Progress Underseas

Did the World War destroy all faith in the submarine? In the popular mind, perhaps, yes; but with the naval technicians it would appear otherwise. The submarine forges ahead, greatly improved, to hold a unique place in naval-building programs today.

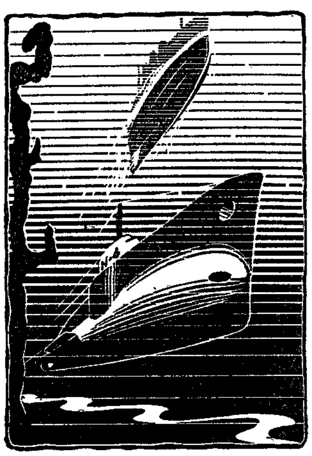
by George H. Engeman

WHATEVER else he may have doubted when the World War ended, there was one thing about which the average American felt at least tolerably certain. It was that the submarine had met its masters on the sea. Depth bomb and convoy, it was asserted, had turned the tables on Germany's underwater raiders.

Such talk was to be expected, for it was war time, but with the coming of peace the Allies' deep-seated respect for this formidable weapon was soon revealed. By the Versailles Treaty Germany was forbidden to keep her submarines, or to build more. But France, Italy, Great Britain, Japan and the United States did not stop building them. And now, sixteen years after the war, the former allies are busy laying down modern developments of John Holland's submerging warships in ever greater and greater numbers.

Japan, which with the United States and Great Britain was limited in submarine strength by the London Naval Treaty, has built right up to the prescribed figure while the American and British fleets are embarked on programs which will not leave them wanting in underwater strength. France and Italy, which place even greater emphasis on this weapon, have built submarines as they have pleased; the French, in the *Surcouf,* holding the record for the largest submarine ever built.

It is for these reasons that we find in the world today nearly 500 submarines with many score more building or authorized. By way of contrast, in July, 1914, the month before she entered the war (although she built to a much greater extent later) Germany had only twenty-seven submarines with eighteen more under construction.



The truth seems to be that the submarine has emerged from the improved construction race in a better position than ever. Treaty limitations on the displacement of surface craft have tended to place emphasis on the development of lighter and stronger methods of construction. But until such limitations were invented, the necessity of adding a few tons to the construction of a surface craft did not constitute a serious problem to her designers. A foot or two added on the water line, or an adjustment in the allowances made for guns, armor, or machinery, would take care of the matter.

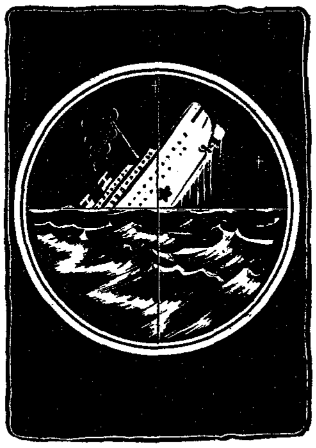
But submarine design is not so flexible. Everything is sacrificed here to safety, to cruising radius and to surface speed at the outset, and naval architects have been extremely handicapped. Meeting required safety factors in a small boat entailed sacrifices in surface speed and cruising radius. Long range and high surface speed could be obtained by building larger boats, but larger submarines, although as safe structurally, are tactically unsafe as they maneuver slowly when submerged, making both attack and escape more difficult and dangerous.

Therefore the weight savings effected by new metals and by improved welding methods were welcomed with open arms beneath the waves. Through their use, cruising ranges have been extended while at the same time the submarines have been made faster, smaller and stronger, the last of particular importance. Modern construction methods may have made today's 10,000-ton cruiser the equal, say, of yesterday's 12,500-ton ship, but a modern submarine of 1,100 tons is a 50 per cent better boat than her 1,600-ton predecessor.

The modern submarine dates back to 1896, when John Holland, an Irish school teacher in New Jersey, began his experiments, although attempts had been made to solve the problem of underwater navigation many years earlier. Principles of the Holland type boat are embodied in all submarines today, although the single-hull Holland design has given way to the double-hulled construction designed by the inventor Simon Lake. In the Holland type boats the water which is taken aboard to permit the submarine to submerge was admitted to tanks within the hull, while in the Lake type the water is admitted to the space between the two hulls. The particular advantage in this is that the space inside the boats can then be given over to the fuel tanks.

As the boats grew larger and the demands for greater cruising radius became more imperative it was found necessary to use the Lake type exclusively and all new submarines today are of the double-hulled class, although they are harder to handle than the Holland type boats which also are more popular from the viewpoint of operating personnel, being comparatively roomy, easy to dive and handle under water, simple in construction and operation and easy to overhaul.

Submarine construction lagged until the war period and



the boats grew very slowly in size. In 1914, the largest submarines were only about 400 tons. The chief explanation of the delayed development was the slow progress of the diesel engine. Gasoline engines were tried, but they were not successful because of the fire hazard and because of the gas fumes which menaced personnel.

The war, however, found the Allied navies masters of the surface of the sea and Germany turned to the underwater arm of her naval service. Under the pressure of the conflict the development of the diesel engine was begun in earnest, and from this time on submarine design progressed with terrifying rapidity. All told, Germany built some 300 submarines during the war, and at the close of the war period practically the entire output of the German yards was concentrated on undersea boats.

There were all sorts and sizes of German submarines, some as large as 1,600 tons, depending upon the purpose for which they were built. Small 600-ton boats were constructed for coast defense while the larger boats were designed as commerce raiders, or as in the case of the *Deutschland,* which came to the United States, as merchant vessels.

Submarine men today are frank to admit the skill of the Germans in handling this new weapon, and while the Allies, particularly the British, attempted to use them, they were not altogether successful. One of the stories told in this connection is that of the six British E boats which succeeded in getting inside the bight at Heligoland without being detected and there found the German high seas fleet at anchor. They fired all their torpedoes at the unsuspecting warships but they did not get a single hit. They had fired too close to the Germans and all the torpedoes ran under the ships.

Perhaps the most outstanding feat of the British submarine service was in the Sea of Marmora where Lieutenant (now Admiral) Naismuth swam ashore from a British E boat and blew up the Berlin-to-Bagdad railway. This same officer during the same cruise sank several Turkish ships and got his submarine entangled in an anti-submarine net, but finally escaped. He received the Victoria Cross for his feat. Admiral Naismuth, incidentally, is the inventor of an invaluable adjunct to modern submarines. It is the "Iswas," a device which enables a submarine commander to determine the exact course of any vessel he may wish to attack.

Although the Iswas, had they had it, would have boosted their average considerably, German submarines clicked with precision. Up to April, 1917, when the United States entered the war, nearly 7,000,000 tons of shipping had been lost through submarine attack and the usual accidents to navigation, and the Germans were sinking shipping in the latter part of 1916 at the rate of 300,000 to 400,000 tons a month. This figure was stepped up during the second quarter of 1917, when they sank over 2,000,000 tons.

Following the war, the size of submarines continued to increase, although the Germans already had learned the handicaps imposed by the larger ships. Their submarine commanders had been returning with tales of the unwieldy nature of their big commands and had been requesting smaller vessels. Never-ending demands for increased cruising radius was the reason for the continued building of the larger types, and the British even experimented with fitting one of their large submarines with a 12-inch gun. The experiment was not successful and the project was abandoned.

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The British post-war program ran to larger and larger boats, the X-1 with a 2,780-ton surface displacement and a displacement of 3,600 tons submerged being the largest. The United States also continued constructing larger submarines including the *Bass, Bonita, Barracuda, Argonaut, Narwhal* and *Nautilus,* the *Argonaut,* a special type submersible mine-layer, being of 2,660 tons displacement on the surface and displacing 4,030 tons submerged. She has a large cruising radius both on the surface and when submerged, though a relatively slow surface speed. The French *Surcouf,* which topped them all, was completed in 1929, having a surface speed of 18 knots and a surface displacement of 2,880 tons. Her submerged displacement is 4,300 tons.

The large submarines have many excellent qualities, particularly a tremendous cruising radius and the ability to stay on the surface and fight it out with a destroyer or small cruiser. But their turning circle is so large that when attacking a target which is zig-zagging rapidly they have difficulty in keeping their bearings on it. For some submarines this is not as difficult as it may seem, because the torpedo may now be made to curve in any desired direction after it has left the submarine, and in addition the submarine in a fleet action does a great deal of damage if it is able to make the enemy ships turn out of line. Thus the large submarine is particularly fitted as an adjunct of the fleet while the small submarine is best adapted as a lone underwater fighter.

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But despite these special advantages, the large submarine seems headed for extinction. The large turning circles, the limitation of total tonnage by the London Treaty and the improvements in engine design and metallurgy have caused all nations to revert to the smaller type. The British have returned to the 1,475-ton class and the French and Japanese also seem to have stabilized their construction in that neighborhood. America has followed, if not led, the new trend, coming down through the *Dolphin* and her sister-ships in the 1,560-ton class to the *Cuttlefish* and *Cachelot* and the newer boats, four of which are now building in the neighborhood of 1,200 tons. The *Cachelot* and the *Cuttlefish,* incidentally, were originally designed as 1,500-ton submarines, but their size was later reduced. They are, however, equipped with guns, indicating that the United States has not definitely abandoned the submarine as a commerce raiding weapon.

Tremendous advances have been made in the new submarines. In the latest types the weight of the engines has been reduced to around 17.5 pounds per shaft horsepower as compared to 50 pounds per horsepower (a conservative figure) during the war. New construction methods have developed other weight savings in every part of the ship with the exception of the batteries, which always have represented a considerable portion of the weight of the vessel. Submarine batteries are very similar to the lead acid batteries seen in all motor cars but are very much larger. A single submarine will have from 120 to 240 of these cells, each cell higher than a man and weighing nearly a ton and a half. No means has been developed for saving in either the weight or the cost of these batteries, which represent an expenditure of about $100,000 and have a life of about eight years.

America's newest submarines (more than thirty-six have been authorized by the Vinson bill) will be distinguished from all previous submarines by the fact that for the first time the diesel-electric drive will be incorporated in an underwater boat. The drive will be similar to that employed in the new high-speed trains, the compact diesel engines turning over electric dynamos which furnish power to turn the electric motors connected directly with the propeller shafts. This drive will increase the horsepower of the new submarines to around 5,000 in contrast to the 3,000 horsepower of the older and larger boats.

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In two other respects the latest type submarine represents a tremendous improvement over the war-time model. Most important of these is diving ability. Whereas the war-time submarine could not operate safely below 200 feet beneath the surface, the latest type can dive to twice that depth. This is a valuable asset for it doubles the number of depth charges a surface vessel must drop in order to destroy an underwater raider.

The depth charge is the deadliest weapon against the submarine and one bursting immediately alongside any underwater boat will spell destruction for that particular raider. A depth charge exploding 100 feet away will do some damage, but will not be fatal, while beyond 100 feet little if any damage is done. Thus the problem of the surface craft is to get over the submarine and drop its charges. But since the submarine now dives twice as deep, even if the surface vessel were to know exactly where the submarine was, it would have to drop twice as many charges to sink a modern submarine as it did to sink a war model. But so far the surface ship still suffers the additional handicap of not knowing under what particular wave the submarine is speeding, an important consideration since depth charges are relatively bulky and expensive and reserve supplies may be thousands of miles away.

The second outstanding advance in submarine warfare is the improvement made in torpedoes. During the war the torpedo was relatively slow, traveling at a speed of about thirty knots. An alert ship's crew could spy out the tell-tale wake created by the escape of the compressed air which drives the torpedo, and by quick action on the helm could steer out of the torpedo's course. But dodging the latest torpedoes will not be so easy, for the newest types have speeds of over fifty-five knots, or more than sixty-three miles an hour. Any action following the discovery of the wake of such a torpedo headed in one's general direction will be somewhat akin to a motorist's turning the corner after he has passed it.

Despite the advances in submarine construction, the tactics of attack have not changed. Relying on its high surface speed and low visibility, the submarine cruises or lies waiting in the steamship lanes until an unsuspecting victim comes over the horizon, first announced by its smoke. Because it lies so low in the water, the submarine can see the approaching surface ship long before the lookouts on the surface ship could possibly see it, and if the approaching vessel is following a course which will not take it too far away from the submarine, the latter puts on speed, and still on the surface, moves over closer to the apparent course of its prey. If a ship is too far abeam when sighted, the submarine, aware of the necessity of conserving its energy, will pass it by, the submarine commander, as a general rule, limiting himself to attacks on vessels which are approaching him at an angle of not over 30 degrees.

After his quick surface run to intercept the approaching vessel, the submarine commander sinks under the water, the largest submarine requiring only a minute to submerge, and begins to stalk his prey, using the periscope to watch the oncoming ship, tracking her to determine her course and speed and getting as close in as possible. Naturally, the periscope is used sparingly, since the tell-tale "feather" it cuts as it slices through the water may betray the submarine's approach to the enemy.

As a ship which sees a periscope before the torpedo is fired has a good chance of escape, the critical time for both the attacked and the attacker is during the interval of approach from a range of roughly 4,000 yards to the firing range of 1,000 yards. This period averages about seven to ten minutes, depending upon the speeds of the respective vessels, the angle of the submarine's approach and the accuracy with which the submarine commander made his original observations.

Beginning at about 4,000 yards, the submarine commander starts to run up his periscope for brief observation periods, usually of about 30 seconds, the periscope seldom showing more than a foot above the surface. Then four or five successive observations probably will be taken at one-minute intervals, the length of time the periscope is protruded being cut down to ten or twelve seconds. As the submarine closes in to about 2,000 yards only a few inches of periscope will be exposed at more frequent intervals but for only five to ten seconds. Finally, at a range of about 1,000 yards, the firing exposure is made, probably for about twenty-five seconds, in order to assure a well-aimed torpedo.

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As the submarine commander develops greater skill he is able to make less and less use of the periscope in launching his torpedoes, four of which might not sink a battleship although they would certainly put it in drydock for six months.

Various schemes have been employed by surface ships to make the task of the submarine more difficult, but all have not been as successful as their originators intended. One defense, easily recalled, was camouflaging, and millions of gallons of expensive paints were spread on merchant and fighting vessels during the war. But it was not effective. Some idea of camouflaging's real value may be deduced from a statement issued January 12, 1918, by the British Admiralty to the effect that "the theory of rendering ships invisible at sea by painting them various colors is no longer tenable," and that "the numerous schemes tried by the Admiralty under actual conditions at sea have been invariably disappointing."

It is now generally understood that a dress of vari-colored paint which makes a ship more difficult to see under certain light conditions may render the ship more easy to see under others, experience seeming to indicate that the

familiar navy gray is about the most effective for concealment at all times.

Another defense against submarines was zigzagging. Constant changes of course hindered the submarine commander in judging an approaching vessel's course. Even were he able to judge the course correctly, there was no assurance that it would be maintained. However, submarine officers soon learned to anticipate the next change in course and they were further aided in the development of the curving torpedo. In the early days of the war, the submarine had to be aimed at a spot ahead of the surface ship, as a hunter fires ahead of a duck, but this became no longer necessary with the development of torpedoes which could be set to curve as constant changes in the course of the submarine to counter the zigzagging were thereby eliminated.

Once its torpedoes are fired, the submarine attempts to escape. This may be done by submerging to the greatest possible depth and stopping all motors so that motor noises cannot be heard and betray its position, or by attempting to dodge close to the surface. Once his torpedoes have been sent on their way, the submarine commander has no desire to hang around to see what happens. His only job is to get away as fast as possible.

Much was made of the airplane as an anti-submarine weapon during the war, but its value in this respect still is not definitely known. There is said to be no question that an airplane which is directly over a submarine submerged not more than 300 feet in the water can see the outlines of the undersea boat. But from an angle, or in deeper water, the submarine is invisible from the air. Even if it is able to see the submarine there is little that the airplane can do except report its presence to surface ships, particularly destroyers, for the odds are long against a few chance depth charges finding their mark, and the scouting airplane has not yet been built which could carry enough of the heavy bombs to make the submarine's destruction sure.

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The chief enemy of the underwater boat would seem to be in the field of highly developed listening devices, particularly those of the supersonic class. Sound waves of the frequencies which are audible to the human ear have certain directional characteristics, but waves of higher frequencies above the range of human ears not only have great range under water but can be trained like the beams of a searchlight. These high frequency impulses can be sent out from a surface ship in any direction. If they encounter any object they bounce back and are picked up by a receiver aboard the transmitting ship immediately betraying the position of the submarine or other object which caused them to rebound.

But the very sensitivity of these devices now mitigates against them, since, because of their accuracy, they must be pointed directly at the submarine in order to detect it. Hence the depths must be combed constantly, a needle-in-the-haystack process, and even a glancing contact between the underwater object and the sound wave will not produce results since the wave will bounce off at the angle with which it hit and will not be returned to the listening receiver. Nor can the waves be sent out in all directions at once to determine first whether there is any underwater intruder in the neighborhood, leaving the task of obtaining his direction until later. For when the sending band is widened the waves interfere with each other and all sorts of freak results are obtained. The submarine also may send out a jumble of such waves, jamming the wave band as a radio station can jam the air by broadcasting radio waves on every band at once.

But even if supersonic devices reach a high degree of perfection, they must always remain the two-edged weapons which they really are, for the submarine by employing them will never have to come close to the surface. Thus equipped, an underwater raider will be able to track the surface ship without ever showing herself and so carry on an attack unseen. With the equipment in use already it is possible for a submarine to make a submerged attack entirely by sound and get hits with torpedoes without once showing its periscope.

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American submarines, so small that they had to be towed across the Atlantic for service, had many unusual experiences during the war. Perhaps the most hair-raising of them was that of the L-4 which in May, 1918, came near being lost with all hands, and incidentally set a record for deep-sea diving at that time.

The L-4 had been cruising at very slow speed at a depth of twenty-five feet when water creeping into the boat through the sea valves made it desirable to lessen the weight of the vessel by pumping out a small adjusting tank with a capacity of only 1,000 pounds of sea water, which was located in the center of the ship for this purpose.

Nearby was the "auxiliary" variable tank with a capacity of eighteen tons of water. When Lieutenant Hulings, then on watch, gave the order "Blow the adjusting tank!" the man on the air manifold, who was not overly experienced, mistook the command for "Open the auxiliary tank," and he proceeded to do just that.

Lieutenant Hulings meanwhile had turned his attention momentarily to the motors which he ordered stopped in order to effect a change in speed, and before the mistake regarding the previous order could be discovered the sub had dropped 294 feet to the bottom, ninety-four feet below the depth she was designed to withstand.

According to an account of the incident in the *"United States Naval Institute Proceedings,"* the chart showed that there was a depth of water in the vicinity of 300 feet and a bottom of soft mud.

The submarine was down too far to attempt blowing the water out of the ballast tanks by air as the added pressure would undoubtedly have carried away the already strained hull, so the motors were first started ahead at a very slow speed in an attempt to plane the boat up, but without results. A faster speed was tried and still the boat stuck.

Next the ballast pumps, which had been designed for 300-foot depths, were tried and the high-pressure ballast pump was placed on the forward ballast tank. But the pump would not take suction as the circuit breakers tripped at the set amperage. The amperage setting on the breakers was doubled but still they refused to hold. They were then set for the maximum under any conditions and for a few moments the pumps functioned—and then the breakers tripped again. While the pressure had been reduced from 127 pounds, the sea pressure at that depth, to 90 pounds, the pumping was discontinued because the motor was extremely hot and besides the pump and the flanges on the pump-discharge-overboard-valve were leaking badly.

Then the main motors were backed, but still without success. Next, the adjusting tank, which had been designed to withstand great pressure, was filled with water three times from the auxiliary tank and blown empty, but by this method the tank had to be vented of the compressed air after each blowing before it could be filled with water again and a pressure was built up inside the submarine so great that the needle of the pressure barometer in the submarine was bent up against the top of the instrument. In an effort to reduce the air pressure in the submarine, the air compressors were started up, but the seawater admitted to cool them burst the cooling shell and this had to be abandoned.

Meanwhile the stern tube glands on the propeller shaft were leaking badly and water began to fill the bilges in the engine and motor room, rapidly mounting to the main motors. Different valves in the engine room also began to leak and soon little trickles of water appeared about the compartment. The situation was becoming desperate.

In a final effort to escape from the mud, the commanding officer ordered every man not on necessary diving stations as far aft as possible to lighten the bow while pressure was again put on the forward ballast tank until the safety valve on the air line blew. The valve was then reset at 15 pounds above the sea pressure, or 140 pounds, away above its designed rating. The main motors were then sent ahead at two-thirds speed while the chief electrician coolly held the circuit breakers closed with his hand despite the fact that his arm would be burned in doing so.

The bow rose to a 3-degree angle, then to 6 degrees, then suddenly broke loose, the L-4 heading for the surface at a 50-degree angle. A moment later she was "topside" after having been stuck to the bottom for one hour and ten minutes.

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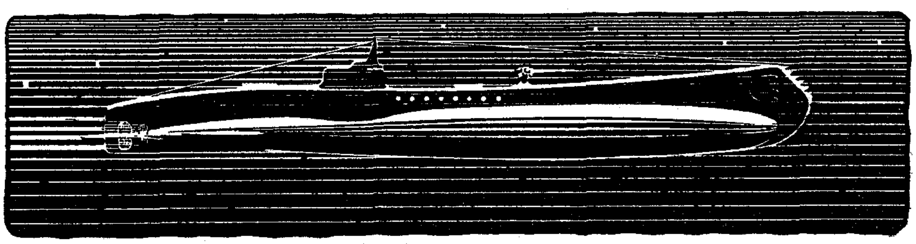
As the weapon of the weaker power, the future of the submarine is still open to speculation, but there are many who believe that in the next war it will be used by all nations exactly as it was used by the Germans in the last. The ruse of carrying neutral "passengers" on every merchant ship transporting valuable war supplies served the purpose of arousing public sentiment in the United States during the last war, but many doubt that such a ruse will work again. And Americans who must travel in troubled waters no longer have excuse to sail under foreign flags since our own merchant marine came into existence.

The submarine, indeed, is too efficient a weapon for economic warfare ever to be discarded. Even treaties can have little effect on its use in war, for the modern undersea boat can be turned out with great speed, six months being the period required for building where haste is necessary. With its new staying power and its new fast thunderbolts, the underwater boat apparently is prepared for a more important role than ever in future wars to end war.



The Murder of King Cotton

"Hot" cotton, handled by bootleggers, loss of foreign markets for American cotton, and unemployment for millions of southern workers are some of the consequences of the New Deal for cotton as seen by Representative McGugin, of Kansas.

By Harold McGugin

THE first farm crop to yield completely to New Deal regimentation is cotton. The growers of that great staple have ceased to be free agents who can do as they please on their own broad acres and have placed themselves completely in the hands of the bureaucrats of Washington.

The Bankhead cotton limitation bill has passed the Congress, has been signed by the President and has become a law. Its purpose is to hold cotton production down to ten million bales a year where it has been running around thirteen or fourteen, sometimes eighteen, million bales. *The theory was* that this limitation of production would raise the price to the farmer, and price raising, without reasonable regard for other considerations equally as vital, has been a blind fetish of the present Administration ever since it came into office. The position of the advocates of the measure has been like that of the motorist who thinks only of speed and ignores the hairpin curve on the brink of the cliff ahead.

This bit of legislation is so true an example of action based on erroneous and disproved theoretical conceptions that it deserves analysis, not for itself alone, and not because it threatens the life of one of our most important industries, but as an example of the quite mad drift of these dangerous times.

It is interesting to take the back track a little on this bit of New Deal legislation. It is fathered, as everybody knows, by the Bankhead brothers, from Alabama, one of whom is a Senator, the other a Representative. It made its first bow to Congress but a few days after the senior Bankhead arrived in Washington as a member of the Senate in 1931. He very promptly introduced his cotton limitation bill. It was received tolerantly as a vagary of a new member but got no consideration whatever. Why? Because it was so obviously unconstitutional, in its proposal to interfere with the individual's right to produce as he chose, as to be foolish.

But this spring, reappearing with the surge of the tide for regimentation, backed by the Brain Trust and a personal letter to the House Committee on Agriculture from the President, asking its passage, it forthwith became a law. Its apparent sole purpose is to limit cotton production to ten million bales, allocating permissible production on that basis to states, counties and individuals in proportion to past yields. Each farmer is to be told just how many bales he may grow and whoever produces cotton above his allotment must pay half the sales price into the Treasury. The Southern gentlemen who fathered this bill were thinking only of this limitation, but the new Americans in Washington who sneer at the time-honored theory of the individual's responsibility for taking care of himself saw it as a long stride toward that Federal control of all activity which they were seeking.

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The original intention was that this law should have the effect of prohibiting production above ten million bales and that this artificially created scarcity would cause the price to go to fifteen cents a pound. From the President's standpoint it was another candle lighted at the shrine of high prices. He could extend the prohibition for a second year, if he chose to do so. Administration influence might make cotton regimentation permanent, if it chose, at the end of that period. So was the first great crop brought under definite Federal control. It might be the first in a series of such actions. Many feared that in the minds of those who controlled policies for the Administration the establishment of the precedent of Federal domination over one great crop was an accomplishment to which more thought was given than to the welfare of a specific farm group. The law was so weakened before final passage, in fact, that it lost much of its actual strength though it retained its force as a precedent.

It was originally intended that its tax on over-produced cotton of one half the market value should be paid at the time of ginning. This was amended to make it payable when sold. Thus a farmer could raise cotton above his allowable quota, pay the gin charges out of the returns from his seed and store his excess in the bale against the time when the law expired, or was repealed. This weakness, allowing cotton in storage to accumulate and thus affect the market, will tend to prevent the law from serving its primary purpose of raising prices. Like so many of the other theoretical interferences with industry which the Administration has fathered it fails to function as planned.

But grant that the result turns out to accomplish its intended purpose, is a success from the standpoint of its supporters, does cut production to ten million bales and