of Smoke Against Superior forces of ENGINEERS AND Infantry.

Heavy Arrows Indicate enemy Attacks.

south of our position, forming a screen in front of attacks coming from west and northwest, and completely enveloping the attackers on the north. Other pots placed to the immediate north and east completely hid movements from all the enemy except weak forces southwest of our position. Apparently this small body reported to their colleagues that their vision was clear, for the ensuing noise indicated the stronger force to our west moving to join the small force to the southwest. Two pots were ignited to our south, another two pots fifty yards south of those two. Our vehicles escaped by driving through these thin screens. The leading drivers, having gone out to lay the pots, had a general idea of obstructions etc., and were able to lead the column at reasonable speed, despite the smoke. Once



SKETCH "C"

Showing Use of Smoke
Against Column

outside the enemy positions, our escape was easy due to our great mobility. This was accomplished without loss of a vehicle or a man.

D. AGAINST TRUCK COLUMN. (See sketch "C") The squadron was in hiding about two miles off the main enemy supply road. Our area was heavily wooded. The trail from our position met two side roads which joined the main road approximately 3/4 mile apart. A detachment of six tanks, four scout cars and eight bantams was given the mission of capturing enemy rations and gasoline. Two scout cars with radios were stationed in the brush within clear view of the main road, one near the junction of each side road and another along the main road two hundred yards from the side roads. Each radio operator had two smoke pots. When gasoline and ration trucks passed the north scout car, the detachment commander was notified. The commander confirmed this report and ordered road stations to block the main highway with smoke screens. The screens concealed our operations from approaching vehicles and forced them to halt. When the screens were well established, our bantams and tanks came out of the woods beside the road, surrounded the ration and gasoline trucks, escorted them along one of the side roads into our bivouac area. When the smoke cleared, no vehicles were to be seen on the road. Casualties, none. Results, twenty-five trucks captured.

The officers of the 91st Reconnaissance Squadron report smoke a very effective weapon in its type of operations, not only for its obscuring power but also for the confusion it produces. Frequently they took no action until the smoke had cleared. The effect on troops is considerably greater when they are actually in the smoke.

THE TANK PURSUIT SQUADRON

The Tank Pursuit Squadron, First Cavalry Division, was a provisional unit comprising Anti-tank Troops of the First Cavalry Division, and Special Weapons Troops of the First and Second Cavalry Brigades. Jointly the three troops had the following weapons: thirty-six anti-tank guns, 37-mm., mounted on bantams; twelve mortars, 81-mm.; one hundred and six machine guns, 30 cal.; twenty-two machine guns, 50 cal. In addition, twelve trucks, two and one-half-ton cargo; three trucks, one and one-half-ton; six command and reconnaissance cars; twenty-two scout cars; forty motor cycles; and three tricycles, motor, were used for transportation.

The ability to bring heavy fire power at a given point in a short time being of paramount importance to the organization, it follows that any action delaying movement of opposing forces will be of greatest value. Like the Reconnaissance Squadron, this unit is frequently widely separated into weak forces, however, when enemy tanks are encountered they are usually of sufficient number to require considerable force to eliminate them.

SMOKE COMPLETELY DISORGANIZES TANK ATTACK

It was in just such a situation that smoke was used on the largest scale, at Zwolle, La. A sergeant and a private first class, both qualified smoke experts, had been attached to the Tank Pursuit Squadron from Division Chemical Officers' Detachment to supervise and assist in smoke operations.

The bulk of the Tank Pursuit Squadron's fire power was positioned

across highway 171 just south of Zwolle, when a number of tanks attacked from the south. Upon being stopped by a superior fire power, the tank commander returned south on highway 171, met his reinforcements, then started his maneuver, a wide swing about our left flank, to enter the town of Zwolle from the east. A smoke detail under command of the chemical warfare sergeant, mounted in bantams, came through town and was able to lay a screen, although a thin one, about half a mile long, along the edge of the forest, just ahead of attacking tanks. This screen, though hurriedly placed and rather thin, slowed tanks to such an extent that 37-mm. guns and 50 cal. machine guns were able to move from the south side of town to the east to meet the attack. This delay of tanks gave an opportunity which was seized upon by smoke details to place an extremely dense and wide screen approximately one hundred yards in front of the positions to which our anti-tank guns were moving. Upon encountering the second screen the tank commander halted before entering, evidently to gather force. While he waited, the first screen was dispersed, and tanks massed in front of the second screen for attack through it. Having encountered little difficulty in the first screen, they approached the second at high speed, in close formation. But this screen was wide and very dense, evidently each driver reacted differently to the impaired vision, some slowed to a snail's pace, others gunned their motors, others lost direction, colliding with one another and with obstacles which they were unable to see through the smoke. Many tanks were thus immobilized and the mass attack was completely disorganized. Only a fraction of their number were ever able to come through the screen and they were singly and widely separated, hence easy targets for anti-tank gunners who were able to see the emerging tanks long before the tank crews could see the guns.



The First Cavalry Division breaks up many tank attacks with the aid of smoke. Here, two bewildered tank crews are shown having successfully maneuvered through a dense screen. In the accompanying article Major Spurlock explains that most of the tanks were immobilized, losing direction, colliding with one another or other obstacles, and in every case becoming confused and disorganized.

A number of our guns arriving late to the new position were not needed on the front, so made a flanking attack about the enemy's left to his rear and as the smoke lifted, captured or destroyed the immobilized tanks. The victory of the Tank Pursuit Squadron was so complete that the umpires declared the "battle" closed in that sector.

A third type of smoke operations executed by the First Cavalry Division was its ground troops defense of a headquarters against enemy tanks. This operation was conducted by the division chemical detachment of six men, assisted by a like number of soldiers from the division signal troop, entirely untrained in smoke tactics.

The rear echelon, Headquarters First Cavalry Division was bivouacked in heavy woods on the east bank of a small stream coursing southwest-northeast. A three mile per hour wind blew from the east. A detachment of eight enemy tanks attacked along the stream bed, from the southwest while half-track scout cars with mounted machine guns simultaneously attacked from the south. The only armament of the headquarters was one anti-tank gun, 37-mm., two machine guns, 50 cal., and one machine gun, 30 cal., mounted on a scout car which had been ruled out of action at first contact.

SMOKE SUCCESSFUL IN DEFENDING HEADQUARTERS

Smoke pots were placed approximately twenty yards apart along the southern boundary of the area. The smoke dispersed widely in low velocity wind, forming a screen to the south and southwest, forcing tanks into a wide circling movement, thus allowing ample time to set pots for another screen on our west. The drifting smoke from the two implacements of pots formed an area approximately two hundred yards depth through which it was necessary for tanks to pass in order to attack our positions. Due to obscured vision, tanks collided with large trees, with one another, drove into marshy places along the stream and were completely disorganized. Only one of the eight tanks emerged on our side of the screen during its six or eight minutes duration.

Here, as in every case, tanks failed to operate with any degree of success when enveloped in smoke. This operation suggested the feasibility of arming foot troops with smoke pots and "molotov cocktails" to combat tanks. This would be especially effective among large trees or other natural obstacles. The men on foot can operate in the smoke and are able to hear and see the tanks long before being observed. In a dense screen, tank movement is so slow as to be easily dodged while the men advancing singly by bounds from one tree to another, can easily approach near enough to throw gasoline filled bottles against the tanks, setting them on fire and forcing the crews to abandon all but hand weapons.

Results of smoke against armored forces were extremely gratifying in every case. The personal reaction of drivers is so different and so unpredictable that mass attack is impossible, and it is doubted if training can overcome the handicap, for even if constant speed is maintained by all drivers, loss of direction in a screen of considerable size will act to disorganize formations and produce confusion, and in many cases collisions of the vehicles with one another as well as with natural obstacles. The greater the number of tanks involved, the more certain are they to become confused and disorganized.

CHEMISTRY IN WARFARE

A Recent Address to the Students and Faculty of William and Mary College

by

***Col. Maurice E. Barker,
Technical Director, Edgewood Arsenal***



Professor Wagener, Members of William and Mary College, Ladies and Gentlemen:

Some months ago Dr. Wagener was kind enough to invite me to come here tonight to address you on the subject "Chemistry in Warfare." When I accepted this invitation I planned to approach the problem from an historical standpoint. Then we were at peace. Tonight we are engaged in a desperate war for our very lives - for our right to exist. Therefore, tonight I want to change my original theme and tell you about some of the chemical problems of warfare that must be solved by this country - to present a challenge to you chemists of all degrees from freshman to professor. Let's quit boasting about what we have done and do some new and useful work - and a lot of it.

THE TASK OF THE PRACTICAL CHEMIST

Our armed forces need most of the usual things that are in production. That means laboratory control of the purity and quality of thousands of raw materials, intermediates, and final products. This is a job for chemists on the payroll of industry and the government. It is a big job, for every soldier has the right to expect that the food sent him will be healthful and palatable; that his shoes will be wearable and resistant to water, snow, and mustard gas; that his gun and ammunition will function in tropical storms as well as in the arctic blizzards; that hospital supplies of good quality and competent medical assistance will be available when and where needed to bring him back to health in case enemy bullets, service accidents, or bacteria have laid him low; that his gas mask and other equipment will serve him where, and as required.

THE JOB OF THE CREATIVE CHEMIST

Not only must the supplies already standard be controlled as to quality and produced in a never ending stream, but new things must be developed

and production facilities for these new inventions must be created. We need all that science can give us in the way of new arms and equipment of many types: medicine, transportation, vitamins and household supplies.

The chemist must do his part in finding acceptable substitutes for tin, nickel, chromium, natural rubber, brass, wool, quinine, and many other things which must be rationed and conserved to make our limited stock-piles of natural supplies meet the possible military requirements. We have set many men and women possessed of creative imagination and sound technical training to work on these problems but all the additional help possible is welcomed.

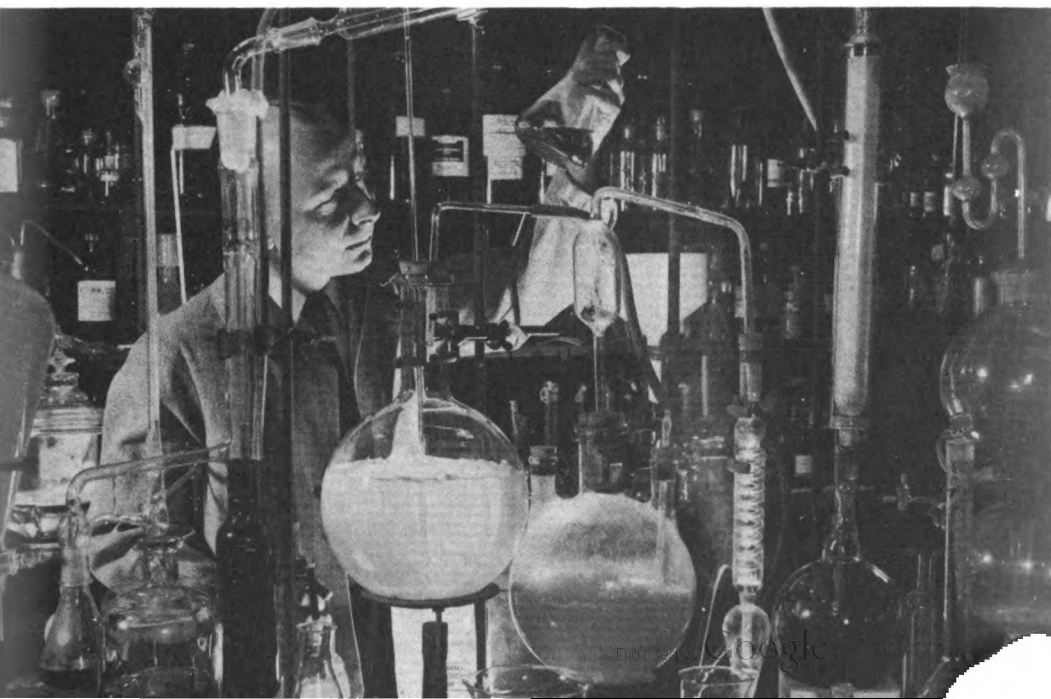
THE VALUE OF IMAGINATION AND VISION

To the man or woman endowed with creative imagination and technical training, there is no such thing as "It can't be done." If Jules Verne could visualize a boat that ran beneath the surface of the ocean and that saw its way by means of reflecting mirrors set in a long tube, then competent marine engineers could build a submarine with a periscope. However, before the submarine could be constructed someone had to visualize the need for the machine and a way in which it could be made and worked.

All of you remember the story of the English author who wrote a book to prove that steam propulsion could not be applied to an ocean going vessel, only to have such a ship bring the first printing of his book to America.

If Buck Rogers can overcome enemies of all kinds with his "Ray Gun," who knows how soon such weapons will be hurling their weightless bullets

"The Chemist must do his part in finding acceptable substitutes for tin, nickel, chromium, natural rubber, brass, wool, quinine, and many other things," explains Colonel Barker. The picture below, in which chemist H. A. Jones, U. S. Dept. of Agriculture, seeks new chemicals, affords a graphic illustration of the modern research chemist at work.



at human targets? Already the "Atom Smashers" at M.I.T., Harvard, and California Tech. must have their generators buried deep in the earth and surrounded with tanks of water and shields of lead, and the approaches must be by a labyrinth of trenches constructed in the best style of the World War approach trench. Without these precautions the M.I.T. "Tin Hat" would be a potent weapon of destruction for the entire surrounding area.

Don't think or say "This is good enough" or "This thing cannot be done." No man in responsible charge of National Defense dare say or even secretly think these things since December 7, 1941. We may, and do have to say to our production people, "We will make ten million items like this model," but at the same time the research department is told, "Make something better!" These better models follow so fast that production people shiver in their sleep for fear that their beautiful assembly lines will be disrupted.

AIRPLANE SPRAY DEFIES DIFFERENTIAL EQUATIONS

As a parting illustration, while we are on this line of thought, let me tell you of an incident that occurred several years ago when we of the Chemical Warfare Service Technical Staff at Edgewood Arsenal, were trying to design an apparatus to spray smoke and liquid gas from an airplane in motion. We employed a famous mathematician to study the problem and advise us as to how to proceed. He made the usual assumptions to set up his differential equations and proved conclusively (to his own satisfaction) that "it could not be done," because the liquid, when thrown against the air at the then terrific speed of 80 miles per hour (1924) would break up into drops so small that they would obey Stokes' Law instead of Newton's Law of falling bodies. Pilot Gilkeson and I went aloft with a ten gallon can full of red dyewater. Gilky flipped the DH on her side and I tipped over the can. Our mathematical friend was out to see his theorem demonstrated. As luck would have it, the blood red water fell like a summer rain and spattered on our mathematical co-worker. Was his face red?

I hope I have not wasted your time and mine for the past five minutes while I tried to illustrate the proposition that anything that the logical human mind can imagine can be achieved. Frequently we hear the question asked, "What would happen if an irresistible force were applied to an immovable body?" No logical mind can conceive of "an irresistible force" and "an immovable body" at the same time, because those two things are incompatible. Again I want to repeat in other words what I have just said, and that is, "Anything which can be imagined that does not violate the fundamental laws of physics, mechanics and chemistry, can be achieved."

Creative, logical imagination is a mighty force in development of new processes and new things. The perfection of these things is accomplished by painstaking, methodical developmental and engineering work.

Not long ago my friend, Dr. Conant of Harvard, made a statement to the effect that "The first World War made the profession of Chemistry, but the second war would make the physicist." In this he was essentially correct, because in recent years the physicists have broken out of their narrow rut, and have dared to dream, then tried to make their dreams come true. There are many signs that more and more chemists are daring to dream. Perhaps there is something to what a pipe-smoking chemist once said, to wit: "No progress in chemistry is ever made unless you have your feet on

the desk and a good pipe in your mouth. Then you can't do anything but think." As proof of this statement he dared anyone to compare the progress in chemistry before and after the pipe was invented.

I hope you have not become overly impatient while I tried to hammer home the thought that progress in chemistry, in physics, in industry, in methods and weapons of warfare, come from those who dare to dream logical dreams as well as by the unremitting toil of the technicians who gather the facts which the engineer can use in reducing the invention to practical utility.

COORDINATION REQUIRED

National Defense demands the best from all of us - from the soldier, the mechanic, the designer, the chemist, the physicist, the business man. We must have coordinated effort. Heretofore, each of these professions has looked at his job as though it resided in a watertight compartment and could go on without reference to anybody else. All too often we knew little, and cared less, about the other fellow's problems. In this connection I am reminded of the professor of colloid chemistry who associated with both physicists and chemists. Now wasn't he a rare bird? When among the chemists he talked about physics and its possible application to chemistry. The chemists couldn't follow him very far or very fast, so they considered him quite a fellow. When the professor talked with physicists he emphasized the importance of chemistry and was followed not at all by the physicists. As a consequence, this professor was a great scientist to both physicists and chemists, though he was nothing like top flight in either science. Today the problems of National Defense will not be solved by the chemist, or the physicist, or the mechanic, or the soldier working alone. We must have the coordinated efforts of all these people to produce new weapons and new products of all kinds which we will need desperately within the next year. We must learn a lesson from the complete cooperation shown by Hitler's tanks, artillery, infantry, and air force.

SOME SPECIFIC JOBS AHEAD OF US

May I give you a few examples and point out some of the tasks confronting the chemist today, keeping in mind all the time that the chemist is just one player on our ball team.

RUBBER. In normal years the United States uses about half a million tons of new rubber. Last year we used over six hundred thousand tons. Most of our supply of new rubber is cut off now. We have some rubber in stock. We have half a dozen synthetic rubbers on the market for special purposes. We have a great stock of used rubber. It is essentially the chemists' job to make greater use of reclaimed rubber by treating it to "unvulcanize" it and to restore the molecules of the used rubber to their original state. For years we have played at this job. Today we need dreamers and a flock of technicians to make new rubber from huge piles of used tires.

SYNTHETIC RUBBER. Neoprene, Butyl rubber, Hycar, Ameripol, and other rubber like plastics are now available in limited quantities. Each one has been so tangled in process difficulties in order to avoid patent

infringement that valuable time has been lost and the product is scarce, expensive, and not as satisfactory from a technical standpoint or as desirable. A pooling of the chemical and engineering knowledge and all patents on this subject has just been made that should make us independent of Malaya plantations in a year. This development should provide employment for thousands of workers and for at least a million dollars of capital. The shame is that this step was not taken two years ago. However, we ought to see both Perbuna and Suna-S rubber available in quantity in the next year.

TIN SUBSTITUTES. We Americans have taken the tin can for granted. There must be fewer tin cans now, both to save the steel sheet and the tin coat. Other containers must be developed to replace the ubiquitous tin can. Perhaps the ladies will have to do a bit more cooking and less can opening. Chemists, men and women, must begin an immediate, intense and continual search for packaging materials made from plentiful domestic materials. Why not make such containers from cotton and corn cobs? It can be done. The cotton could be formed into sheets and these bonded with plastics from the corn cob, or from the protein residue left from corn during its processing into sirup (e.g., zein plastic).

QUININE. What a challenge to the organic chemists! Are they going to sit placidly by and watch our own malaria-bearing-mosquitoes wage a terrible bacteriological warfare for the Japs? We need 3-1/2 million ounces yearly. 95 percent of this comes from the plantations of the East Indies.

NICKEL AND CORROSION RESISTANT METALS. Who knows what may be accomplished by the proper heat, sound, X-ray, or physical treatment of iron alloyed with such cheap and plentiful domestic raw materials as silicon, carbon and titanium. We must have huge quantities of corrosion resistant metals for chemical plant equipment. Perhaps the gold and silver in our vaults might well be put to work as the linings of reaction kettles and stills. What a joy a gold lined reactor would be to the man who prays each day that his precious thousand gallon glass lined reactor will not crack that day!!! And why not? The gold would not be used up. It would be doing its bit for National Defense. Therefore, I say, let's take out a few tons of gold and a few hundred tons of silver from the vaults and use them to overcome some of our serious corrosion problems which are bound to get worse due to the growing scarcity of Monel and stainless steel. Then, too, other solutions to the corrosion problem might be found.

WOOL. We do not have enough sheep to furnish all the wool we need. But there is rayon, nylon, and cotton. If cotton could be converted into a fiber having the desirable effects of wool, what a boon this would be to the cotton farmer, the cotton mill owner, and the worker. Here is a problem that every southern chemist should take to heart. Who knows that a process cannot be worked out that will make cotton the King of all fibers? We know now that it can be made water resistant and almost fireproof.

VITAMINS. We have made a good start on this problem. At least we know that vitamins are useful and can be produced. A plentiful supply is essential for our national health and well-being. Improvements are in order.

SYNTHETIC TOLUENE. A few years ago this material was a dream. Now, thousands of gallons are pouring from our factories every day. The

job has just started, for without toluene there will be no TNT. There is plenty of room for progress and improvement.

BUTADIENE. Five years ago this was a rare chemical. Next year (1943) we will make a hundred thousand tons. That will be a fair beginning, but a beginning only. Starting materials may be natural gases or buttermilk. Here is a great field for the organic chemist and the chemical engineer. Synthetic rubber is here to stay. For this we must have butadiene in great quantity and low price. The same applies to styrene and acrylo nitrile.

ALUMINUM FROM CLAY. Hall discovered the basic principles of producing aluminum from bauxite by electrolysis while he was still an undergraduate. We have comparatively little bauxite in the United States. Other proven supplies available to us are not inexhaustible, but there is plenty of aluminum in clay which is scattered over the entire U.S.A. The aluminum is there. We need it. It can be extracted, for a pilot plant has been operating on Tennessee clay for a year. It will be a real contribution to National Defense and to America. We need aluminum for airplanes, for making thermit fillings for incendiary bombs, and for many other uses, both military and civil.

BETTER MILITARY EQUIPMENT. We need a lot of better things, such as a good ten cent dust mask; waterproof, air permeable, unwettable fabrics of many kinds for tents, gloves, clothes; fire resistant cloth for use of guards in munition works, workmen in powder and incendiary plants, and soldiers in tanks and airplanes; better smoke filters for air purifying devices; new synthetic fibers having a diameter of micron or less; and others.

WHAT RESEARCH CHEMISTS ARE DOING NOW

Large numbers of research chemists and chemical engineers are employed by the National Defense Research Committee (N.D.R.C.) in our college, university, and industrial laboratories on problems proposed by the Supply Services of the Armed Forces. The Air Corps, the Ordnance Department, the Naval Research Laboratory, and the Chemical Warfare Service, employ large numbers of chemists of all kinds, chemical engineers, and other scientists, on problems of direct military application. Never before in our nation's history has such a vast coordinated research and development program been undertaken. Of course, I am not at liberty to discuss the details of such work, but you may be interested in the general scope and the procedure that are being followed.

When any of the Armed Services has or foresees the possible need for specific scientific information not available in the literature, the problem is described, the kind of information needed is outlined, and the N.D.R.C. is requested to investigate the problem. This committee places a contract with one or more educational and/or industrial laboratories and the problem gets underway at once, and is directed by the best available men who employ the assistants required. The information obtained is furnished the Armed Services by means of reports and personal conferences. Direct application of the information to military problems is then initiated by the supply branch concerned, and N.D.R.C. and industrial specialists are brought in to assist from a scientific and practical manufacturing viewpoint.



Some fifteen million pounds of rubber are represented in the view **above**, which is a part of the great used tire pile of the United States Rubber Company in Connecticut, and it is to such piles as these that Col. M. E. Barker refers, when he says in the accompanying article, **CHEMISTRY IN WARFARE**, that "Today we need dreamers and a flock of technicians to make new rubber from huge piles of used tires."

Modern rubber plantations, such as the one shown **below**, are no longer available to us since enemy action in the Dutch East Indies, and reclaimed and synthetic rubber are the principal alternate sources at present. A vast amount of research work is yet to be done in these fields before they can hope to meet wartime demands.

At left is pictured the mixing of crude rubber and ingredients by the Firestone Tire and Rubber Company.





Scenes such as the one **above** are entirely too infrequent to satisfy Col. M. E. Barker, who explains that not enough sheep are available to furnish the wool of wartime demands.

Colonel Barker suggests that this problem deserves the attention of every southern chemist in an effort to convert cotton into a fiber having the desirable effects of wool.

The vast cotton fields of the south, such as the one shown **below**, would then, with the introduction of this wool substitute, be an even greater contributing factor to the success of the United Nations in the present conflict.

At the right is shown a textile chemist of the U. S. Department of Agriculture preparing a sample of material for subjection to the various tests necessary to show its strength, durability, and resistance to mildew attack.



Gas masks, new manufacturing methods, new guns, new tanks, new air-planes, and other needed military weapons and supplies are then designed and produced in limited quantities. Part of these are put into the hands of troops for field tests. Others are submitted to synthetic tropical conditions, cold tests, rough handling, infrared and ultraviolet exposure, and every form of mechanical and chemical torture that can be thought of as possibly affecting the functioning of the article. As a result of the information obtained from these field, laboratory, and engineering tests, improved models are produced until we get a process or model that performs satisfactorily and is suitable for quantity production. Both performance and procurability must be considered and achieved. This is a long, tedious, expensive process, but you dare not send untested equipment into battle. Of course we should have done all this during the years of peace, but money, men and driving incentive were not available. Today no effort or cost is being spared to develop these new weapons and items of supplies. But this sort of thing cannot be done in a day, or a week, or a month. We are driving ahead as fast as human nerves and sinews can hold together. Many of our men have put in sixty and seventy hours of intense labor every week for months. They will do their best without regard to damage to their health, or lack of safety, or earned vacations, or other personal sacrifice.

A SPECIFIC EXAMPLE

As a specific example of the research effort required to develop a new product and a new process, and to arrange for the production of a material in quantity, I would like to review with you, briefly, the history of activated charcoal, so useful in our gas mask canister for air purification.

At the beginning of the World War, a little bit was known about activating ordinary wood charcoal and using this material to expedite the aging of liquors. A need was envisioned for highly activated charcoal to use in producing vacuums; and Dewar had done a lot of work on means and methods of increasing the absorptive power of ordinary charcoal for use in making his vacuum containers. A few other workers had merely touched upon the problem. When the Germans decided to introduce chemical warfare, they they had some knowledge of the properties of activated charcoal and, of course, their chemists foresaw the need of a compact device of some kind to protect their own soldiers from the effects of poison gas. Their first activated charcoal was made by taking comparatively small blocks of ordinary wood and soaking these blocks in a solution of zinc chloride. They then carbonized this material in contact with a small amount of air and then heated the charcoal to a relatively high temperature out of contact with air in order to distill out the zinc chloride. They then washed the charcoal with dilute acids and hot water in order to remove the zinc chloride which was undesirable in the charcoal granules. Another process was developed by an Austrian and patent application was filed in England. This process involved the production of ordinary charcoal in granular form and then treating this charcoal with steam and air under conditions approximately the same as are used in the water-gas reaction. The residue was found to have a much greater absorptive power of gases than other types of charcoal. So, by the end of 1916, we found activated charcoal being produced by the Allies by two distinct methods; that is, by the zinc chloride

method and the partial oxidation. At the end of the World War, both of these methods were in use. In the United States, the steam and air activation process was used exclusively during the World War, and it was found that coconut shells, cohune nut shells, black walnut shells, peach pits, apricot seeds and some very high quality semianthracite coal could be used as a raw material for conversion into gas mask charcoal.

At the end of the World War, the product obtained by the zinc chloride and the partial activation was about on a par, and according to our standard methods of test, the material would have a heat of wetting of about six or seven calories per cc. and chlorpicrin tube test life of 20 to 25 minutes.

During the first few years after the World War, the process was studied sporadically and improvements were made in the technique of activating charcoal so that the chlorpicrin tube life was raised to about 35 minutes when coconut shells were used as a raw material. Gradually, due to the availability of and the difficulty of producing charcoal from other sources, coconut shells became the only raw material used in the United States, and, of course, almost all the shells had to be imported, most of them from the Philippine Islands and the Dutch East Indies.

INTENSIVE STUDY OF CHARCOAL PROBLEMS BEGUN

About 1928, the problem of producing charcoal from domestic raw material was undertaken in earnest in this country. A systematic study was made of materials and processes. During this study, activated charcoal, or activated carbon as it is sometimes called, was produced by one hundred and twenty-eight (128) different processes or combinations of processes and raw materials. As a result of this study, it was decided that three distinct methods of manufacture offered great possibilities. I shall now describe each of these processes very briefly, in order to give you an idea of the wide variety of ways in which a single problem can be solved. As a guiding principle, however, it was established that activated charcoal suitable for use in gas masks must be of such a quality as to absorb its own weight of gas from air containing a high concentration of the gas at ordinary room temperatures. Furthermore, in order to keep the size of the gas mask canister to a reasonable figure, it was decided that an apparent density of ordinary granules of at least four-tenths that of water, would have to be obtained. That is to say that a gallon of gas mask charcoal ought to weigh about 4-lbs. and that a satisfactory charcoal would have to be hard enough and tough enough to resist shattering under the severe conditions to which a gas mask canister is subject in the field.

The three methods by which this hard, dense, highly activated charcoal could be obtained were found to be about as follows:

BRIQUETTING. It was found that high quality coal could be reduced to a low temperature coke and could then be treated with air just below the ignition temperature, to give a partial activation. Ordinary hardwood charcoal and the low temperature oxidized coke were then ground to pass a 200-mesh screen, mixed with the required quantity of high melting pitch ground to pass a 200-mesh screen, heated up in the dry powder state and forced through extrusion dies by means of a suitable press. The extruded material, now in the form of spaghetti-like strings, could be passed through suitable low temperature carbonizing, high temperature carbonizing, air

activation and steam activation steps to produce an exceptionally fine grade of gas mask charcoal. While this process involved numerous steps, the raw materials were available in unlimited quantities at comparatively low prices in many places in the country.

CARBONIZING UNDER PRESSURE. In many parts of the country, especially the Pacific northwest and in the south, there are enormous quantities of sawdust which must be burned in order to prevent this material from becoming a nuisance at the mills. It costs money to dispose of this material. It was thought that here was a suitable raw material which the producer would pay to be rid of and that nothing cheaper than this could be obtained. It was found that sawdust and wood refuse could be run through a suitable hammer mill and then compressed into logs and that the logs so formed could be carbonized under pressure to produce a charcoal having the density of ordinary coal and having the ease of activation of wood charcoal. Once the logs were formed and converted to the dense type charcoal, the procedure for converting this charcoal into activated carbon was essentially the same as in activating the briquetted materials. Here then was another source of activated charcoal which might be produced in unlimited quantities. The problem, of course, was to convert the wood blocks into dense charcoal by a suitable process.

ZINC CHLORIDE METHOD. In view of the success of the Germans in making activated charcoal during the World War by the zinc chloride method, it was, of course, natural that we should take this process and develop it on a production basis to make a product equal in quality to that produced by the other two methods described above.

Up until a very few years ago coconut shells were regarded as one of the most important strategic materials which we would have to import from the East Indies in large quantities. Thanks to the developments described above we are now able to make charcoal of excellent quality at a reasonable price from a variety of domestic raw materials which are available in unlimited quantities. This is the type of work which, of course, requires coordinated effort, a lot of money and a considerable period of time. It is the type of work to which a great many people must contribute in order to bring the project to a successful conclusion. I cite this example of the development of activated charcoal from domestic raw materials not to boast of our accomplishments, but as an example to indicate what can be done when enough intelligent effort is applied to a problem.

CONCLUSION

We suggest that you college chemists of high and low degree, put your talents to work. Put one night each week and one hour every day on some problem that may advance our national welfare or defense ability. Bind yourselves together in groups. Learn to work as a scientific team just as you play as a ball team. Ten or twelve of you tackle a problem together and bring your every ability to bear on the subject. Who knows what great discovery or useful improvement you, in this school, might produce.

GET-A-WAY SCREEN FOR SCOUT CARS

***A Device Designed to Furnish Scout
Cars with a Ready Cloud of Smoke
for Escape from Surprise Attack***

by

***Maj. Harry W. Miller, Cav.,
Ft. Lewis, Wash.***



An analysis of the combat losses of armored reconnaissance vehicles of foreign warring armies would no doubt bring out the very pertinent fact that an overwhelmingly large percentage of these losses were due to action of hostile anti-tank weapons. As more and more emphasis is placed on anti-tank defense, and as improved anti-tank weapons are becoming available in larger quantities, we may expect as high, or an even higher percentage of losses in our own reconnaissance units. The fact exists, and should be of paramount importance, particularly to reconnaissance units, that these damages due to anti-tank weapons will become increasingly large unless preventive measures are taken.

One of the preventive measures that can be taken to minimize or reduce the loss of vehicles due to anti-tank gun fire, without the loss of tactical mobility, is the use of screening smoke.

Experience has positively proven that the use of smoke is of great importance in reducing the effectiveness of aimed fire. The degree, by which aimed fire is hindered by screening smoke, depends primarily upon the location of the smoke in relation to the firers, and to the target. When the firing personnel is actually enveloped in smoke, fire is least effective. Obviously, while in a smoke cloud, the individual or gun crew loses, to a great extent, the ability to maintain directions and elevation while firing. Difficulties of control are also experienced in this instance.

However, the only means in use at present, for a reconnaissance unit which is fired upon to place smoke upon the firers, is by the use of artillery fire or mortars, neither of which will be on hand.

The effectiveness of aimed fire is also hampered when the smoke is placed on the target. Exhaustive tests conducted from time to time by several branches of the service have decisively indicated that the percentage of hits obtained when the target is obscured in smoke is only about



In the top picture scout cars on a reconnaissance mission are shown approaching hidden machine guns which open fire when the cars come within close range. In the lower view is shown the scout car's reaction to the surprise attack. Its smoke device is put into operation at once and a cloud of FS begins to form as the vehicle withdraws.





The rapidly growing cloud of smoke furnishes cover under which the cars quickly make their getaway. Fire from the machine guns is only slightly as effective through the smoke screen as otherwise.



one-fourth of the hits realized when the target is not smoked. This very rapid diminution of hits is, from the reconnaissance units' view, well worth seeking.

The Chemical Warfare Service has developed F.S., a mixture of sulphur trioxide and chlorsulfonic acid, which when atomized or vaporized, produces minute droplets which reflect light rays and gives the appearance of a cloud of smoke, with the resultant screening properties. F.S. is a non-toxic chemical agent and is not harmful in the concentrations normally attained in the field.

F.S. DEVICE PROVES EFFICIENT

A device to immediately and completely cover the leading car of a reconnaissance element with a screen of smoke so that it and the following cars may withdraw in safety has been developed by the writer. Tests indicate that it will prove practical in the field. It consists essentially of the Chemical Portable Cylinder M1A1, about ten feet of three-quarter inch water pipe, uniforms, and a Nozzle M1.

The Portable Cylinder M1A1 and the Nozzle M1 are standard items procurable from the Post Chemical Officer. The water pipe and fittings are usually easily obtained from the Post Utilities. The installation can be made by unit mechanics in about two hours time.

The F.S. mixture is carried in the cylinder under one hundred and fifty pounds pressure per square inch. The approximate thirty pounds of liquid F.S. in the cylinder will make a sufficient quantity of smoke to produce smoke clouds for probably eight or ten enemy contacts.

The cylinder is mounted in a tin lined box in the foot well, immediately back of the driver's seat. A three-quarter inch water pipe comes up through the already existing hole in the floor plate, makes a "U" turn at the proper height, and is fastened to the cylinder outlet valve by means of a pipe union. This same pipe after protruding through the floor plate is carried forward by means of an elbow and projects just beyond the front axle, where it turns upward and runs into a "T" connection immediately in front of the radiator shields. This "T" in turn carries the pipe opposite both bumpers, where two Nozzles M1 are used to deflect the F.S. both forward and downward.

When the leading vehicle is fired upon, or when an anti-tank gun trap is suspected, any member of the car crew can quickly open and close the cylinder valve. This permits sufficient F.S. to be forced from the cylinder through the two nozzles to create a large cloud of smoke. Under cover of this smoke the vehicle is rapidly backed --- spreading the cloud as backing is continued. Then, under cover of the larger cloud, the vehicle is turned and seeks cover.

Considering the slight cost in time, effort, and money, and the benefits and protection to be derived, it would seem a worthwhile undertaking to equip our reconnaissance cars in such a manner.

The ideal officer should be afraid of nothing -- not even a new idea.

--- Dr. H. A. DeWeerd.

BOMB SHELTERS

Remarks on a recent General Electric Science Forum Broadcast over Station WGY, Schenectady, N. Y.

by

**Col. George J. B. Fisher,
Chief, Civil Defense Division,
Office of the Chief, Chemical Warfare Service**



Anyone who has heard the whine of an aerial bomb, falling at a speed that mounts to 600 miles per hour, has felt the urgent need of a bomb-proof shelter.

We learn, on excellent authority, that the music of falling bombs is now being heard with increasing frequency over Germany. And, as a result, the Nazis are at last beginning to take a very lively interest in air raid shelter - this despite the fact that the British on their part are becoming less enthusiastic about large-group type shelters. This may very possibly denote a trend.

It is easy to build a shelter that will protect against 50 or even 100 pound bombs. What the designer has to worry about is a structure that will withstand the terrific force generated by an exploding 2000 pound bomb - a type, incidentally, which the R.A.F. appears to regard with increasing favor.

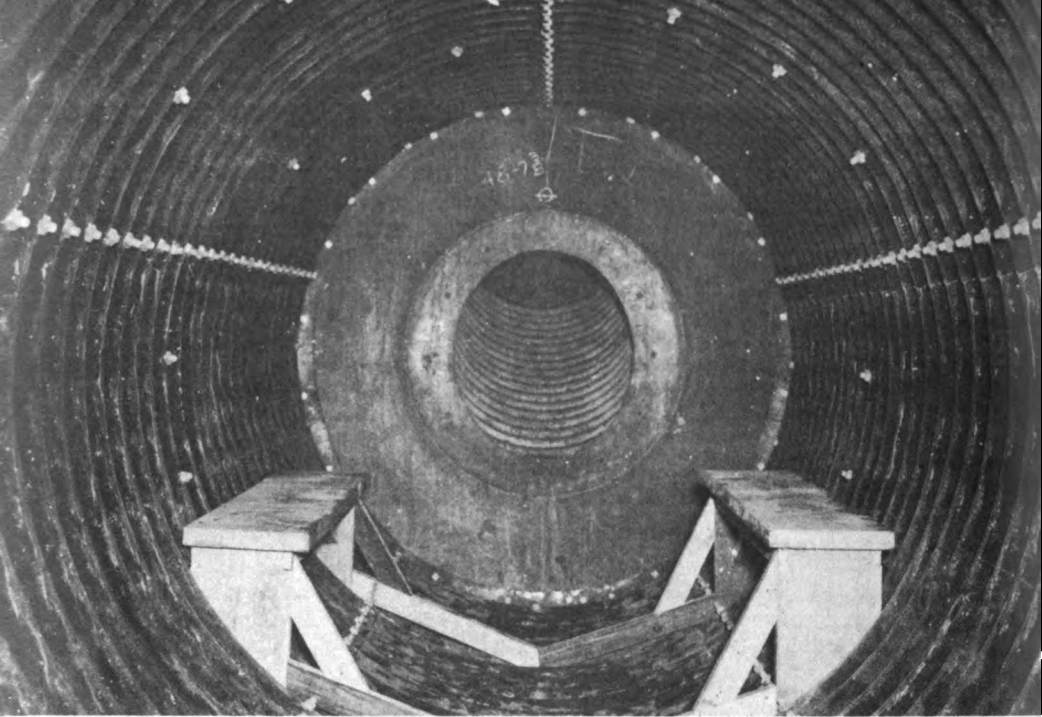
In 1939 and 1940, the typical high explosive bomb weighed 100 pounds. Occasionally, 500 pound bombs were used, but these were rare in the early stages of the war.

Today, however, 2000 pound bombs are not uncommon; and sizes up to three and even four thousand pounds are being dropped. As better bombers are developed, the proportion of larger bombs definitely increases.

THREE OPTIMUM EFFECTS PRODUCED BY BOMBS

We can best appreciate the structural strains imposed by these huge demolition bombs by considering the optimum effects they produce. These are three in number - all coming in split-second succession, yet each having its own direct influence on the design of protective shelters.

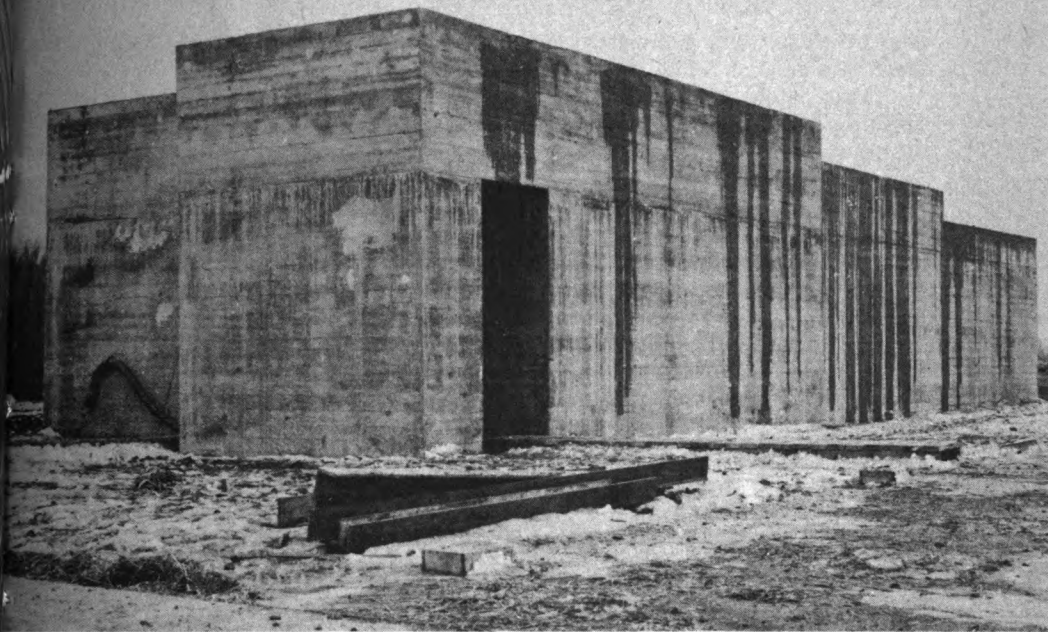
The first is impact - the shock imposed when a mass of a ton or more, moving at a speed of a thousand feet per second, meets a stationary body.



The **above** photograph shows an interior view of one end of a 50-person shelter. This cylindrical shelter, which was used in bomb tests conducted on the Edgewood Arsenal Military Reservation, was only slightly disfigured after the extensive tests. Heavy bombs produced a slight elliptical shape in the shelter.

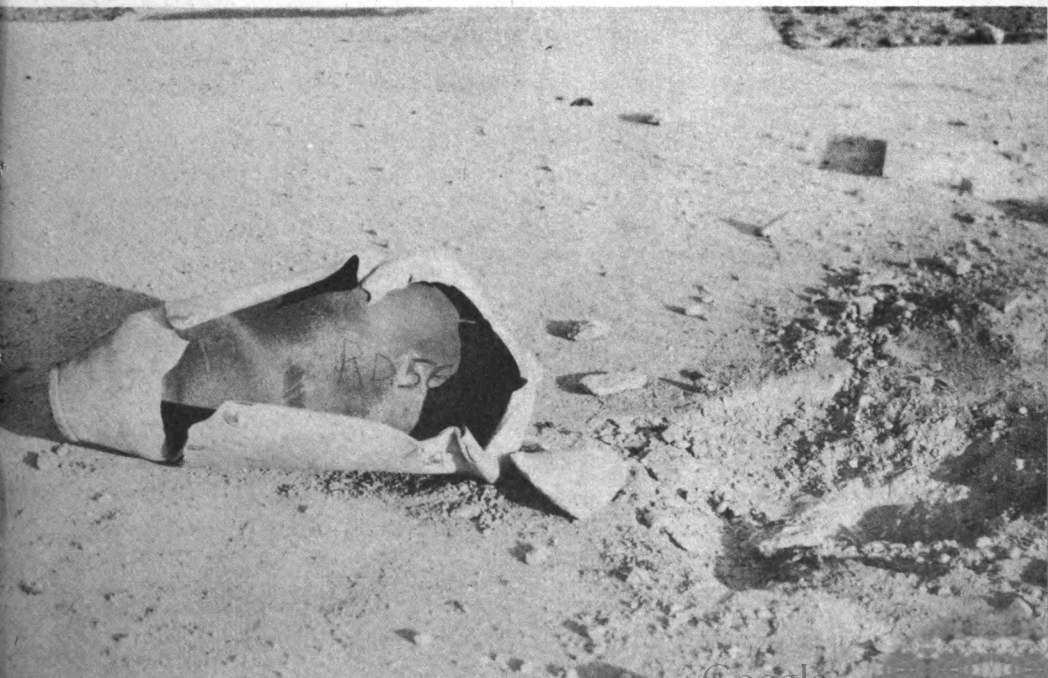
Below is shown the effect of a 600 lb. demolition bomb on the entrance of a 6-person sandbag shelter during the tests.





A three-quarter left front view of a bombproof shelter appears in the picture **above**, before bombing. **Below** is shown the effect of a 300 lb. demolition bomb, sand filled, dropped from 8,000 feet. Only a small crater was produced at the point of impact.

On page 93 are shown the results of a 600 lb. demolition bomb hit on Section C of the above shelter. This section was completely demolished by the hit.



The tensions thus generated have no more than started when, within a tenth of a second ordinarily the detonation occurs.

This detonation is, technically, the reaction occurring when a suitable stimulus is applied to a relatively large quantity of trinitrotoluene, amatol, or other high explosive. The entire mass is converted, almost instantaneously, into other more stable substances, principally gases. The volume thus liberated by one cubic feet of explosive may equal one thousand cubic feet of gas.

The explosive reaction exposes the bomb case to heat as high as 20,000 degrees centigrade; it distends the case to one and a half times its normal size; and when the limit of expansion is reached, splits the case into a shower of sharp-edged splinters or fragments which may run, on the average, to about the size of a man's thumb.

Thus, we have the second effect - fragmentation; and the third effect - blast.

The flying white-hot fragments are propelled initially at speeds as high as 5000 feet per second - twice the velocity of most military projectiles. But this velocity diminishes rapidly, as air-resistance breaks the irregularly-shaped fragments. Shelters fulfill their most useful purpose by absorbing the impact of these hot, sharp bomb splinters, which are hurled distances of say 1200 feet.

Blast effect, too, is readily protected against by a well-designed shelter. Yet as much as 55 percent of the kinetic energy developed by the exploding bomb goes into a blast - or the ultrarapid displacement of air to accommodate the transformation of high explosive into gas.

So powerful is blast effect against weakly designed structures that a special bomb - the aerial or land mine - has now been developed to apply an even larger proportion of force to this effect alone. The downward flight of the aerial mine is retarded by a parachute, so that its impact effect is negligible. The case is extremely thin, so that fragments are smaller; its powerful punch goes principally into a shattering air blast which demolishes all nearby structures that are not sturdily built.

PROTECTION AGAINST IMPACT TOO EXPENSIVE

We may say, then that a good bomb-proof shelter is one that protects against impact, against fragments, against blast. As a practical proposition, protection against the impact of very large bombs in community shelters was too high per capita costs. Protection against fragments, falling debris, and blast effects, on the other hand is entirely feasible and need not be unduly expensive.

An impressive volume of scientific data had been developed, prior to this war, as to resisting media for protecting against bomb attacks. Some of this data was empirical. Some was compiled with a great deal of interpolation. Actually, there had been little in the way of critical evaluation of war experience. On the whole, however, scientific theory under which early air raid shelters were built, has stood up remarkably well.

Yet most of the data in the field had been compiled abroad. Our War Department was not satisfied to accept it as entirely applicable to American conditions. So back in 1938, seven months before Hitler attacked Poland, the Chief of Engineers of the Army commenced an exhaustive scientific

study of structural protection against aerial bombs with particular relation to architectural and engineering practice in the United States.

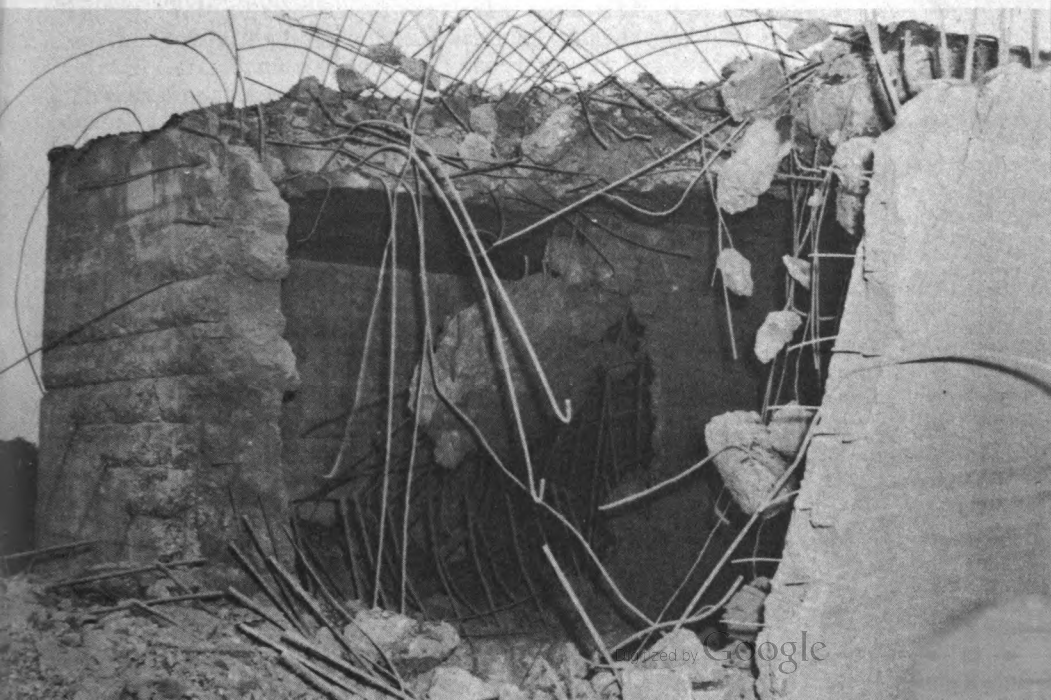
By the fall of 1940, this project was far enough advanced to warrant the erection of type structures which in due time were subjected to actual bombing from service altitudes. These tests, conducted on the Edgewood Arsenal Military Reservation in Maryland, were substantially completed early last year - and the area (the only intensely bombed area of this sort in the United States) is now regularly visited for instructional purposes by students attending Civilian Defense Courses at the Chemical Warfare School.

Results of the Edgewood tests have now been published in a brochure issued just this month by the United States Office of Civilian Defense under the title, "Report of Bomb Tests on Materials and Structures." Study of bomb-proof shelters is, of course, continuing and will continue as long as necessary. In this work the War Department is being materially assisted by the "Committee on Passive Protection Against Bombing" of the National Academy of Sciences.

This committee - the chairman of which is Dr. R. C. Tolman - has conducted numerous experiments of its own to develop resistance data and to establish general laws governing the penetration phenomenon. This scientific work is in all cases checked with Army and Navy experience and with data now continuously available from our allies.

We, in the Army, are sometimes accused of "passing the buck." That's exactly what I intend to do now. Instead of trying to explain, myself, how to make a good bomb shelter, let me advise everyone who is interested in this important subject to obtain and study the excellent publications of the Office of Civilian Defense - the agency through which the scientific data on protective shelters that has been developed by our Government is made available to the American public.

Effect of a 600-lb. demolition bomb on Section "C" of the concrete shelter shown on page 91.

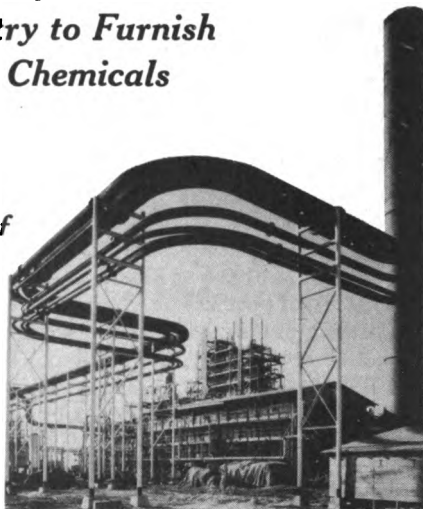


WAR PRODUCTS FROM PETROLEUM

A Discussion of the Rapid Rise of Our Petroleum Industry to Furnish Much Needed Chemicals

by

*Lt. Col. Martin B. Chittick,
Technical Service, Office of the Chief*



A modern cracking unit.

The present world conflict has placed a tremendous load on industry - a load that has been complicated by the disruption in normal world commerce and by a corresponding short-

age in many raw materials and intermediate products. The actual entrance of the United States into these hostilities has further complicated the problem. Foreign sources for many critical and strategic materials, that were available to U. S. industry previously, have now been closed, or at least seriously reduced. The expansion of our own armed forces has increased the demand for supplies of war, thereby increasing the load on industry.

This situation is rapidly being corrected by the chemist through the development of new engineering materials and substitute materials, as well as the development of new sources of critical raw materials. In this connection a distinction is made between substitute materials and "ersatz."

CHEMISTRY CANNOT REACH A STATIC POSITION

In many instances the development of a new material introduces new problems in the way of raw materials so that chemistry can not reach a static position or a point of equilibrium. Perforce, it is a dynamic science.

These basic materials, in the final analysis, have become in recent years the objectives of war. The publicized objective of contemporary war lords that they make war to raise a backward people to a higher plane of civilization and development, or to relieve a persecuted minority, is a pure smoke screen for the gullible. Certainly, raining death and destruction on women and children and undefended civilians is a peculiar method to attain such an idealistic objective. A casual survey of the basic raw materials and industrial converters of these raw materials, in territories conquered during the past ten years belie any such fantastic claims. Therefore, if raw materials and industry are the objectives of war one can logically conclude that by the same token they become the instruments of war.

This is an industrial war and ultimate victory will come to that nation, or group of nations, with the greatest industrial resources. Victory? - The chemical profession of America knows the answer today. The chemist has put his shoulder to the wheel and will produce from the American mines, fields, forests, the seas and the air, the necessary raw materials and finished products to insure this victory.

There exist many problems of supply as yet unsolved, or at least solved only in part. From the military standpoint, as well as the industrial standpoint, it is desirable to look for these supplies in a source of raw material that exists in large quantities and with low cost. Such a field is found in petroleum.

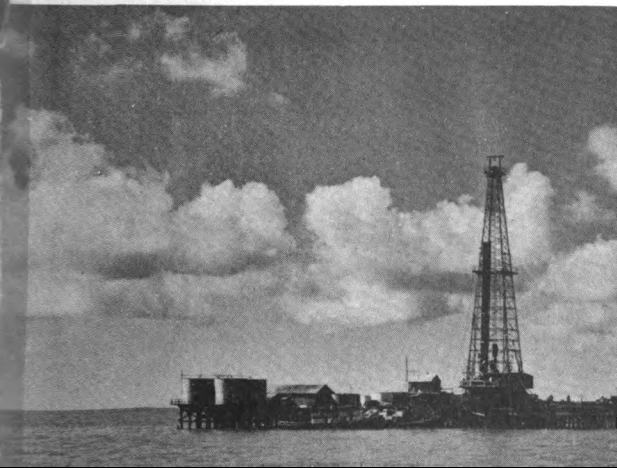
U. S. HAS LARGEST PETROLEUM SUPPLY

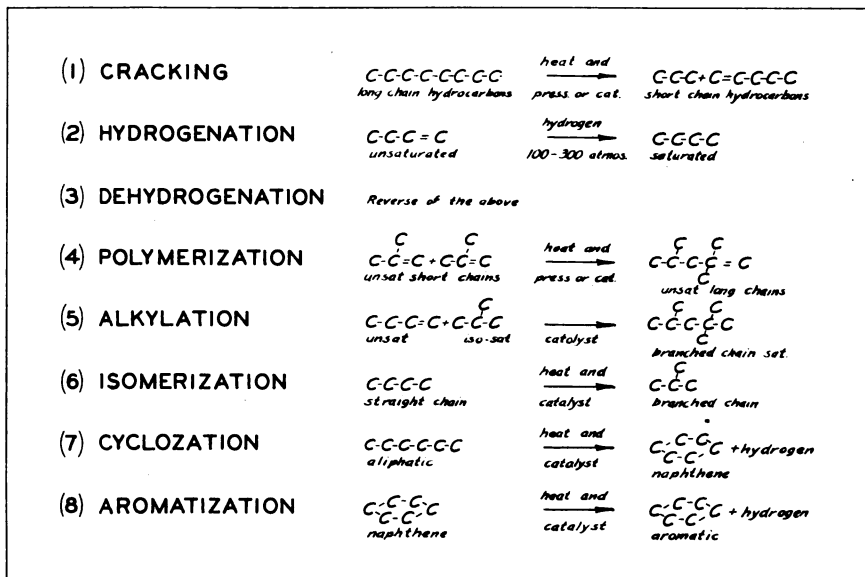
Let us briefly examine this source from a statistical viewpoint. The total crude oil production of the world is somewhat over two billion barrels per year, of which North and South America produce 75 percent. In the United States, we produce one billion four hundred million barrels a year. Germany produces seventy-five million barrels per year, of which fifty million barrels is natural crude and twenty-five million barrels is synthetic. To Germany's supply, we may now add the production of the Balkan Countries, and other subjugated countries. Therefore, we find ourselves in an advantageous position as regards availability of supply. The requirement of low cost is self-evident.

It has been aptly stated that this war is For and With petroleum. Certainly, this premise is supported by the above indicated distribution.

The petroleum industry has passed through two distinct phases and has now entered the third. The infancy of the industry may be termed the burning oil phase. This phase covered that period when kerosene and other burning oils were the principle commodities, while gasoline and the heavier cuts were drugs on the market. Ghosts of this period whisper of valves opened at midnight to discharge gasoline and naphthas from overflowing tanks into mountain streams.

Typical of America's extensive oil resources is this Creole well just off the coast. At the right are shown supervisors of a new Petroleum Research Laboratory studying a model of the long heptane molecule which has been transformed into a ring form to make toluene.





The above Reaction Chart indicates the possibilities for the synthesis of organic chemicals from petroleum.

With the development of the automobile the picture changed with gasoline and lubricants becoming the volume commodities and the industry entered the gasoline phase.

In the meantime the chemist, realizing the potentialities in these hydrocarbons, had been quietly applying himself in the laboratory to this fertile field. His results have carried the industry out of the gasoline phase into the third and final phase to a degree that has established the petroleum industry today as a major chemical industry.

The scope of this presentation will not permit a comprehensive review of the entire subject of the chemical phase of petroleum and, therefore, we will be limited to those products of pressing importance.

The possibilities for the synthesis of organic chemicals from petroleum are indicated, in part, by the accompanying Reaction Chart.

HIGH OCTANE MOTOR FUEL PRESENTS PROBLEM

Possibly the foremost problem is that of high octane motor fuel, not alone for aircraft, but for our highly mechanized land forces. The latest available information on aviation fuel employed by the Axis powers, indicates an 87 octane average and containing about 40 percent aromatics. Some lead has also been used.

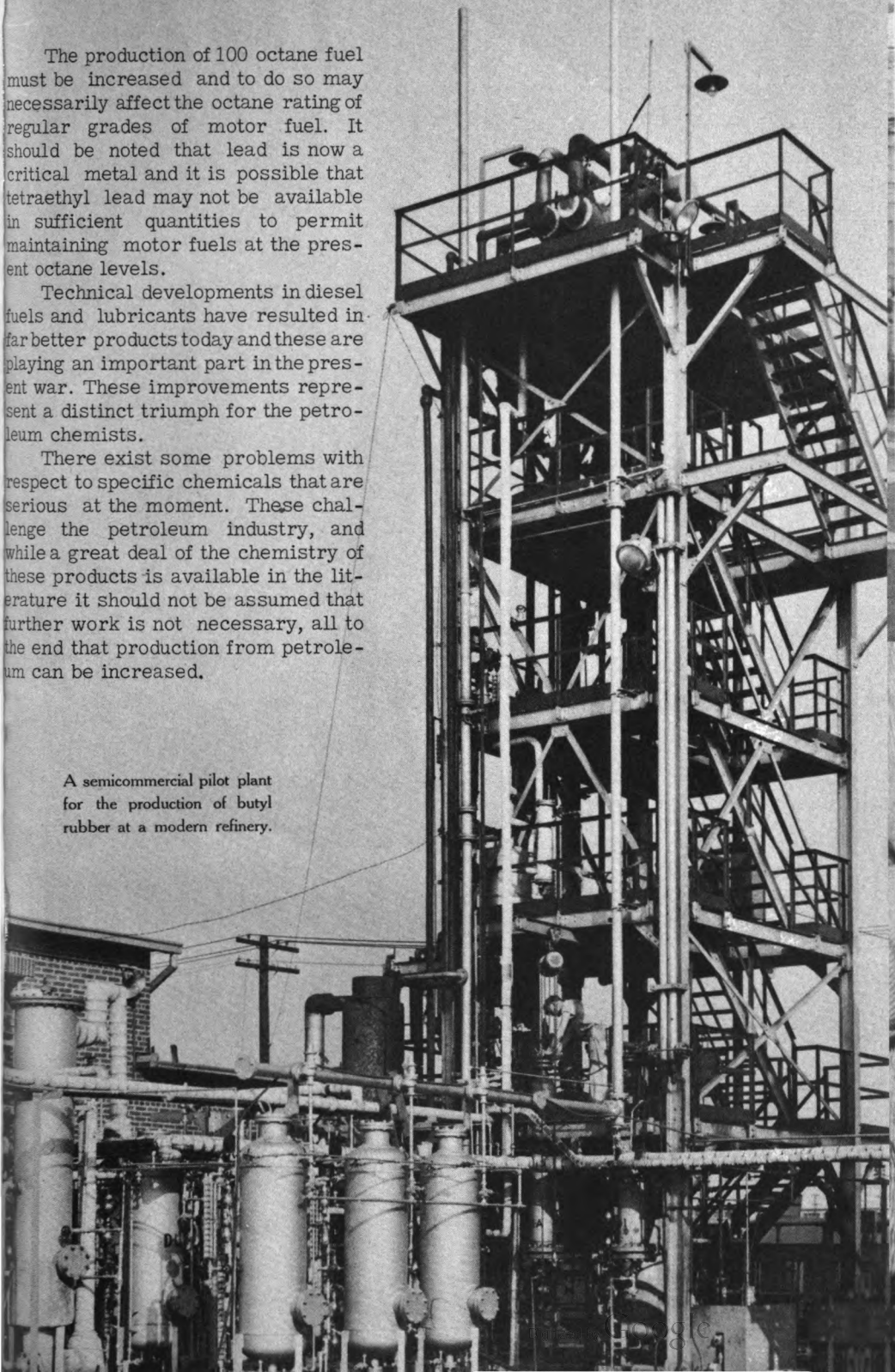
The 100 octane fuel being produced domestically is superior not only in anti-knock properties but has a better boiling range, is more stable and at the present is giving a superior account of itself. In this connection some types of tanks are powered with aircraft engines.

The production of 100 octane fuel must be increased and to do so may necessarily affect the octane rating of regular grades of motor fuel. It should be noted that lead is now a critical metal and it is possible that tetraethyl lead may not be available in sufficient quantities to permit maintaining motor fuels at the present octane levels.

Technical developments in diesel fuels and lubricants have resulted in far better products today and these are playing an important part in the present war. These improvements represent a distinct triumph for the petroleum chemists.

There exist some problems with respect to specific chemicals that are serious at the moment. These challenge the petroleum industry, and while a great deal of the chemistry of these products is available in the literature it should not be assumed that further work is not necessary, all to the end that production from petroleum can be increased.

A semicommercial pilot plant for the production of butyl rubber at a modern refinery.

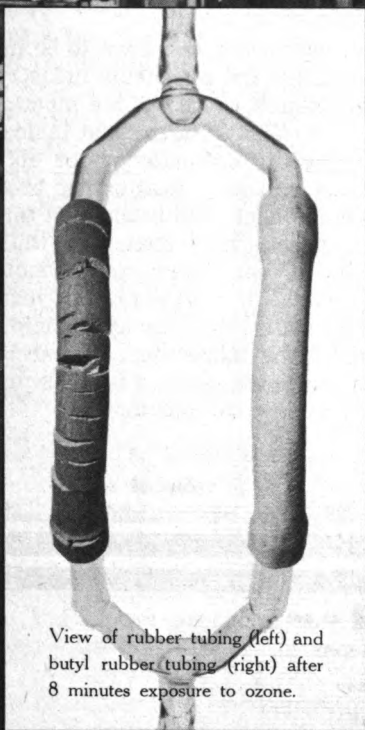
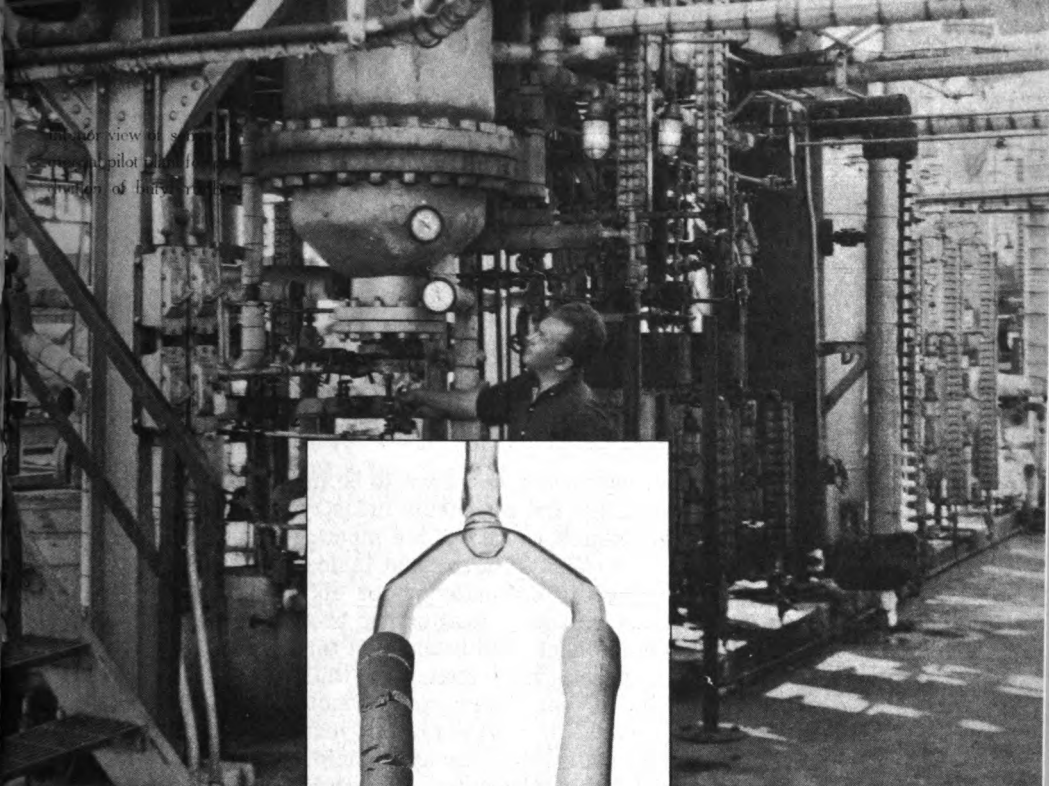


Illustrations on these pages are indicative of the prominent place Petroleum will play in the future synthetic rubber program.

Crude Butyl Rubber

Butyl rubber has plenty of stretch and strength

Polybutene undergoes extrusion screening



View of rubber tubing (left) and butyl rubber tubing (right) after 8 minutes exposure to ozone.



Making butyl rubber tubing

The reports of the Office of Production Management indicate a serious shortage in acetic acid. Consequently, procurement of the esters and salts of acetic acid is difficult. This applies particularly to ethyl acetate.

There is a shortage of formaldehyde and this has been reflected in the plastic field. With the strategic and critical situation in so many metals, particularly magnesium, aluminum, tin, and copper, it has been necessary to look to the plastic field for material to make many of the component parts of our military items.

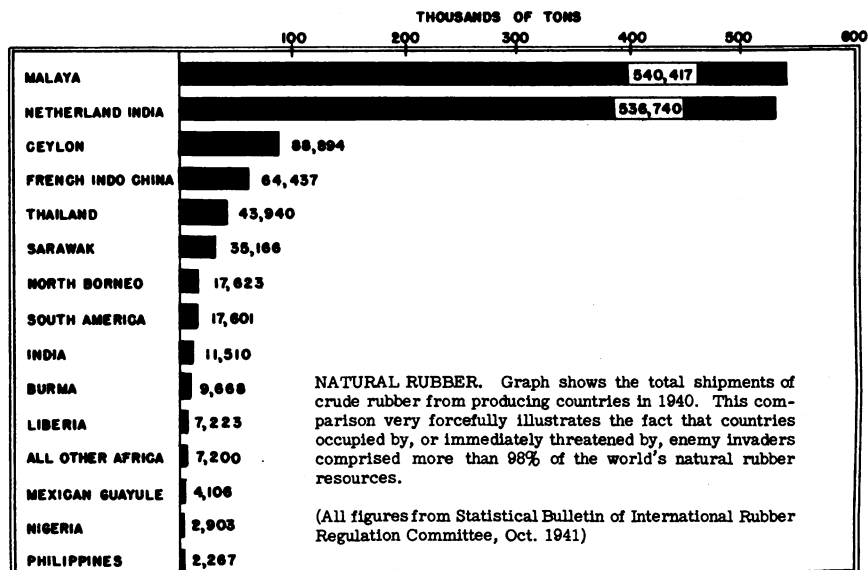
Phenol can be considered at this time in connection with plastics and we should not hesitate in putting phenol on the MUST list for increased production.

The cresols, which have such a wide use, are far short of our requirements. A sufficient quantity can be secured if the petroleum industry will extract them.

Methanol and ethanol production will have to be increased and the economics of the problem indicate the petroleum industry as the source.

The shortage of aromatics is one of the most serious current problems especially as regards toluol. The present indicated requirements for toluol for military purposes is estimated to be 150,000,000 gallons per year. The rapidly changing military situation has brought a substantial increase in the toluol requirements within the past three months. There is a shortage of benzol, xylol, and naphthalene, and while not as important in the general picture as toluol, their increased production is necessary.

Those of you who have attempted to protect your automobiles against freezing temperatures recently will fully appreciate the shortage that exists with ethylene glycol. The increasingly greater use of liquid cooled aircraft engines will increase the demand for this product and here again, the logical source appears to be petroleum.



The production of glycerine from petroleum has been definitely established and it is not impossible that we shall see a substantial increase in production from this source in the near future.

Drying oil substitutes made from petroleum are relieving the situation resulting from the shortage of imported oils such as chinawood oil.

Now - what is the situation as regards rubber? This problem is one of the most important projects facing us today. In the event that supplies of natural rubber were cut off, we would run short of this item in less than a year, and, under certain conceivable conditions, in a very few months. We are dependent on the Middle East for our supplies of natural rubber at the present time and to maintain that supply, shipping facilities must be adequate and available. This situation can well explain, in part, recent diplomatic developments.

It has been estimated that there will be approximately 600,000 tons of rubber in stock in the United States at the end of this year, and that over 40,000 tons will have been used during the year. It must be recognized, therefore, that the potential and continued supply of rubber is a matter of serious concern. This situation emphasizes the immediate increased capacity for the synthetic rubbers.

Synthetic rubber plants under construction are expected to produce by the end of 1942, approximately 7,000 long tons per month, totaling 78,000 long tons annually, less than 10 percent of the total annual consumption under emergency conditions. Including related synthetics, which could be substituted for special purposes, the amount of 1,500 long tons per month may be added to the 7,000 long tons mentioned above. *

PETROLEUM'S PLACE IN THE RUBBER SITUATION

Now where does the petroleum industry fit into this picture? Some of the types of synthetic rubbers which can be made wholly or in part from petroleum raw materials are: Neoprene, Butyl rubber, Buna rubber and similar polymers from butadiene, the latter coming from either butylene or acetylene.

Thiokol is produced from sodium polysulfide and ethylene dichloride. Koroseal, Vinylite, and Vinyon are produced from ethylene chloride from chlorination of ethylene. These examples by no means complete the possibilities.

Synthetic rubbers are high priced in comparison with natural rubber. This unfavorable economic condition can, in part at least, result in reduction of costs by more extensive use of petroleum as a source of raw material and by reduction in costs of these raw materials through increased production. It is not impossible that we may see the petroleum industry entering into the manufacture of synthetic rubber itself.

The present conflict has brought forth a real challenge to the American Chemist - a challenge that will be met and with no handicaps demanded.

* Since the above article was written the War Production Board has released estimates in excess of those indicated here. The Board's synthetic rubber estimate predicts that an annual production rate of 200,000 tons will be attained by the end of 1942, and that an annual rate of 400,000 tons will be attained by the end of 1943.

GAS MASK CARBON

*Past and Present Problems in Connection with the Procurement of Activated Charcoal are Explained **

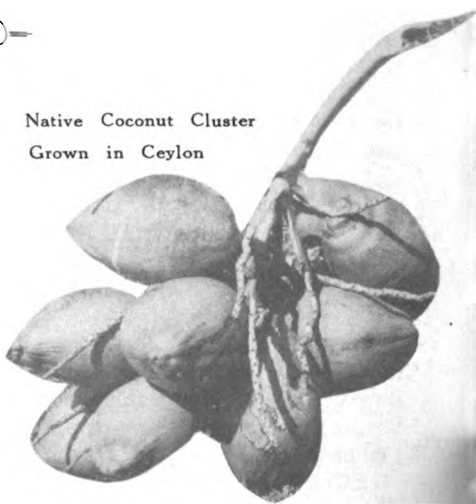
by

**Maj. H. N. Calderwood,
Industrial Service, Office of the Chief**



Activated charcoal, the chief component of chemicals within the gas mask canister, has long been used by chemists as an adsorptive agent for gases - and it is this property upon which may depend the lives of many American soldiers. Research and development in this important field was necessarily carried out on a very modest scale until July 1, 1940, due to small appropriations allotted for the purpose. However, since 1918, the Chemical Warfare Service has made great improvement in the design of protective equipment against gas and has been successful in manufacturing

Native Coconut Cluster
Grown in Ceylon



sufficient quantities to supply Army personnel at all times. Even during the current expansion several million gas masks, including extra canisters, have been manufactured, and a combat mask is at present available for every member of the armed forces, sufficient funds having been provided. In such a production program the procurement of activated charcoal is of course an important problem for the Chemical Warfare Service.

COCONUT SHELL IS MOST DESIRABLE CHARCOAL SOURCE

Intensive and extensive research of 1917 and 1918, substantiated by later work, has shown the coconut shell to be more suitable for producing

* In connection with this subject the reader may wish to consult the latter portion of the article, CHEMISTRY IN WARFARE, by Col. M. E. Barker, on page 74, in which are considered the more technical phases of producing activated charcoal.

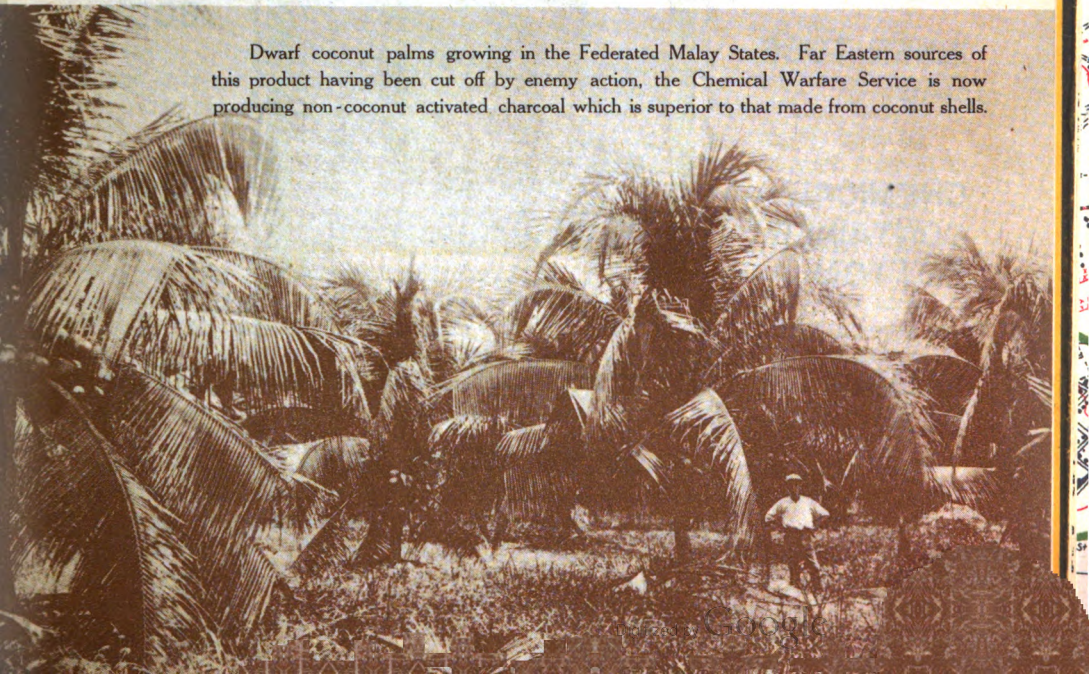
activated charcoal of the density used in gas masks than is any other raw product. A large amount of processing is necessary to produce dense enough activated charcoal from non-coconut materials, though such a synthetic process often results in a product of even higher quality.

Activated charcoal, or better, activated carbon, can be divided into three classes: (a) de-colorizing or color adsorbents, (b) water purification or taste and odor adsorbents, and (c) gas or vapor adsorbents. The first and second classes differ only in degree, and with the exception of bone-black, which is now relatively little used, are usually marketed in the form of fine powders that may be made from many varieties of carbonaceous material. The third class, however, is used in the granular form and requires for its production a raw material with special characteristics. This form of activated carbon, being the one used in gas masks, must be dense, resistant to abrasion, and at the same time highly selective in its adsorptive power. Besides its use in gas masks this third class is used widely by a large variety of industries for both solvent and vapor recovery. The latter use is chiefly responsible for the availability in industry of facilities for the manufacture of gas mask carbon.

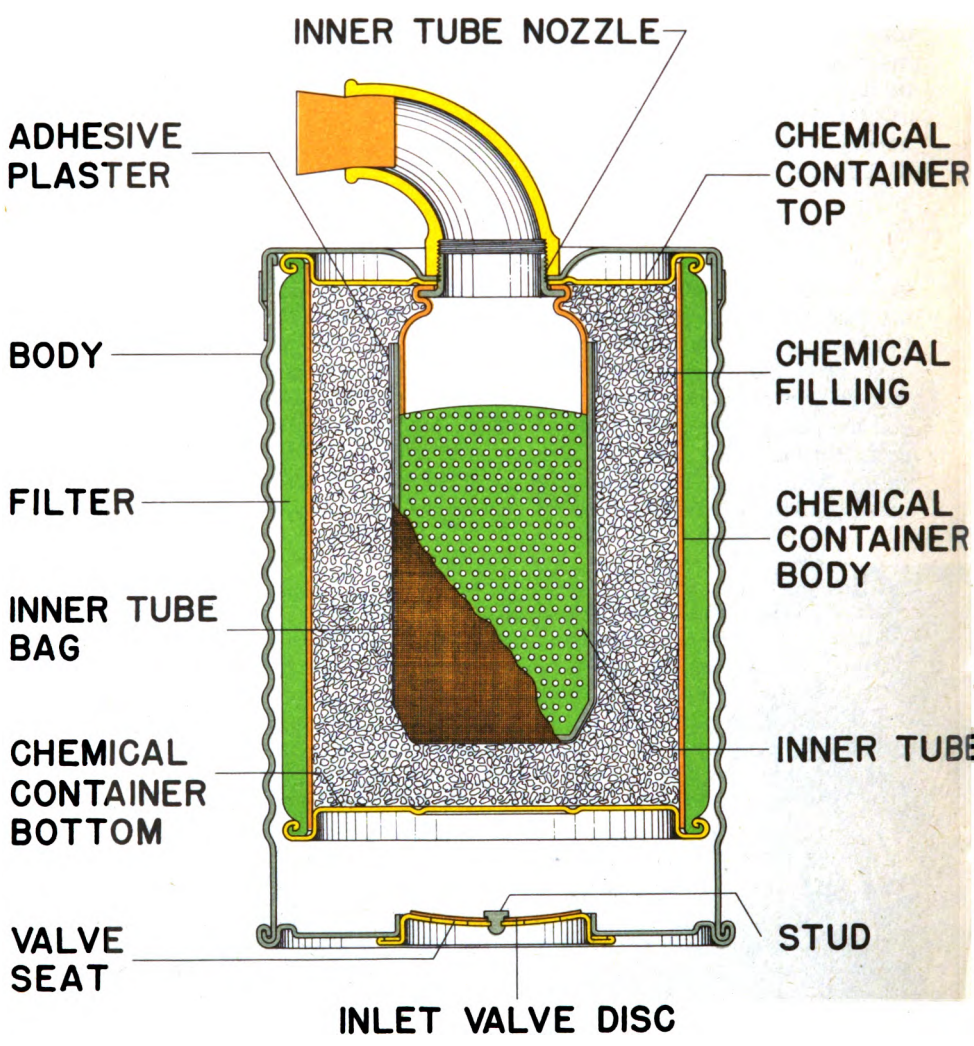
GROWTH OF COCONUT PUZZLES CHEMISTS

As the reasons for using a dense and abrasion resistant carbon for both gas masks and solvent recovery plants have been published, there will be discussed here only the preference for coconut shell as the raw material. In order to obtain a dense activated carbon, the raw material for activation must be dense. One of the many riddles still unsolved by the plant chemist is, how a single ovule (as in the case of the coconut palm, the black walnut, and the peach tree), will produce from the same source of nourishment a soft, fibrous outer layer - a dense, hard, flint-like middle layer of shell - and a firm oleaginous inner meat or kernel. A valuable characteristic of these middle layers is their ability to maintain the dense hard structure

Dwarf coconut palms growing in the Federated Malay States. Far Eastern sources of this product having been cut off by enemy action, the Chemical Warfare Service is now producing non-coconut activated charcoal which is superior to that made from coconut shells.



Gas Mask Canister, sectionalized view. The chemical filling shown consists largely of activated charcoal, the density and adsorptive properties of which must meet specific Army requirements.



after pyrolysis or carbonization, thereby yielding the dense basic material to be activated for use in gas and vapor adsorbent apparatus.

The coconut palm being indigenous to the coastal regions of both the tropical and sub-tropical zones through the world bears fruit the year round, in marked contrast to the walnut and peach tree which bear only once per year, with growth limited to certain portions of the temperate zone. The use of coconut shell charcoal has the added advantage of being the utilization of a secondary product from a permanent industry which exploits the coconut for its other two parts, the outer husk and the meat. From the outer husk comes coir with a variety of uses such as cordage, brushes, door mats, and press mats for the oil industry. The meat is converted into desiccated coconut for culinary purposes or copra, which after pressing to get the coconut oil of commerce, is disposed of chiefly as a fertilizer. Conversion of the residual coconut shells, the supply of which far exceeds the demand for them as fuel, into charcoal is really the disposal of a nuisance, being done at very little cost in primitive sod kilns by low priced native labor. During peace, crude coconut charcoal can be delivered, f.a.s. New York for \$38.00 per long ton. The seeds of a small number of other nut palms have been used to some extent in making gas adsorbing activated carbons but the output is not great.

COCONUT INDUSTRY LOCATED ALMOST ENTIRELY IN FAR EAST

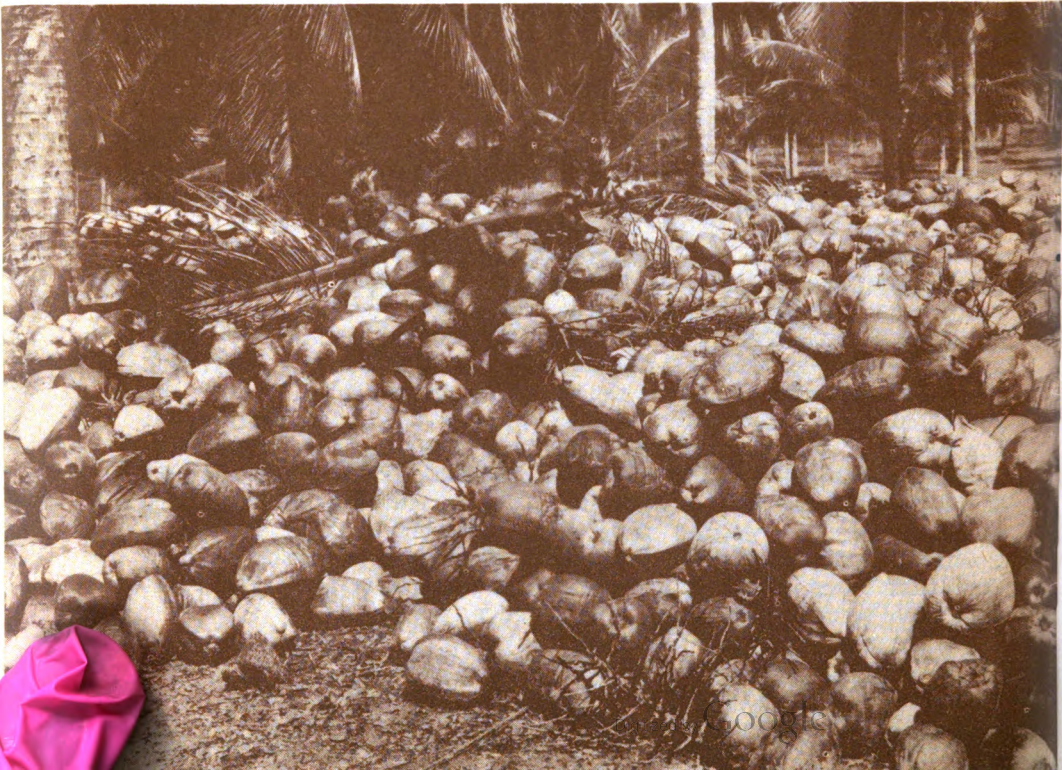
It might well be asked in view of the extensiveness of the large coconut industry, why coconut charcoal is a strategic item. The answer is found in the geographic location of the coconut industry, situated as it is almost exclusively in the Far East, where the extensive coastline of the tropical regions and the teeming population of the orient make the exploitation of the coconut cheaper than elsewhere. It is thus separated from the U. S., regardless of the direction traveled, by an ocean of water, the trade routes of which we must control in time of war. To this must be added the disadvantage of coconut shell being a secondary product not produced when markets for the chief products are inactive. Such a condition exists today, not because coir and copra cannot be sold, but because the steamships will not pick up this bulky cargo when they are getting more business than they can handle in the form of compact cargo such as crude rubber and the ores of tin, tungsten, and manganese. Although the quantities of coconut shell charcoal required do not begin to equal in magnitude the requirements for crude rubber, manganese or tin, yet it requires a lot of coconuts to supply the activated carbon needed to equip the present-day Army. As one example, a ship recently discharged at a United States port a cargo of coconut shell charcoal which required for its production the use of 45,000,000 coconuts, yet when this charcoal had been finally processed to the material used in gas masks, it sufficed to fill only 100,000 service canisters. It is a combination of the above mentioned facts which causes coconut shell charcoal to be classed today as a strategic item. The seriousness of the foregoing situation has been realized since 1918, but prior to the enactment by Congress of the Educational Order Law, there were no means whereby the results of the laboratory and pilot plants research on non-coconut carbons could be converted to industrial practice.

However, as soon as the Educational Order Law became effective, the Chemical Warfare Service began contract negotiations for the construction of non-coconut activated carbon plants. These negotiations have resulted in there now being completed enough non-coconut activated carbon plants to meet all contemplated military requirements of the United States. Methods used in these plants are those which were investigated in 1917 and 1918, and which in most cases have been under laboratory and pilot plant investigation ever since. The synthetic material now produced is considered definitely superior in quality to that obtained from the coconut shell, but the cost of production is considerably greater. This higher cost is brought about by the fact that in the synthetic plants, machinery requiring heat and pressure are used to accomplish the same thing which the tropical sun, soil, and atmosphere accomplish in the growing coconut palm. For this reason, private industry has, wherever possible, continued to use the coconut shell as a raw product.

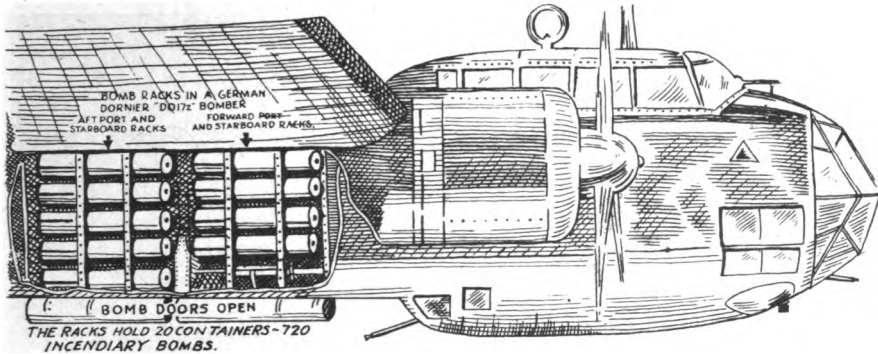
References:

- (1) Barker, *Industrial and Engineering Chemistry*, 22, 926 (1930).
- (2) a. Morrell, U. S. Patents 2,008,144; 2,008,145; 2,008,146.
b. Barker & Brown, U. S. Patent 2,163,366.
- (3) Chaney, Ray and St. John, *Trans. Am. Inst. Chem. Eng.*, 15,309 (1923).
- (4) Burrell, *J. Ind. and Eng. Chem.*, II, 93 (1919).

One part of a large pile of coconuts grown on a 2000-acre coconut plantation, Colombo, Ceylon. The hard middle layer of these nuts are ideal for the manufacture of activated charcoal for gas masks. Because of the low cost of processing into a dense product, this raw material is used as much as the strategic location of its source will permit, even though other materials have often produced a superior charcoal.



German Incendiary Bombs



Clockwork and Electrical Types

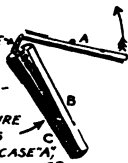
1

**CLOCKWORK TYPE
INCENDIARY BOMB
CONTAINER JUST
AFTER LEAVING THE AIRCRAFT**



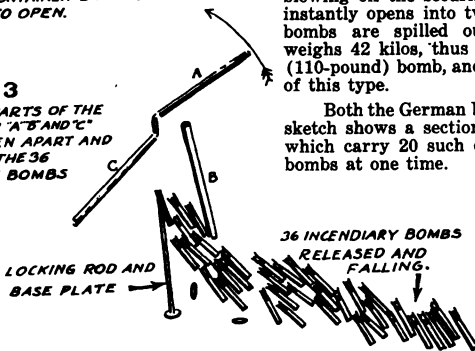
2
LOCKING PLATE

THE DELAY ACTION MECHANISM HAS OPERATED THE RELEASE PIN AND PRESSURE CAUSED BY THE FALL HAS SWUNG OPEN THE OUTER CASE 'A', THE LOCKING PLATE IS THUS OPERATED, RELEASING THE LOCKING ROD AND THE SIDES OF THE CONTAINER 'B' AND 'C' COMMENCE TO OPEN.



3

THE THREE PARTS OF THE CONTAINER 'A' 'B' AND 'C' HAVE FALLEN APART AND RELEASED THE 36 INCENDIARY BOMBS



The German 1-kilo type (2,205 pound) of incendiary bomb is stowed in an aluminum container, about 39 inches long, holding 36 incendiaries. The one shown here operates by clockwork. The clock-container has a device which begins to tick as it is released from the bomb rack and, at a predetermined moment, the clockwork rotates a cam holding a key in position, which, in turn, closes the third, or outer side, of the container. The moment this is released, it flies upward and in its turn withdraws a fork which holds the locking rod, and which on its release opens the other sides of the case, with the result that 36 bombs are ejected.

The electrically operated container (not shown here) has only two sides and is hinged at the bottom. When this container is released from the rack, a fuse operates an electric current, which runs up a wire, thereby releasing a small explosive charge, thus blowing off the securing head of the container. It instantly opens into two halves and the incendiary bombs are spilled out. This container, loaded, weighs 42 kilos, thus approximating to the 50-kilo (110-pound) bomb, and can be carried in bomb racks of this type.

Both the German Dornier "Do17z," of which our sketch shows a section, and the "Ju88" have racks which carry 20 such containers, or 720 incendiary bombs at one time.

Article and sketch from *The Illustrated London News*, 1 March, 1941.

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