THE RED FUSEE IS A SIGNAL TO STOP

At night, red-burning fuses, sometimes called flares, afford a splendid means of warning to railroad men.
HOW THIS BOOKLET CAME TO BE WRITTEN

T
HE "Fair of the Iron Horse" of 1927 brought together over one million and a quarter people to see a historical pageant of great importance. It was more than a celebration of the achievements of one railroad, it crystallized the spirit back of the railroads of our great country. Some time afterwards, an associate editor of a scientific journal paid a call on the official in charge of public relations and during the conversation a wish was expressed by both that while the "Fair of the Iron Horse" could not be carried around the country that possibly some informative substitute might be evolved which would bring the railroad closer to the people. In other words, the public is interested in knowing that a locomotive costs $85,000 or more and a dining car $45,000. When it comes to construction and maintenance, the public is avid for statistics as to weight of rail, cost per mile, amount of coal and water consumed. The matter was milled over for quite a long time, then a comprehensive plan was outlined and not infrequently a locomotive could be seen, carrying a couple of photographers to some outlying roundhouse or freight yard. Finally a series of articles was written which were published in the "Scientific American" during the greater part of three years. It was the favorable reaction of the public to these articles that suggested the publication in this condensed folder, of the mass of information collected.

RAILROADING TODAY

RAILROAD CONSTRUCTION AND MAINTENANCE

WHo has not, at one time or another, gazed down the length of a straight-of-way of railroad track and found a fascination in watching the steel rails converge to a vanishing point in the distance? But how many of us know the story, equally fascinating, of how those rails were put there and how they are kept so straight and true.

Briefly to tell about railroad construction and maintenance, there is first to be considered the present or probable future need of a railroad as a means of transportation between two different points. When this has been determined a corps of field engineers or surveyors starts to map out the best and most economical route. From their observations they prepare plans so that the necessary right-of-way may be purchased. They also draw up plans and specifications for the use of the contractor who will do the work of grading.

As the work of preparing the finished grade of the road progresses, materials for the construction of the track are assembled at the job and then distributed to place. For the track structure of today, 22 creosote-treated ties are laid for every 39 feet, which is the length of a steel rail. This is followed by the distribution of the steel rails, joint fastenings, bolts, tie plates, spikes and rail anchors.

To build one mile of single track railroad, the following material is required: 204 tons of 136-pound (per yard) steel rails; 270 joint fastenings, which with abrasion tie plates weigh 141 pounds each; 5418 tie plates, weighing 16.5 pounds each; 70 legs of track spikes, weighing 200 pounds each; 15 legs of track bolts, weighing 200 pounds each; 1650 rail anchors, weighing 2 1/2 pounds each, or a total of 4125 pounds; 2979 treated cross ties, size 7 1/8x8x3 1/2; 3600 tons of stone ballast. This represents about 80 carloads of material, the cost of which is $23,000. Labor, supervision, accounting and freight charges add $17,000, so our mile costs $40,000.

After the distribution of material, the ties are evenly spaced and the tie plates placed on the top face of the ties, using a gauge, so that when the rail is placed on them, the inner or gauge side of the rail heads will be exactly 4 5/8" apart. This is the distance that has been adopted as standard on all railroads in this country.

Carloads of engine cinders are brought in and dumped on the track. The trackmen raise the rails on these cinders until there is a mat 12 to 18 inches thick, extending over the width of the roadbed. Time is now allowed for settlement of the cinders and then when the roadbed has become stabilized, the cinders are "screened out" or cleaned out and used to widen the banks of the roadway, and new ballast, of stone, gravel or crushed hard slag, is distributed. Stone ballast is generally used in heavy traffic, high-speed territories. It is necessary to have from six to twelve inches of ballast between the bottom of the ties and the cinder foundation. This takes from 2200 to 3000 cubic yards of ballast, or from 35 to 75 carloads per mile of single track railroad.

With the completion of construction, the work of the engineer is not finished. Wear and tear, increased by the constant demand for greater speed and heavier trainloads, need to be constantly remedied by replacements and repairs, which have to be made without interruption to traffic. This is the maintenance problem.

A slight insight into the magnitude of this important work may be gained from the following statistics covering the seven-year period of 1922-1928, inclusive, for the railroads of the United States:

Roadway and Structures

<table>
<thead>
<tr>
<th>Description</th>
<th>1928</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional track and track material</td>
<td>$464,182,000</td>
</tr>
<tr>
<td>Resurfacings</td>
<td>$23,109,000</td>
</tr>
<tr>
<td>Additional ballast</td>
<td>$2,629,000</td>
</tr>
<tr>
<td>Strips and engine houses</td>
<td>$282,600</td>
</tr>
<tr>
<td>All other improvements</td>
<td>$1,283,000</td>
</tr>
<tr>
<td>Total</td>
<td>$5,099,790</td>
</tr>
</tbody>
</table>

The annual program of maintaining a railroad calls first for the renewal or replacement of rails that have become worn. New rail is generally laid "out of face"—that is, uninterruptedly, without patchwork—in stretches of from one to five miles on main line, high-speed tracks. Local conditions and the amount of rail to be laid determine the methods to be used.

Regular and frequent inspections are made of the tracks and their integral parts to detect any flaws in material or workmanship that may develop into safety hazards. This standard of materials, workmanship, and inspection that is maintained on the railroads is reflected in the freedom from accidents due to defective tracks and other faults that can be avoided by proper attention to important details. In fact, on one major railroad there have been only 1.5
passengers injured in any manner whatsoever per 1,000,000 passenger miles traveled. On this same railroad there has not been a passenger killed in a train accident in over 14 years.

Bridges, buildings, signals, and other structures form a considerable part of the property of a railroad, the construction and maintenance of which call for close attention not only to utility but dignified appearance as well. Safety is the first element of consideration, so that no accident shall occur as a result of failure of these structures. "Safety above everything else" guides here as it does in every phase of railroad activity. All of these facilities, adequately supervised and maintained, provide for rapid and safe transportation. Railroad maintenance is a most fascinating subject because changing conditions never allow problems to remain permanently solved.

Fascinating as this phase of railroad ing is, probably the greatest appeal to young and old is the so-called "iron horse" or the locomotive.

**ROUND A ROUND HOUSE**

Although we cannot say truthfully that a locomotive actually sleeps, it is true that a period of rest is beneficial. At the same time it allows a thorough cleaning and inspection of the machine before it again undertakes the responsibilities that accompany its long runs over the rails. Few of the inventions of man see harder service than the engines which haul our passenger trains on schedules that are seldom broken.

While locomotives are built nowadays on a progression system compatible to that of automobile mass production, still there is an individuality about them which is different from that of any other machine. Early in their careers they disclose variability as to steam distribution, acceleration and tractive effort. All of these little quirks have to be straightened out, so that there may be uniformity in the locomotives as they stand fully fueled, with steam up, on the "ready track."

The service period of a locomotive begins in its berth in the round house. Probably all have seen round houses from the outside, but few have inspected them. A round house should be visited only when "personally conducted" by someone who knows the ins and outs of railroading, for there are many pitfalls for the unfamiliar in the railroad yards. A roundhouse is a grooming shelter, circular in shape, where locomotives can be berthed for examination and firing up, and where minor repairs can be made. The shape of the building is such that the locomotives may be assigned to any designated berth and shifted to it with the aid of a turntable. The same turntable routes the locomotive to the "ready" tracks which lead to their daily tasks.

An along-sided hoot or "smoke jack" is located over each stall of the round house. This, in conjunction with electric motor-driven draft generators, permits the smoke and gases to be eliminated, so as to keep the round house less smoky that it would be otherwise. The locomotives are fired up with the aid of oil under air pressure. When the steam pressure is high enough to permit operation the engine is run out by the hostler to the turntable, which is rotated so that the engine can be run, either to the "ready track," if already supplied with fuel, or to the coal tipple, where 8 to 12 tons of coal are run by gravity into the coal space of the tender. The coaling is accomplished with the aid of chutes and the amount of coal delivered is charged up against the locomotive and the run. While normally the locomotive backs beside the coal bridge to receive the fuel, these are provided at most terminals for coaling on any one of the multiple tracks.

The water is supplied to the tank in the tender with the aid of a movable spout. This tank supplies water to the boiler under the direction of the firemen. The tanks hold from 10,000 to 18,000 gallons and a run from New York to Washington would require about 25,000 gallons of water and 11 tons of coal for each of the "President" class. Additional water is taken up, while the train is in motion by scoop from track tanks.

All is now readiness for the crew, the sand boxes having been filled at the time of taking coal. Sand is indispensable and is usually supplied at or adjacent to the coal-handling station. The sand, to be of any use, must be delivered to the sand dome of the locomotive in dry condition so that it will flow freely when needed. Varying with weather conditions, approximately two bushels of sand would be required for the trip mentioned. Sand is quite a substantial item. A truck line may readily pay $500 a year for sand. The sand is used for starting, in order to give the driving wheels better adhesion to the rails. The sand is blown on the track with the aid of a compressed air jet controlled by the engineer in the cab.

The crew arrives and the engineer and fireman sign the book in the master mechanic's office. They look over their $80,000 beauty to see if everything is "O.K." The dispatcher's orders must now be obeyed and the engine slowly moves to the head of the assigned train and the coupling is completed. The engineer and the conductor compare their watches. The leaving time approaches. The tower man gets a signal from the dispatcher's office. A lever clicks, a disk or semaphore changes position. The conductor signals the engineer, who sends the tracks, opens the cylinder cocks, and pulls the lever which controls the throttle valve to the full position. Water from the feed jet ceases in the dome of the locomotive. The stately machine is in motion over the steel rails and we sit back in our comfortable seats while the baggaged and bagged crew on the pulling locomotive watch for anything that looks like danger.

There is plenty for the crew to do until the end of the run is reached. Then the locomotive pulls back the train into the yard. Here the engine stops at the hodgman's quarters, delivers the locomotive to the shop forces, and gives an account of his stewardship in a written report.

What now becomes of the locomotive? In the early days the engineer and the fireman did the cleaning, but as business increased, engines became larger; a group known as "wipers" was engaged to go over the machinery, jackets and tanks, and finally six or eight men had to spend several hours to "wipe" a large locomotive. Now, however, a new plan has been introduced. This process, using what is known as the "locomotive wash rack" rapidly removes the accumulation of oil, dirt and dust by a mixed stream of air, oil and water, played at high pressure on the parts to be cleaned.

When the engine comes in from the run, the ashes are dumped at the cinder pit of the inbounds tracks. Six men now inspect the locomotive and it is then ready to go to the roundhouse for another preparatory period. At the scheduled time it will be tuned up and fired, ready for the next long run.

But, so far as safety is concerned, careful grooming of the locomotive would be unnecessary unless proper signals are installed and kept in good working order, for signals are the "eyes and ears of the railroad."
THE RAILROAD'S EYES AND EARS

The modern complex art of railway signaling, in which the swift, sure power of electricity is taking a more and more prominent role, has its beginnings in the necessity for avoiding confusion and collisions in passenger and freight traffic and in the desirability of giving certain trains precedence over others. One of the first major developments, on a large scale, was the manual block signal system, the chief principles of which are still in use. The lines of the railroads are divided into sections, or blocks, each section protected by signals, and the operators, located in strategically placed stations, control the necessary signals by hand through the manipulation of levers. Such signals are usually of the semaphore type and are operated in three positions: Horizontal means STOP; Diagonal conveys the message, CAUTION; Vertical—the way is CLEAR.

While the manual block system provides protection, it is supplemented and improved by the next step in the evolution of train operation by signals—the automatic block signaling system. Such things as broken rails, uncoupled switches and other accidental hindrances are detected automatically by the electric devices of this system, which supersedes the manual block system, permitting closer train movements since trains following one another are spaced by the automatic signals, the latter having as a controlling media a track relay energized only when rails are unbroken, switches closed and the block unoccupied by a train, engine or car. Trains moving in the opposite direction, however, are protected by the manual block system, although the automatic system acts as a check on the former, giving double assurance of safety.

Large passenger terminals a great many signals are concentrated in a comparatively small area, and the result is a highly evolved pattern of switches, tracks and signals which appear hopelessly interwoven and baffling to one who is not acquainted with the mechanical interties of the system. A good example of this is Union Station at Washington, D.C.

The Washington Terminal Company operates a ground area of 18 acres, including 60 miles of track, and an interlocking network of signals and switches requiring the use of over a million feet of electric wiring. The track arrangement entering from the north consists of three double-track lines converging at the New York Avenue interlocking plant and diverging into ten parallel tracks which run through to the point where they again diverge to 32 station tracks at the K Street interlocking plant.

Another and most recent development in signaling is the color-position-light signal and its increasing use is attributed to its several important advantages over the semaphore. These signals are controlled by continuous track circuits, that is, electrical connections, with the tracks so arranged that the presence of a locomotive or car over a signal zone automatically and instantly sets the lights. Supplementing the signals for general operation are the hand, flag, and lamp signals. For instance, there is the picturesque signal language of the lantern or flag. When the trainman swings his lantern across the track, it means "STOP." Hold horizontally at arm's length when the train is moving, the lantern says to the engineer, "The way is clear."
The same position when the train is standing, sends the message, "Ready to leave." Raised and lowered vertically, the signal is flashed to "proceed." Swung vertically in a circle at half-arm's length across the track when the train is standing, the signal is to "back." But when the train is running and the lantern is swung in a circle at arm's length across the track, the code of the railroad tells the engineer that "the train has parted." If the trainman swings his lantern horizontally above his head when the train is standing, the engineer is told to "apply the air brakes." When the lanterns are held at arm's length above the head while the train is standing, the message to the engineer means "release the air brakes." The flag or the hand, used in these ways, conveys the same messages as the lantern. Another signal recognized by all engineers is an informal but very familiar and urgent one, and it is not necessary for a railroad man to give it. When the engineer sees someone waving any object violently on or near the track, it means to "stop."

These signs are for the eye and ear, while a new and another means of communication in railroad signalization which appeals to a different sense. There has been developed an ingenious system of sound signals, using the locomotive's vociferous whistle. To the uninitiated, these blasts are an exciting experience. Apparently they are sounded at random, but in reality every series of whistles has a meaning, and to those trained they mean every railroad man within earshot listens subconsciously and understands them.

For the benefit of those who have listened carefully to the language of the locomotive and felt curious to understand what it says, these are the messages that come from its steel throat:

One short: "Approaching, stop.
Two longs: "Ralph breaks, proceed.
One long, three short: "Flagman protect rear of train.
Four longs, three short: "Locomotive is at grade.
Five longs, one short: "Flagman protect front of train.
Four short, one long: "Flagman protect rear of train.
Three short, one long: "Flagman is at grade.
One long: "Flagman may return from east or north, under certain conditions.
One long, one short: "Flagman may return from east or north, under certain conditions.
Two longs, two short: "Return sign not otherwise provided for.
Two longs: "Locomotive changing track.
Four short: "Call for signals.
One long and two short: "Stop stranded engine or garbage train or interlocking signal for display signals for following section.
One long, two short: " TYBucking from yard engine, or "hounding to show yard signals.
One long: "Continuous warning whistle.
One long, continuous whistle: "Approaching slack trains, functions, and railroad maintenance work, with falling block signals.
One long, continuous whistle: "Approaching slack trains, functions, and railroad maintenance work, with raising block signals.

The ringing of the locomotive's bell, which sounds a warning in the yards and on the right-of-way, might also be called the voice of the signal system.

The torpedo plays a loud and efficient part in sound signaling. The explosion of two torpedoes is a sharp warning to reduce speed, or for a train ahead, or an obstruction. The explosion of one torpedo will indicate the same as two, although the use of two is required. Trains move with customers and passengers, and a signal is required in the way is cleared. At night, fuses are sometimes used as signals. When the operator of the conductor whistle to get in with the engineer to notify him to stop, to start, to reduce, or increase speed, as the case may be, he pulls the bellcord and passengers hear the familiar "past-go's" of the signal.

Still another group of signals to be assimilated by the railroad man is that which takes in the numerous flag and light displays on the rear-end of a train, in the front of a locomotive, or the rear of the tender or caboose. Each color, light, or flag has a different meaning.

All of these care-fully worked-out sig-naling systems and methods have been gradually built up and perfected along with the development of the railroad and all the trainmen know the signals which go with the operation of the trains, the safety of the people and the protection of goods, and they bring us next to the important question of "Time" and the responsibilities of the train dispatcher.

TIME AND THE RAILROAD DISPATCHER

On the railroad, "Time," it might be said, is a benevolent monster. The hands of the clock daily control the movements of thousands of trains. Time tables are consulted by millions of people scattered in cities, towns and hamlets everywhere. The working of the first major division of the railroad and all the trainmen know the signals which go with the operation of the trains, the safety of the people and the protection of goods, and they bring us next to the important question of "Time" and the responsibilities of the train dispatcher.
worker looks at his watch, the housewife checks her clock, as the last limited fly past city, town and countryside. The city motorist, driving to work in the morning past the railroad station, glances at the clock tower to check his watch, even though he does not catch a train. The railroad agent and ticket clerk receive scores of telephone calls inquiring about the time.

An examination of the machinery by which this split-second accuracy and rigid uniformity of time are brought about, doubtless will interest the layman. On the Baltimore and Ohio, a special department handles the job—the "Time Service Department." Accuracy is achieved by this department through a system of standard clocks located in the office of every train dispatcher, and in every terminal where trains and engine crews are required to register and begin their work. It is the task of certain designated employees of the Company to keep the standard clocks accurate. At noon daily, they receive the correct time by wire from the Federal Government. Should the standard clock be as much as ten seconds fast or slow, it is corrected.

Uniformity of time over the railroad system is brought about by rules that require men in many branches of the railroad to compare their watches with one of the standard clocks at certain specified times. These men include supervising officers, such as road foremen of engines and trainmasters; members of train crews, such as engineers, firemen, conductors and flagmen; employees in the Maintenance Department, such as signalmen, supervisors of track and track foremen. All these men have something to do with the running of trains and each man must have what is known as a standard railroad watch, the product of any one of a designated group of watchmakers, well-known for making time-pieces of enduring accuracy. To insure the safe operation of trains, each railroad man's watch must tick in unison as the fine craftsmanship of the most skilled manufacturers of watches of our day can make possible.

As a further guarantee of uniformity, employees in the branches of service mentioned must take their watches once each month to an official watch inspector for comparison, and twice each year (April and October) for thorough inspection. For this purpose, the Baltimore and Ohio has 136 official watch inspectors, all of whom are practical jewelers and watchmakers. Their work has been examined and certified by the Horological Institute of America, a body sponsored by the Bureau of Standards of the United States Government. These inspectors are located seasonally in the cities and towns along the line of road and, with their cooperation, inspection service is kept at maximum efficiency.

While the main tracks of the trunk line railroads of the country are well protected by modern signaling devices, there are still many miles of single track where trains are permitted to run from block to block, with time accuracy—and that means time-piece accuracy—as their principal safeguard. In emergencies, or on the occasion of violent storms, the signal systems of even the most highly developed main lines may be thrown out of order, and here, again, the un-failing watches in the hands of engineer, conductor and flagman, are the basis of safe operation.

Most of us at one time or another, have seen the engineer and conductor of a passenger train stand beside the steaming locomotive at a terminal comparing their watches at the start of a long run. This is a check that takes place hundreds of times a day on the quarter-million miles of American railroads. The running of trains nowadays, however, is more than the mere job of getting them from one terminal to another on time. Regularity and smoothness of operations all the way are also considered important factors in good railroading. This is why we may often see conductors and flagmen looking at their watches as they pass familiar landmarks, such as towers and bridges along the line, even when passing them at high speed, in order to check the regularity of the run and smoothness of the speed maintained.

HOW TRAINS ARE MOVED

Now we come to another part of the story. Who guides the engineer along the many steel lines of the railroad, through the dense centers of traffic in the big cities, and out of busy railroad terminals—always on time? Unlike this motorist, who not only operates his machine, but also has a choice of the roads he wishes to follow, the engineer controls only the speed of the locomotive, not the route. It is not his job to "steer."

He must follow orders, which are conveyed to him by the highly efficient devices of the modern railroad signaling system. Silently, day and night along his route, lights flash, semaphore arms move, switches turn, controlled by an invisible hand guiding the trains to their destinations. Trust that guiding force to its origin and you will find the railroad train dispatcher sitting at a table in his office, probably poring over his "train sheet."

A superficial glance at the things required of a train dispatcher will convince you that his job is not a simple one. Upon his shoulders rests the responsibility for moving many trains daily in a precise and orderly manner with safety and promptness. In unforeseen emergencies he must decide quickly what to do to forestall costly blockades and to avoid confusion. It is essential that he possess qualities of steadiness, sobriety and reliability, together with initiative and capacity for passing rapid, sure judgment on any given situation.

Assigned to each dispatcher's office is a certain part of the railroad, and all trains entering or leaving that section are subject to his orders. Also subordinate to him are the operators in the towers and telegraph offices located in the territory under his care.

Supplementing the telegraph in dispatching, the telephone has come to be commonly used, so much so that it has long ceased to be a novelty. With the receiver at his ear, instead of his hand upon the key, the dispatcher keeps in constant touch with operators and engineers.

When the dispatcher desires to talk with an operator at a certain location, he "calls" that station by turning the proper key in a cabinet directly in front of him. A bell rings on the operator's end and he quickly answers. Frequently the dispatcher is in touch with several stations at one time, which is made necessary when orders are issued to trains at different locations.

In his important and responsible work, the dispatcher functions hand in hand with time. The standard clock in his office is his most valuable ally. He uses it constantly in directing and following the movement of trains. He uses the minutes and seconds in planning the routes of trains. And time is also vital to him in making the quick decisions that are always necessary.
Now, specifically, just what does the train dispatcher do? For one thing, he compiles daily an elaborate train sheet, which is the dispatcher's record of the movement of trains in his territory. Operators in the telegraph offices and towers out on the line keep him informed as to the time of trains passing those points in an easy-to-read manner, making note of this information on the train sheet. In the case of freight trains, he must ascertain and record the total number of loaded and empty cars in each train and the total "weightage." These facts, studied in relation to each other, enable him to tell which trains to side-track and which to let through, in short, to chart the course of trains through his section.

How does the dispatcher know which train shall precede others? In this he is guided largely by definite operating rules which give the precedence of trains, and it follows that in order to give the passenger train a clear track, the freight train would be diverted or sidetracked at the proper time to enable the passenger train to pass without delay. The same is true of freight trains of different classes. For instance, a freight train which carries stock or perishable shipments is considered fast freight and would be given preference in right of way over a train handling ordinary freight.

When there are many freight trains moving upon the road, the dispatcher's job becomes even more exacting. He must be familiar with the class and capabilities of the engines pulling the trains and, as previously mentioned, must ascertain how many cars, loaded and empty, make up each train, together with the total tonnage. If a freight train consists of 100 loaded cars, for instance, and the gross weight of each car is 90 tons, the total tonnage of that train would be figured at 8,900 tons. Passenger trains, of course, have precedence over the freights and this ever-recurring problem of getting the freight trains out of the way becomes more difficult with each increase in the number of trains handled.

Another interesting chapter in railroading of today and maybe more interesting in these pages, because as a public sees only a portion of its complexity, might be termed the birth, life and death of a railroad ticket.

The Railroad Ticket—Its Birth, Life and Death

Every railroad traveler has heard the trite, courteous and important request of the conductor as he enters a car and starts to check: "All tickets, please." But the ordinary person gives little thought to the origin of this request, which specify the precedence of trains, and it follows that in order to give the passenger train a clear track, the freight train would be diverted or sidetracked at the proper time to enable the passenger train to pass without delay. The same is true of freight trains of different classes. For instance, a freight train which carries stock or perishable shipments is considered fast freight and would be given preference in right of way over a train handling ordinary freight.

When there are many freight trains moving upon the road, the dispatcher's job becomes even more exacting. He must be familiar with the class and capabilities of the engines pulling the trains and, as previously mentioned, must ascertain how many cars, loaded and empty, make up each train, together with the total tonnage. If a freight train consists of 100 loaded cars, for instance, and the gross weight of each car is 90 tons, the total tonnage of that train would be figured at 8,900 tons. Passenger trains, of course, have precedence over the freights and this ever-recurring problem of getting the freight trains out of the way becomes more difficult with each increase in the number of trains handled.

Another interesting chapter in railroading of today and maybe more interesting in these pages, because as a public sees only a portion of its complexity, might be termed the birth, life and death of a railroad ticket.

As the railroad ticket developed, so did its various kinds. The simplest is the local ticket, but its progeny are many, including the one-way, the round-trip, the excursion, the confirmation, the printed destination, the clergy, the conductor cash fare receipt, the interline one-way and round-trip, and third-class and master ticket book.

Upon receipt in the office of the ticket supply clerk the tickets are filed in cases awaiting requisitions from the agents along the line.

When paid for, tickets are consecutively numbered so as to be readily identified in the records.

This might be called the infantile period of the ticket's existence, for the ticket has yet not begun to move, but it does not move when requisitions cannot be filled.

Then it steps into pastime, being taken from the ticket supply case where has been received and sent to the agent, who stores it in his selling case subject to call.

Now the ticket has "gone to school" and the big experiments of its life are before it. It is ready to be sold to the first customer. Suppose it be an interline ticket. The prospective passenger steps up to the little station, says, at Napoleon, Indiana, and expresses a desire to go to Boston, Massachusetts, and in consequence of having a ticket from the case where it has been resting, stamps the date on it and hands it over to the agent in proper amount and the ticket changes hands. It leaves home—for a while. Although the issuing line may not reach Boston, the interline ticket will take care of the passenger to that point, and the passenger will not have to worry about procuring other tickets.

Next the ticket begins its active life. Under its new owner (who really seems to think a lot of it for he carefully preserves it, slips it away, slips it away, slips it away, slips it away), it is passed from one to another, from hand to hand, to several hands, to many hands, to many hands. "One ticket, please," is the cry which brings the traveler a step nearer his goal. After the train is in motion, the ticket is shown to the train conductor (and, perhaps, as well as to the Pullman conductor) and the passenger announces it intention of stopping over in Washington, D. C. The train conductor then punches the Nappanee to New York portion of the ticket, indicating that he has honored it to the end of its run, and written on the back of the coupon: "Off at Wash., D. C." Distinctive ticket punches are furnished to the division superintendents by the supply clerk, and the division superintendents give them to the conductors on their respective divisions. Each punch, different from any other, tells an interesting story to the uninitiated. If the destination shown on a ticket be a point on the parent line, the last conductor examining the ticket and honoring it to destination would retain it and send it along with other collected tickets and his report to the auditor of passenger receipts.

Conductors distinguish passengers in the coaches who have already traded their tickets from those just boarding the train by issuing small train checks which are of different colors to signify various destinations or travel zones. Reverting to the interline ticket to Boston, the various conductors en route, after writing on the ticket, report to the auditor of passenger receipts that they "have honored but not filled" it, this report being made on a special form. On the next to last lap of the trip, the journey is thus recorded: "Conductor takes up the Nappanee to New York coupon of the ticket, sending it to the auditor of passenger receipts, thus the passenger retains the larger portion of the ticket that is good on the foreign line for the remainder of the trip to Boston. This part of the ticket is taken up by the conductor on the last foreign line and forwarded to his auditor for final disposition.

Under the regulations of the Interstate Commerce Commission, used tickets may be destroyed at the option of the carrier after completion of the audit, with some exceptions. The used ticket coupons, however, are held by the Baltimore and Ohio for a period of six months after the audit, and home line and foreign line interline tickets are held for a period of three years after the audit, as the tickets are needed for reference purposes.

A merging machine puts an end to the useful life of the railroad ticket. It again becomes pulp, whence it came.

Accounting For The Tickets

As interesting as the life of a railroad ticket are the records in connection with its collection by the conductor and the accounting through the auditor's office. Cash fares collected by conductors from passengers who have not provided themselves with tickets beforehand are reported and waiting for freight auditor come by and are sured
reported by the conductors on a special form. A separate form is also made of scrip coupons honored. The conductors forward these reports to the auditor, with a report of tickets "honored but not lifted," together with lifted tickets or coupons reaching to destinations on their respective runs. This enables the auditor to keep a complete check of the earnings of the various passenger trains.

When coach fares are collected the conductors issue duplici- cate receipts, one to the passenger and the duplicate portion for the auditor. The cash so collected is deposited by the conductor with the agent at the end of his run. This cash as given to the station agent is deposited by him with his other station receipts in local bank, subject to the check of the railroad's treasurer.

After the conductor has examined and punched all tickets and coupons, local and interline, collecting those terminating on his run, he assembles his reports and arranges the tickets and coupons he has collected, separating coach from Pullman passengers for statistical and rating purposes, and puts them all in a large envelope addressed to the auditor. The envelope is then forwarded by train mail.

These envelopes, filled with tickets, coupons, and so on, which have been collected, and the various reports of the conductors, are found each morning filled high on the mail table in the office of the auditor of passenger receipts. The mail clerk sorts the envelopes according to divisions of the road as represented by the territory covered by the run of each conductor.

The train earnings bureau next receives the envelopes, and from the contents the clerks "work" the revenue and earnings of each train by divisions. After the train earnings clerks have completed their work, the bills of each home interline tickets are assembled into selling station order and filed in the ticket cases. At the end of each month these filed tickets are checked against the agents' ticket reports, and the fares, at which time the tickets are reported, are checked against the authorized tariffs so as to insure proper accounting. Tickets issued by other railroads are assented by the names of the companies issuing them and are checked against the reports issued by the companies with which they are associated.

Having shown what happens to a railroad ticket, we pass on to a kindred subject—the wunderings of a freight car.

PEREGRINATIONS OF A FREIGHT CAR

As soon as a freight car starts on its peregrinations, agents and agencies of the road begin to make records of its travels, so as to render proper charge of shipments. While the actual operation of a freight car in transit is important, equally so is the accuracy of the detailed records of its movement. Upon these records depends the main source of a railroad's life—the revenue which, through the treasury of the company, buys the cars, the motive power that hauls them, and quantities of supplies. Most important of all, these revenues provide the pay rolls for the men who maintain the tracks, men who make records, men who watch over the freight in transit and protect it from robbery, men who are in the signal towers, men who track the platform freight and those who work in the shops to repair locomotives and cars when a wheel has gone flat or some part broken, and other men and many women who form the big "railroad family.

Before freight is loaded, the transportation department has seen to it that the proper type of car is available and that it is in good physical condition. The car is examined as to its roof and sides, and to make sure that the doors fit snugly when closed, so that the contents will not be damaged by dew or wet weather on the road.

The car is then placed alongside the loading platform of the freight shed, and is cleaned and made ready for its consignment of goods. After being weighed, freight is loaded into the car, particular care being taken to pack it so that it will not be tossed around in the car and that the available space is used as far as possible. The car is then closed and sealed.

The merchandise has been brought to the freight station by drays and trucks, with an order from the shipper, and on this order should be given complete information as to the name of the consignee, destination, description of the shipment and whether the shipper wants to specify the railroads over which the shipment will move. In the freight station the orders are taken up and a receipt is given to the drayman for the shipper.

The shipping orders are sent to the freight office for making up the waybills, which show the name of the consignee, destination, full routing and so on. Should the shipper fail to specify the roads over which his shipment is to move after leaving the original line, the original railroad will handle the freight forward to destination in accordance with tariffs in effect at the time. The waybills accompany the shipments to their respective destinations.

The car is next pulled out from the loading platform track and forms one unit of the freight train. At strategic points "classification" yards help to simplify the making up of trains in order to route them economically. The train finds itself on its way to Chicago, passing over several operating divisions, and there are as many operating train crews as there are divisions. The waybills pertaining to our car are passed along from conductor to conductor, usually through the medium of the yard master at each divisional or terminal point.

When the train pulls into a receiving yard at Chicago, the road engine is taken off and a switch engine takes its place. Then the train is split up, the switch engine "drilling" out the cars, shoving those for the freight house on one track, those for truck delivery on another, and those for industrial or private sidings on another. Through this process our car is spotted on the freight house delivery track. It is put in its place as soon as possible after arrival, generally by 7:00 A.M. The waybills are turned over to the agent, who prepares the notions of arrival, expense bills and delivery receipts. Notices are sent to the consignees who sign the delivery slips when they or their representatives send for their freight.

In unloading our car, the freight for delivery in Chicago is taken first and then the freight for other points is either transferred to another car or moved by the conductor to the connecting line serving as a medium through which the shipment is moving toward its destination. It might be, however, that there would be a large consignment for Milwaukee, Wisconsin, the transfer of which might entail considerable expense and time. In this event, the freight would be left in our car which would go on to Milwaukee over another road, or "foreign line," filled up by the freight agent with shipments received from other points for Milwaukee. If room permitted, all freight that could be packed into the car for points beyond Milwaukee would also be stored in this car. Should a similar condition prevail upon arrival of a car at Milwaukee, it might, eventually, be found on the Pacific Coast, for it is not unusual to see eastern road cars in all parts of the country. If the car was loaded with all Chicago consignments, it would have been emptied there and put in shape for re-loading.

The first clearing-house for the records where the location of any car, on the line and off the line of road, belonging to the Company or hired from another company, can be ascertained at any time, is the car service department. With the records of cars moving over all lines of the railroad, thousands of miles apart, or on sidings waiting for loading, the department serves the shipper by being informed where consign- ments are located. To be able to accomplish this service the department has the experience of years plus modern accounting devices, as well as a system of forms that were not just "drawn out." In advance of the purpose, as one would plan a building, but are economical forms that have been made from practical study over a long period of time.

The records are made from freight train reports and show the movement of cars not only over the "home" railroad, but the various lines over which cars belonging to the home railroad may be in transit, as well as foreign line cars moving over the home road.

Transfers are checked at junction points or in the yards as illustrated. The cablistic chalk marks on the cars have
Air conditioning the equipment of railroad trains means that the air is first cleaned—dust, smoke, fumes, stoekers, etc., are removed—and then this pure air is cooled and dehumidified to the proper degree and circulated. Should the thermometer outside register 100 degrees, inside each car of these trains the temperature can be made fifteen or more degrees cooler, if desired, or whatever might be the proper degree of comfort. This is thermostatically regulated.

Each car in these specially equipped trains has its own air-conditioning unit so that any car may be taken from a train without interfering with the mechanical and electrical devices that control the air-tempature, scotching, comfortable effect in the other cars of the train.

The windows of the cars are kept shut purposely, first, so that the air-conditioning apparatus may function properly and, secondly, this practice greatly reduces the noise from outside. Compared to the ordinary train, the interior of the air-conditioned trains is noticeably quiet, which has a pleasant and restful effect on travelers. Altogether, the comfort provided by these trains on hot, humid, muggy days makes summer travel a real pleasure.

The air-conditioning apparatus is operated by a specially designed combination belt and gear drive from the axle of the car. This generator is of sufficient capacity at all times to furnish the necessary power for operating the air-conditioning equipment and simultaneously provides the additional current to the storage battery, so that the equipment can be run for pre-cooling before a car leaves the station, and whether the car is in motion or standing still.

The refrigerator is located under the car and is driven from flexible belts under the car. The air is circulated inside the car, being drawn from the car into the air-conditioning unit under the ceiling at one end of the car. Here it passes over fine-surface cooling coils containing the refrigerant, "Freon." Heat and moisture are removed from these coils, and at the coils are always saturated with moisture, any dust and dirt in the air are also removed. This air, after being cleaned and dehumidified, is then forced through the car so that one side of the car through openings in the upper deck into the car. On the vestibule ceiling of the car is a fresh-air intake, controlled by a damper. This fresh air is filtered for the removal of dust and dirt before it is mixed with the returning air from the car to be again cooled and forced back into the body of the car.

In the Diner

In addition to air-conditioning and air-cooling solid cars, the Baltimore and Ohio, in the last two years, has introduced and developed another feature of summer travel, the pre-cooling of sleeping cars for comfortable night travel.

The pre-cooling arrangement consists of small enclosed trucks in the interior of which are placed 1700 pounds of ice. A tube connects the ice compartment of the truck with the sides of the Pullman sleeping car and when the motor, with which the truck is equipped, is set in motion, air is pumped through the ice compartment. This is done prior to the cars being put at the disposal of passengers, so that on hot, humid nights, those taking the "night train" find the air of the sleeping car cooled in comparison with the outside temperature and can sleep comfortably. This arrangement is in use at all principal terminals of the railroad, and there are now 72 pre-cooling machines in use throughout the system.

Other major innovations on the Baltimore and Ohio during the past several years have advanced travel comfort to a superior degree. The individual seat coach has become the standard coach on trains of the Baltimore and Ohio. It is a great improvement over the old style, double-seat coach in vogue for so many years on all of the railroads.

The reclining-seat car offers overnight comfort for those who do not care to use the sleeping car. By means of cracks each seat can be inclined independently. The arm rests are of sponge-rubber composition, soft and comfortable.
middle arm rests are collapsible and disappearing so they can be removed if desired to permit children to lie down.

The foot rests are also provided, adjusted to the proper angle so that when the seats are in a reclining position, the posture of the occupant is conducive to rest. Thermostatic control is provided on each side of the car to insure even temperature throughout, and, in addition, there are ceiling and window ventilators. Decorations are plain, the car being finished in living-room style. In addition to ceiling lights, small indi
dividual night-lights are furnished so that those who wish to read may do so. There are separate smoking rooms for men and women, with comfortable arm chairs. A novelty of these cars is the lunch room at one end, where simple refreshments can be obtained at all times during the night, with a watchful attendant on hand to supply the various needs.

There is also the individual bed-room car, used on over

night trains for the greater convenience of those who desire more comfort and privacy. These bedrooms are equipped with full-length beds, instead of berths, hot and cold running water, toilet, electric fan, large mirror, thermostatic control, and all the other special conveniences, all within the private room.

The 蓔ock feature of the car is the private sleeping car, containing ten regular sections and four private sections. In the private sections, the beds are slightly recessed to allow standing position in the berths while dressing and undressing. Immediately adjoining are private washroom and toilet.

The tracks underneath all passenger cars have been made uniformly six-and-a-half inches wide and they have also been "rubber

headed," rubber shock absorbers having been put in between all metal parts. This decreases the noise as well as makes for smoother riding.

With the same attention to little things, locomotive engi

ders are trained to take great care in handling their trains to

avoid jolting. Large locomotives are directed so well that trains of steel passenger cars are started and stopped so im
eruptly that the passengers hardly know the cars are moving. Longer locomotive runs have been established so that not so many stops as formerly have to be made to change engines on through runs.

If space permitted, many other more or less important improvements to passenger service could be enumerated here—but the dining car is always an attraction if not a necessity.

The Railroad Refectory

The Baltimore and Ohio has lent itself to establishing on its principal trains the colonial type dining car (most of which have been air-conditioned). This type of car has a very home-like appearance, with an atmosphere of refine

ment. Without sacrificing elegance and hospitality, the management has striven to keep its high standard and make its dining car service everything that might rightfully be required of transportation catering.

One of the major parts of a dining car is the kitchen. Rarely does the public ever see this sanctum of the chef. Like the engine cab's interior, the kitchen is private. Yet, as there would be no locomotive without the engine room, there would be no meals without the kitchen, which is a dynamo of activity and energy.

On one side of the little kitchen are the ovens: above it, the flat stove for frying and boiling. Next to it is the 56

inch hearer for steaks, chops, etc. Adjoining the broiler is the steam table, on which roasts are kept savory and juicy. Then there is the soup tureen. Next is the coffee urn from which is drawn the beverage whose excellence is celebrated. Across the narrow aisle from the frying, the steaming, the broiling, the boiling and the roasting, stand the refrigerators where meats, fish and vegetables are kept fresh. At one end of the kitchen are the warming cupboards containing the platters and all service dishes. Every square inch of space is utilized. The food for the dinner is passed from the kitchen through two small apertures to the waiters in the pantry.

There is practically nothing in the way of food that cannot be prepared in the pantry and kitchen, with their complete facilities, that is prepared in the largest hotels.

The chefs on the dining cars are experts. Any one of them could write a book of master recipes for any kind of meal. Under the chefs are two assistants, one of whom is called the second cook, whose duties are to prepare certain foods, while the other, the third cook, who takes care of cleaning the utensils, dishes, etc., and keeping everything quick and span and in order in the kitchen. The second and third cooks are serving apprenticeships to become chefs some day. In addition, a traveling chef makes the rounds further to indoctrinate other niceties of cuisine and help standardize methods in preparing the meals on the railroad.

Extraordinary care is exercised in the selection of the stewards and waiters, and even in greater degree in purchasing food. Expert buyers do the "marketing" to supply the cars. All cars receive two or three times a month with dry goods and bottled goods, while perishable food is put on every day at Baltimore, Chicago, Cincinnati, Pittsburgh and other Western.

Although stewards are held responsible for their men and supplies in equipment and food and much depends on the skill of the chefs, another principal element in successful dining car operation are the waiters. Their attentive, polite and courteous manner does much toward inviting a "guest" to come again, because he leaves the dining car with appetite appeased and with pleasant recollections. Coming into closest contact with the public, the waiters are especially trained in decorum under all circumstances. Upon them, as well as upon the stewards, the management relics as "host" for the Company.

Finally!

There are many other things of fascinating interest about a railroad, but it would require volumes to hold their stories. Considering that the steam railroad has been in existence but a little more than a century, which is but a small span of years compared with the many centuries of slow animal

propulsion upon which man depended for transportation, the present state of efficiency, reliability, safety and comfort provided by the modern railroad is really marvelous. While other means of inland transport have come into public favor during recent years, it must be remembered that the rail

roads of the country not only are responsible for the quick settling of a people across a continent and unifying them, but even when faced with competition on land, on sea, in air, they still haul 75 per cent of the nation's natural resources and industrial products. Like Tennyson's "Brook," they'll "go on forever."

Copyright, 1933

Baltimore and Ohio Railroad

Copyright, 1930, 1931, 1932

by Scientific American Publishing Co.

Collaboration:

Francis X. Muholland, Asst. to Senior Vice-President, Baltimore and Ohio Railroad

Albert A. Hopkins, Associate Editor

Scientific American

A Glimpse of a Dining Car "Kitchen"

Baltimore & Ohio Railroad Printing Dept., Baltimore, Md.
Railroading after a Century of Progress

Warm in Winter

Cool in Summer