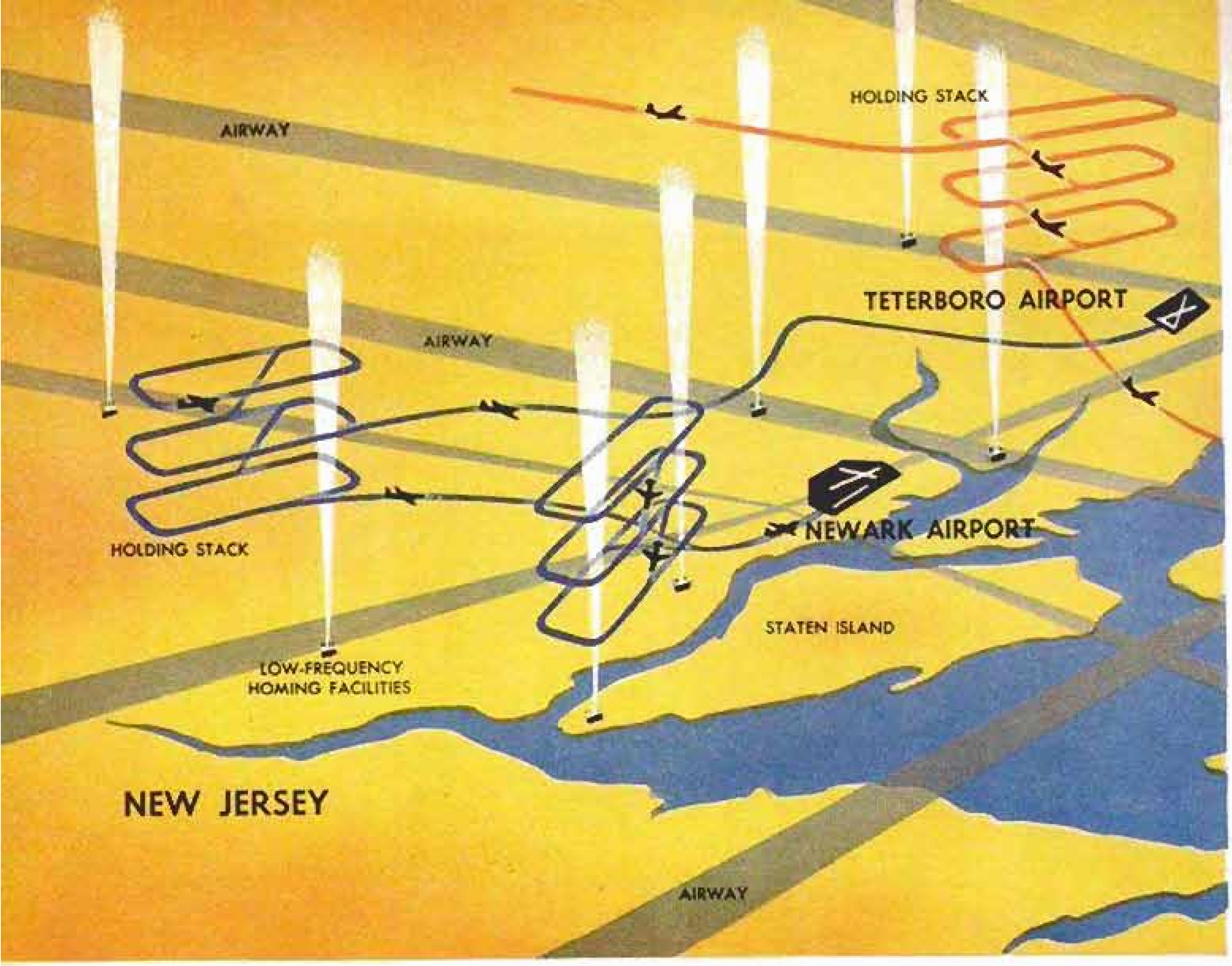
We're Running Out of Airspace

By Clifford B. Hicks

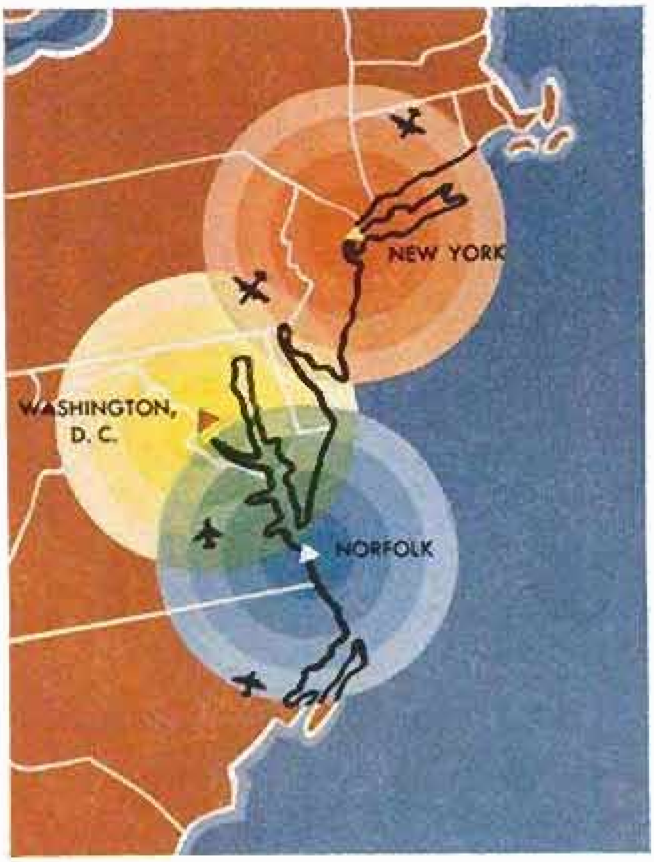
FOR A THREE-DAY period in September 1945 — called "Black Friday" by the traffic controllers, who will never forget it— there was literally an air-traffic jam in the skies above New York City. Planes were stacked up in every holding pattern around the city, with more roaring in from every direction.

At one point for nearly an hour Civil Aeronautics Administration controllers were not accepting any flight plans whatever. Planes were backed up halfway across the country. In Chicago and Miami, disgruntled passengers looked at clear skies and grumbled about the delay, while in New York the tense traffic controllers were sweating out the exacting job of guiding onto cleared runways all those planes that were droning through the murk overhead.

Thanks to the expert work of the controllers, every plane landed safely and every passenger waiting on the ground got into the air. The worst air-traffic jam in history finally was unsnarled without violation of a single safety rule.



Long-range radar at terminal cities (below) puts much of the East Coast area under continual surveillance

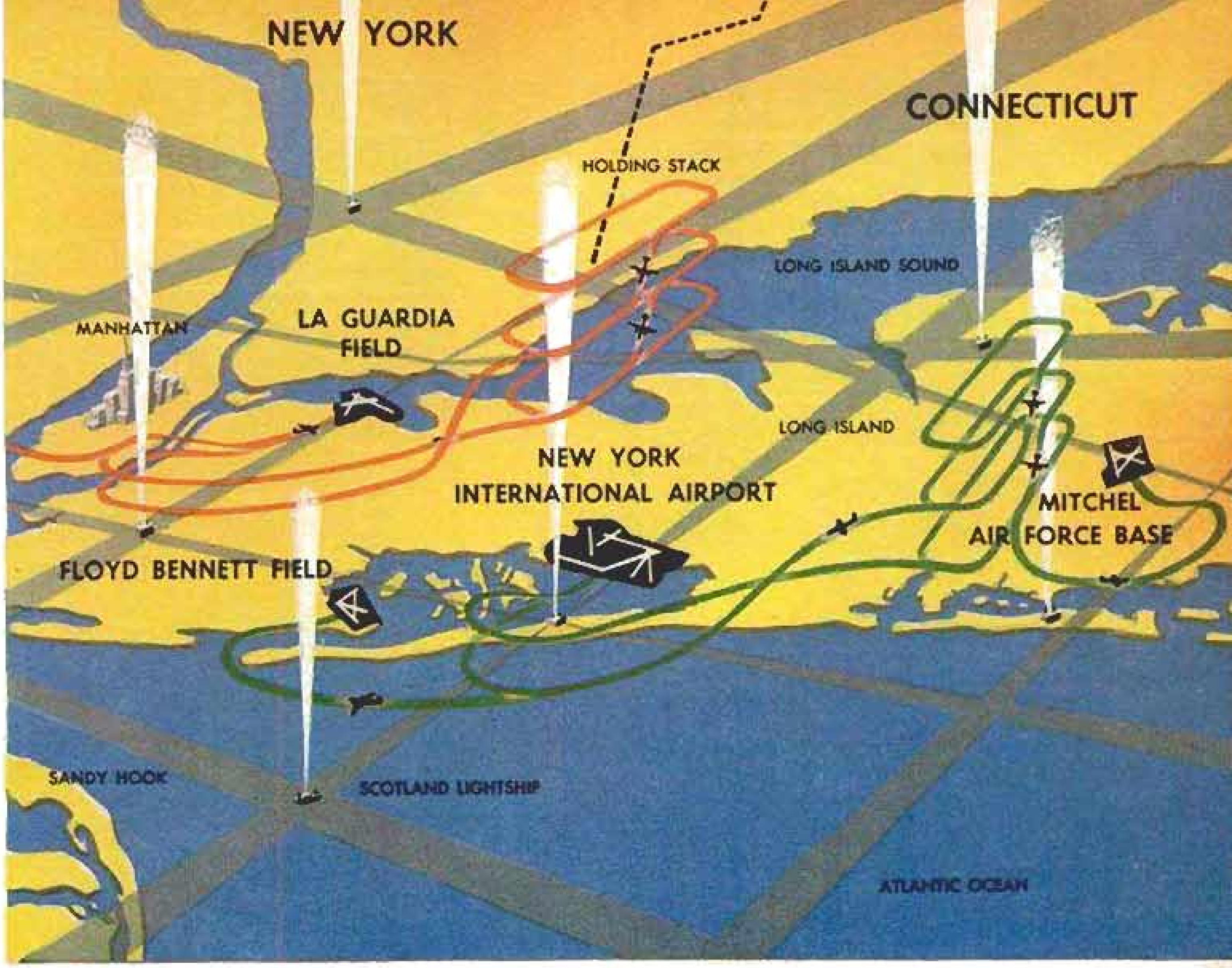


Studies of Black Friday never pinned down the precise reasons for the sudden glut of air traffic. But these studies, along with others made by the CAA, proved one thing: *in some areas of the country we're rapidly running out of airspace.*

Airspace is a nonrenewable asset. On the ground, you can build more highways and rail lines to solve traffic jams. But overhead there's a definite, limited amount of airspace. When it's gone, there is no more.

Surveying the magnificent bowl of blue sky, man tends to think his airspace is endless. Actually it's carved into a good many imaginary chunks—so many that in some areas there's nothing left to carve.

When you take a plane flight you fly along an airway, an aerial highway 10 miles wide. These highways are laid out by the CAA to provide the most direct route between airports while skirting any hazards to safe flying or safety on the ground. During instrument-flying weather, regulations require that all aircraft flying on the same airway be separated by at least 1000 feet in altitude, or by 10 minutes' flying time if two or more planes are at the same altitude. Thus a single plane oc-



Several airports and high traffic level cause air-traffic jams above New York. Changes now being made will produce the pattern diagrammed above. Gray lines represent the airways and white vertical lines are the holding fixes. In some cases, holding stacks will serve more than one metropolitan-area airport

cupies a tremendous chunk of airspace measuring at least 1000 feet high, 10 miles wide and some 40 to 60 miles long.

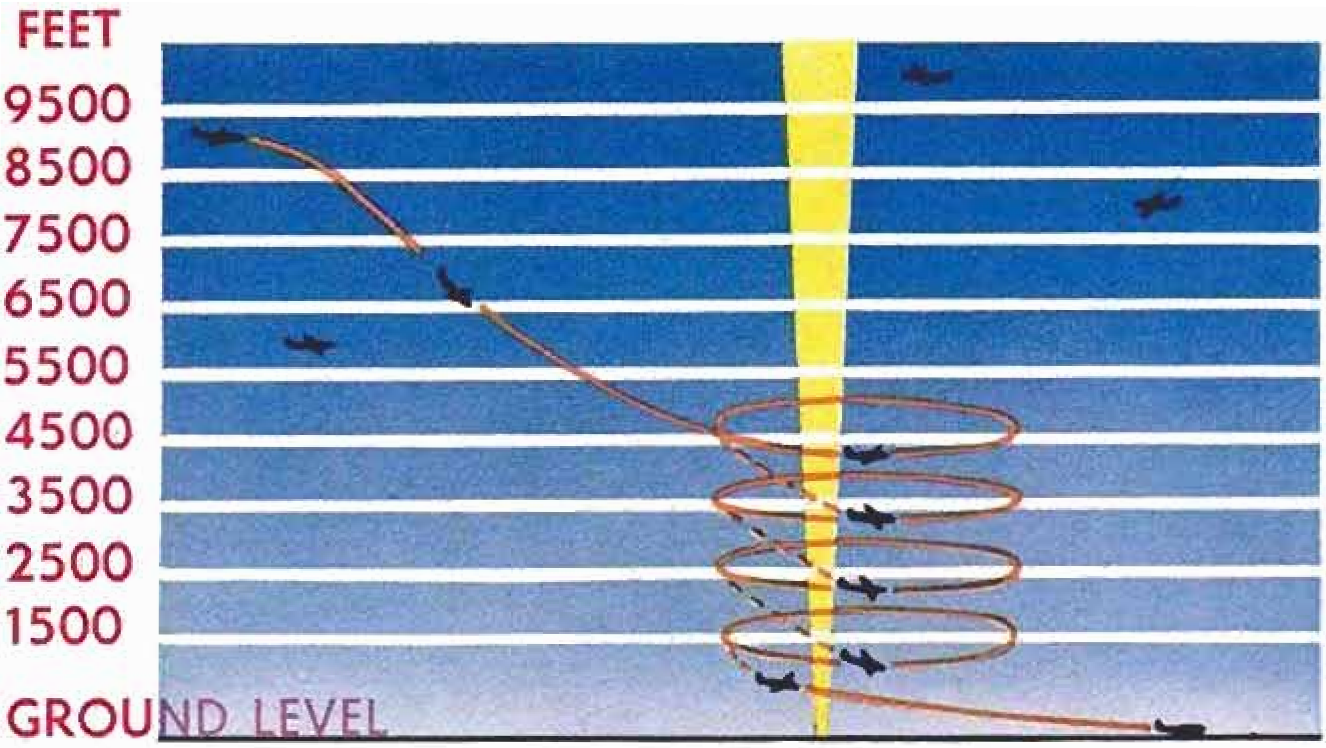
Multiply this by the number of planes in the air. Traffic on scheduled air routes of the United States today is nearly three times what it was when World War II ended. During 1954, control towers handled 17,261,461 plane movements, or almost 2000 every hour, day and night.

Today there are about 140,000 miles of airways. The airspace problem is not critical on most of these airways. But by their very nature, the airways converge upon metropolitan areas. Around these cities the air, except for scattered prohibited areas, is literally all airway. It is here that the airspace has been used up.

Take an example. At the Chicago Municipal Airport the daily traffic peak occurs between 5:00 and 6:00 p.m., when there is a plane landing or taking off every 20 seconds. Other trouble spots are Washington, D.C., Norfolk, Miami, Los Angeles, San Francisco and Seattle, with ominous hints of traffic jams showing up at Detroit, Dallas, Pittsburgh, Cleveland and St. Louis.

The obvious answer—to add more airports—is probably the worst possible answer because it simply compounds the confusion. New York has the most critical airspace problem in the country, and here within 20 miles of La Guardia there are three major airports and four others capable of handling instrument approaches.

To see the problem clearly, watch what happens as you approach New York high in the air. Your flight is bound for New York International (Idlewild), one of the three major airports serving the city. As you enter the metropolitan area under instrument-flight conditions, the traffic controller must guide you unerringly through the web of New York traffic. Planes—some four of them per minute—may be taking off or coming into the various airports from every point of the compass. Your plane must bypass or pierce all the traffic around Newark Airport and much of the traffic around La Guardia to reach Idlewild. Since the weather is bad, planes are stacked up throughout the area,

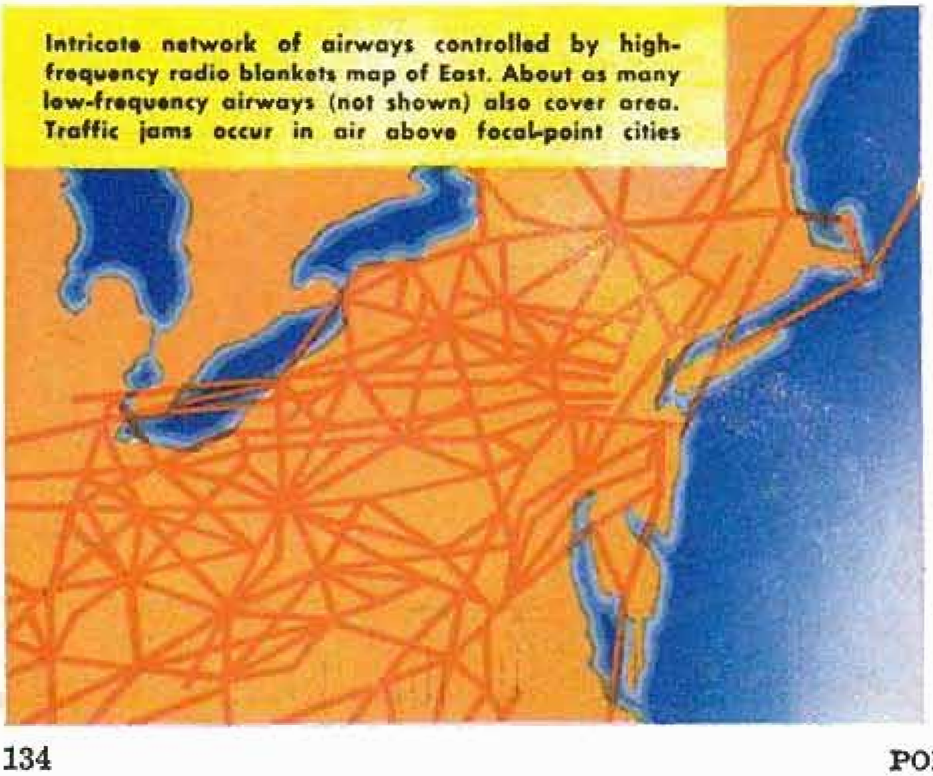


Each holding stack is looped around a radio beacon. Incoming plane enters top of the stack and works its way down. Controller's big problem is to feed planes through stack and onto runways with minimum delay

and your controller directs you to one of the two holding patterns for Idlewild. This is simply a long oval where planes are stacked up like cards in a deck awaiting their turn to land.

Holding patterns are divided vertically into layers of 1000 feet. Planes are handled on a first-come, first-served basis; you enter the top of the deck and work your way down. Eventually, when you reach the bottom and the tower man gives you permission to make your approach, you pass through the "gate" (the final wave-off point if anything is wrong) and land. It takes the average plane two minutes to descend from one level to another so, until recent improvements, one landing every two minutes was the maximum possible rate. CAA controllers shuffle you through this deck of planes with an expert hand. Your safety is their primary consideration. Indeed flying today, despite the traffic jams in some areas, is safer than it has been throughout its history.

But the slightest hitch can cause an aerial misdeal. For example, a Boeing 377 Stratocruiser once dropped an engine on its way into Chicago. The tower controller had to hold 42 inbound airplanes simultaneously until the cripple landed. This held up traffic for 25 minutes and compounded the problem of getting the planes down.



Intricate network of airways controlled by high-frequency radio blankets map of East. About as many low-frequency airways (not shown) also cover area. Traffic jams occur in air above focal-point cities

"We know that air-space and traffic-control problems are serious and must be solved if we are to have sound aviation," says F. B. Lee, Administrator of Civil Aeronautics. "We have no doubt they can be solved."

More Holding Patterns

What are the solutions? More holding patterns? To make room for them, you sometimes have to establish them farther from the field, thereby increasing the time necessary for the bottom plane in this stack to reach the gate and land.

In experimental setup, radarscope is projected on glass table. Controllers move markers as the blips move

The CAA is using a high level of imagination to come up with some of the answers. Men, women and some ingenious instruments are hard at work on the airspace problem at the CAA's Technical Development and Evaluation Center at Indianapolis, Ind.

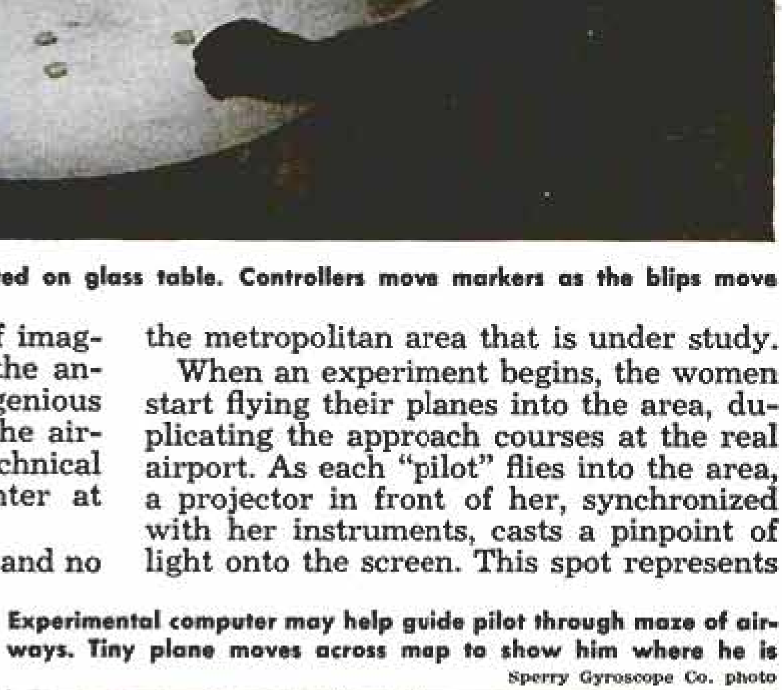
Each airspace problem is unique, and no pat formula applies to all of them. That's why a complex research tool developed at Indianapolis is so valuable. It's called the dynamic air-traffic control simulator and it combines radar, television, optical projectors, calculators and aircraft instruments. With this tool, researchers can duplicate the traffic conditions around any airport in the country, right down to the exact speed of every approaching plane.

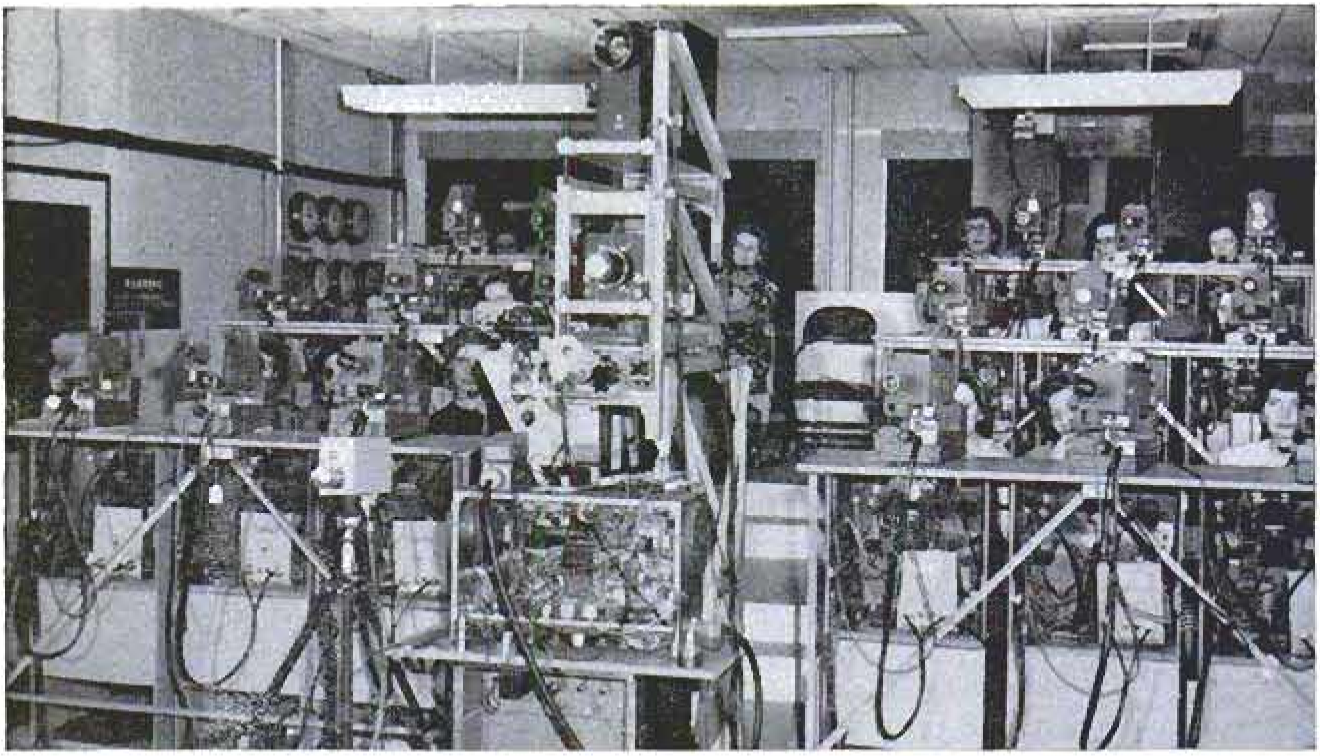
The simulator is installed in a big room at the Center. Some 18 women (wives of CAA workers) are seated at one end behind aircraft-instrument panels. Each woman serves as a pilot and has been taught to "fly" her plane in response to orders given her by radio or according to instructions on a written script. Across the room from these "cockpits" is located a large screen which is overlaid with an airways map of the metropolitan area that is under study.

When an experiment begins, the women start flying their planes into the area, duplicating the approach courses at the real airport. As each "pilot" flies into the area, a projector in front of her, synchronized with her instruments, casts a pinpoint of light onto the screen. This spot represents

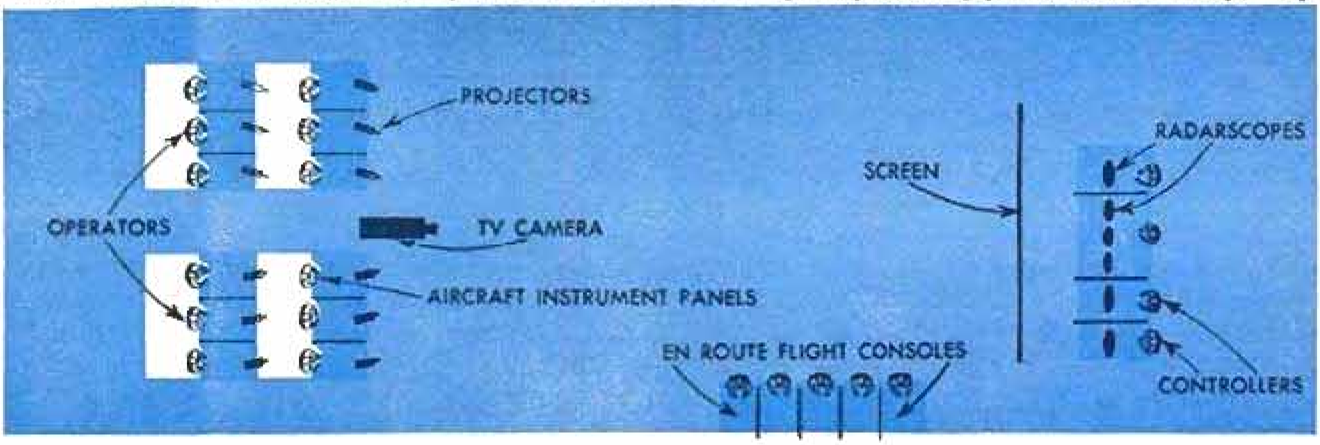
Experimental computer may help guide pilot through maze of airways. Tiny plane moves across map to show him where he is

Sperry Gyroscope Co. photo





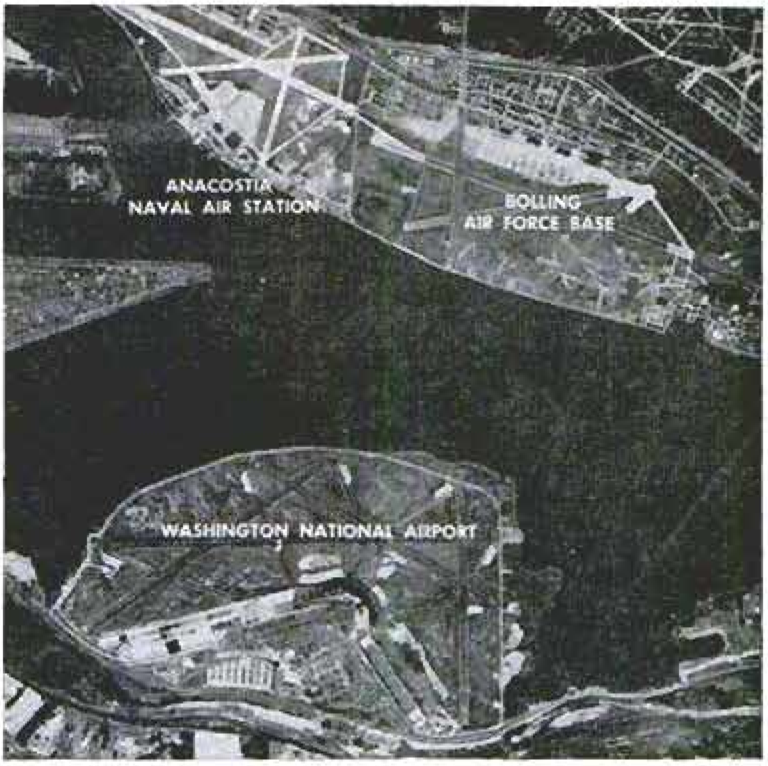
Complex instrument shown above and in diagram below can simulate air traffic anywhere in the world. "Pilots" sit behind instrument flight panels and guide dots of light representing planes across airways map



Controllers behind the screen must unscramble the traffic and guide each plane in for a safe landing at airport

her plane as it nears the airport.

A camera televises this screen with its moving spots of light, and projects the picture onto a radar screen. CAA controllers, seated in front of the radar screen, must handle the planes safely and land them with the least possible delay. They radio instructions to the pilots, who respond exactly as regular commercial pilots. As each woman "lands" her plane, she starts piloting another into the area. For experimental purposes the area can be so saturated with planes that the system actually breaks down. (In actual practice, of course, this never happens.)



Jams have occurred at Washington where the National Airport and two service airports are located within a mile of each other

With the simulator, the controllers can try any alterations in the terminal area. They can change the course of the airways, move holding patterns or increase their numbers, decrease the distance between the bottom of the stack and the "gate," even experiment with changes in safety regulations, all without endangering the life of a single pilot or plane passenger. The simulator is made to order to solve the complicated problem of the New York area, or the unique problem at Washington, D.C., where elements of three different airfields are located within a mile of each other.

The simulator was used with excellent success in solving the traffic jam at Norfolk, where there are five different fields, military and civil, within a few miles of each other. Long experimentation with the simulator brought about a solution whereby the bulk of the traffic flows along a single course and individual planes peel off into "feeding troughs" leading to their terminal airports.

One-Way Airways

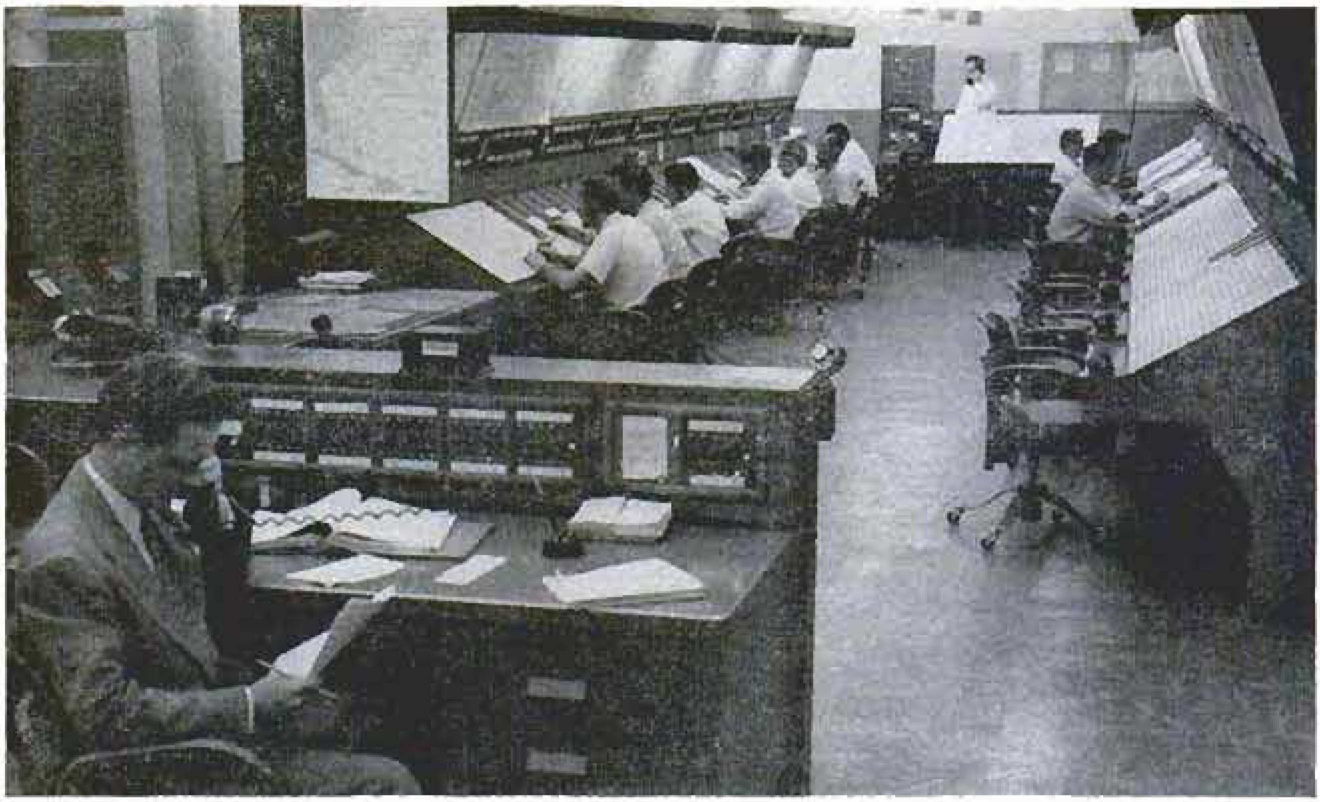
One development that has come out of the simulator is one-way airways. In many situations these prove just as efficient as one-way highways. With all traffic moving in one direction there's no need to assign specific altitude levels for two different directions, nor is there a problem of high closing speeds. With planes at their designated altitudes, conflicts can occur only when one plane overtakes another. One-way airways have led naturally to the development of aerial intersections, much like the clover-leaves of superhighways, with intricate but efficient traffic patterns for high-speed turnoffs.

Other studies show that minor changes in runways can pay off with a great increase in an airport's traffic-handling capacity. On the average it takes a plane about 70 seconds from the time it passes the wave-off point until it lands, brakes to five miles per hour and makes a right-angle turn off the runway. Research at Indianapolis shows that a plane can safely negotiate a gradual turn off the runway at a speed of up to 30 miles per hour. If such a high-speed turnoff is available, the runway can be cleared in about 40 seconds, at which time a skillful controller will have the succeeding plane passing through the wave-off point.

Simulation studies of the New York problem have resulted in some concrete action. An Instrument Landing System has been in use on one runway at Idlewild for years. Now another is being installed. This is the first time two ILS systems have served the same airport. In addition, holding patterns have been changed, so that in most cases two different holding fixes serve each airport, giving the controller much greater flexibility in bringing in planes.

Long-Range Radar

But the biggest aid for solving the traffic jam is long-range radar. Until recently, airports had only short-range radar (about 30 miles) which was used by the tower controller as a visual check on the planes landing or waiting to land. By the time a plane was picked up, it already was approaching and virtually in the holding pattern, so radar served as a valuable safety



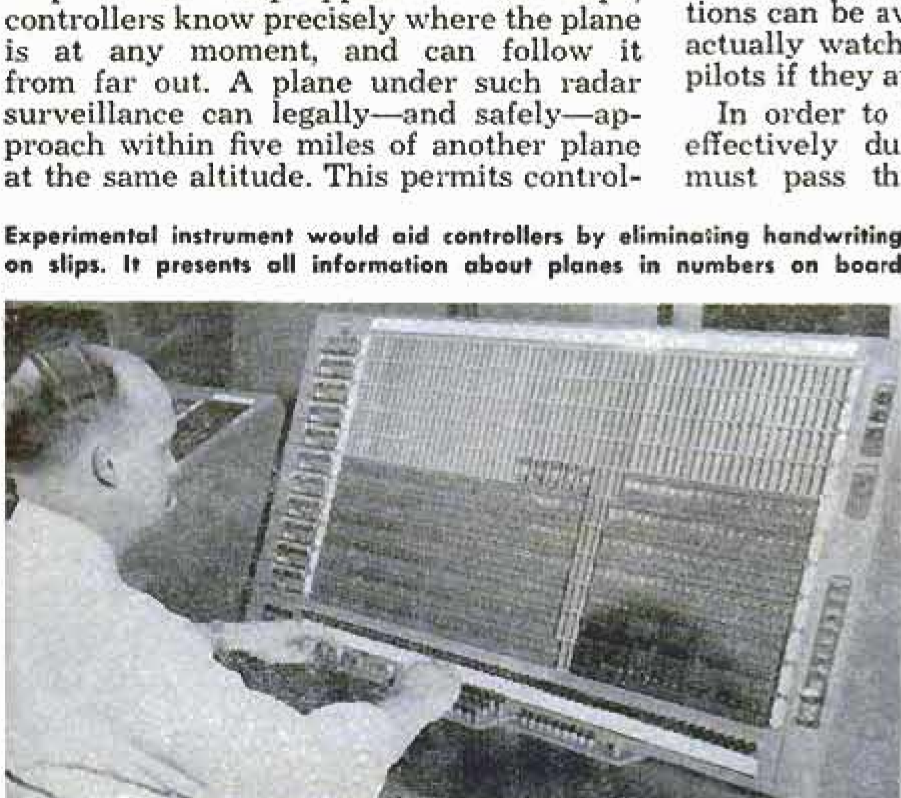
Men in traffic-control center know precise location of each plane, preserve a chunk of airspace around it

check but little else. Now a big new radar has been installed at Washington and another, on loan from the Air Force, now is being operated at New York by CAA personnel. Still another long-ranger already is in operation at Norfolk. This means that a plane can fly from Norfolk to Boston and be under radar surveillance virtually the entire distance.

To the controllers this is an incalculable help. When a blip appears on the scope, controllers know precisely where the plane is at any moment, and can follow it from far out. A plane under such radar surveillance can legally—and safely—approach within five miles of another plane at the same altitude. This permits controllers to bring planes into the metropolitan area much faster. They can route planes from some distance away toward one of two different holding patterns. If there are no conflicts, they can order a pilot to start his descent a long way from the airport. Often a plane at 11,000 feet is denied a normal letdown because another plane is cruising along at 9000 feet less than 10 minutes behind. The first plane is required to hold over a fix. With radar, such situations can be avoided, as the controller can actually watch both planes and warn the pilots if they approach too close for safety.

In order to make any airport function effectively during heavy traffic, planes must pass through the gate with the regularity of clockwork. There can be no big gaps. With radar, controllers can spot such impending gaps and route an incoming plane directly to the field, filling the gap without forcing the "holding" planes to wait any longer than would otherwise be necessary.

Experimental instrument would aid controllers by eliminating handwriting on slips. It presents all information about planes in numbers on board



Radar will be even more important with the coming of jet transports. Jets, with their enormous fuel consumption at low altitudes, will not be able to fly a holding pattern for very long. Radar

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permits the controller to take over positive control of the plane from some distance, save a place for it in the landing parade, and slip it directly into this niche.

Transponder Answers Radar Call

Another instrument that may prove valuable in the future is the transponder. The radio band now is so crowded that radio and radar beams are interfering with each other. At long range, a ghostly blip may appear on a scope that may—or may not—be a scheduled plane. At Indianapolis, six DC-3s of Lake Central Airlines have been equipped with transponders. These are small metal boxes housing special radio equipment. A faint radar beam from 200 miles away will trigger the transponder, which automatically sends out a strong beam in return. This not only produces a bright, strong blip on the scope, but the equipment can be so rigged that it will send out a coded message so the plane identifies itself. The transponder, if installed in all commercial planes, will greatly extend the range and usefulness of radar. No longer will a tower man have to ask a pilot to make a 90-degree turn so he can identify the plane on the scope.

Strong, long-range radar will also prevent the kind of traffic pile-up that occurred in Chicago not so long ago, when a small private plane became lost on instrument flight somewhere near the city. Neither the airport radar nor the radar at the Glenview Naval Air Station could find the lost pilot. All flights into the city were held up for one hour and 45 minutes until the plane finally was located and guided in. During that time this one small private plane forced some 80 scheduled airline flights from all over the country either to land immediately or to proceed to holding fixes.

Air traffic has become so heavy and planes so large that some thought is being given to ways that the pilot himself can spot imminent collisions. An experimental periscope, installed in a DC-3 at Indianapolis, enables the pilot to see the air all around him, eliminating his present blind spots. Electronics firms may produce an aircraft-proximity warning indicator.

Computer May Be Answer

Perhaps the inevitable answer to the airspace problem is a computer that will take much of the personal element out of juggling planes for a landing. Such a unit, called Volscan, already has been built and is reported to be under test by the Air Force. As soon as a plane turns up on the edge of the radar scope, its blip is connected electronically to the computer. The computer surveys a scope full of blips and figures quickly and constantly the course that the planes must fly to bring them safely to the airport at a rate of two per minute. All the dovetailing is done by calculating an indirect route for each plane, so its entry into the gate will be on time.

Experiments also are underway at Indianapolis to solve the controllers' biggest headache. For years controllers have kept track of each plane in flight on a flight-data strip. This slip contains a description of the plane, its destination, altitude, the time that it passes certain fixes and any other pertinent information. By expert reading and juggling of these strips, controllers are able to spot conflicts in advance and give the necessary orders to each pilot to keep the precious block of airspace around his plane.

To solve this problem, research workers at Indianapolis have come up with some ingenious electromechanical display boards that present instantly in numerical fashion all the data on any flight. They also are working on horizontal map-type display boards. On such pictorial displays, each plane is identified by a small "shrimp boat" (so named for its pointed shape). The point of the boat indicates the direction the plane is moving. A slip of paper on the boat gives all the vital information on the flight. As the plane checks in at various points on its course, the boat is moved with it. A somewhat similar system has been tried with a radar projector. The picture of the scope is thrown onto a large horizontal glass disk, and the shrimp boats are moved along as the radar blip moves. These systems give the controller a two-dimensional image of the traffic. He adds the third dimension mentally.

Color Radar?

And even this problem may be taken care of if another new development is adopted. Officials at the Center hope to test color radar within a few months. This equipment, when used with transponders, would present a great deal of visual information about planes approaching a metropolitan area. For example, the traffic controller in the New York area could tell at a glance (by the colors) the altitude of each plane in the area and its terminal airport.

All this research adds up, not only to safe air travel in the future, but better means of utilizing one of our most precious of modern resources, the crowded space above our heads. ★ ★ ★