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Informal Working Note 20

YARD HARDWARE--COMPONENTS AND THEIR FUNCTIONS

In our discussions with various railroad personnel, suppliers, and consultants, we are left with the impression that yard design know-how is possessed by a handful of people scattered within the industry. Most of their valuable knowledge is either undocumented or obscurely documented. The need for a systematic compilation of this scattered knowledge is obvious. It is the goal of our current project to fulfill this need. More specifically, we will prepare a handbook-like document from which a person unfamiliar with yard design and operation can learn the essential steps of yard design. This paper, meant to serve as a sample of the type of information we choose to disseminate, will discuss a few hardware components and their functions. It is to be emphasized that the work is still in progress, and the information presented here is preliminary. Our intention of disclosure is to solicit comments and criticisms so that the final document will be more complete and more accurate.

Since the primary function of a classification yard is to shuffle and reassemble heavy rail cars, it is necessarily hardware-intensive. In this paper, a list of hardware components is compiled. In our final document, each of these components and its function will be described and analyzed. Whenever appropriate, an evaluation of its effectiveness, its reliability, its pros and cons, and its relative cost with respect to rival device(s) will be given. Discussion of sample components is given in this paper.

It may seem surprising, but the basic hardware components used in a yard are relatively few. These components are then ingeniously combined to perform a myriad variety of chores. For this reason, the subject under discussion will be divided into the following sections:

A. Basic building blocks

B. Tools available to a yard designer

C. Potential tools.

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It should be pointed out that our discussion will be limited to mechanical/electrical hardware as opposed to computer hardware. We will also limit ourselves to components that are unique to yard operation. As a result, facilities such as electric power supply system, compressed air source, and standard equipment such as rails and locomotives will not be mentioned.

A. Basic Building Blocks

The division between the basic building blocks and the tools available is, at times, vague. As a general rule, a device is classified as a basic building block if it can be purchased off-the-shelf from a supplier, and if it requires little or no design effort for its installation. All other equipment or systems are considered tools. A list of such building blocks is given below.

- Switches
- Retarders
- Radar
- Wheel detector
- Photocell
- Weigh rail
- Presence monitor
- Dragging equipment detector
- Hot box detector
- Rail head oiler.

Among these components, switches, wheel detector, and presence monitor have been chosen as samples to be discussed.

1. Switches

The function of a switch is to switch rail car(s) from one track to another. There exist several types of switches, and each type comes in different sizes. The five types we have identified are

- Simple split switch
- Lap switch
- Slip switch
- Flip switch
- Three-throw point.

A simple split switch is shown in Figure 1. The switching is accomplished by moving a pair of tapered switch rails. The physical movement is accomplished either manually by throwing a switch level that is mechanically linked to the tapered rails, or remotely via an electrical or electropneumatic actuator. The split switch comes in different sizes and different turnout angles. In selecting the appropriate switch, a yard designer should keep in mind the frequency of switching and the relatively low car speed that is common in a yard. In the selection of a power switch, one of the most important criteria is its response time. This is because the response time directly determines the allowable spacing between consecutive cars, or cuts of cars. Most modern power switches have response times on the order of 1/2 second.

Almost all hump yards use remotely controlled power switches in the switching area, that is, the area between the hump crest and the tangent points of the classification tracks. In many modern hump yards, the operation of these switches is controlled by analog or digital computers. In a number of yards, the switches located in other areas of the yard are also remotely controlled power switches. Nearly all of the switches in flat yards are still manually operated.

The use of a simple split switch allows one track to fan out into two. If further fanout is desired, a second split switch will have to be used. Because of physical limitation, the second switch will have to be placed a certain minimum distance away from the first one. This minimum distance is usually slightly longer than the switch length, sometime referred to as the frog length. The frog length, in turn, is a function of the turnout angle. The existence of such minimum spacing implies that the fanout from one track to many tracks, as is the case in the switching area, will have to be accomplished over a relatively large distance. For a number of reasons, it is sometimes desirable to achieve a quicker fanout. Under such a circumstance, a lap switch is often used.

A lap switch is essentially a compound switch incorporating two split switches in close proximity. It allows one track to fan out into three within a shorter distance than two independent split switches would. The difference between a lap switch and two split switches is shown in Figure 2. It is seen that in order to accomplish the quicker fanout, an additional frog is needed. The use of a lap switch has another disadvantage. Whenever a track circuit is laid under a switch to detect the presence of cars, the switch and its adjoining tracks needed to be electrically insulated. A lap switch, because of its complexity, is more difficult to insulate.

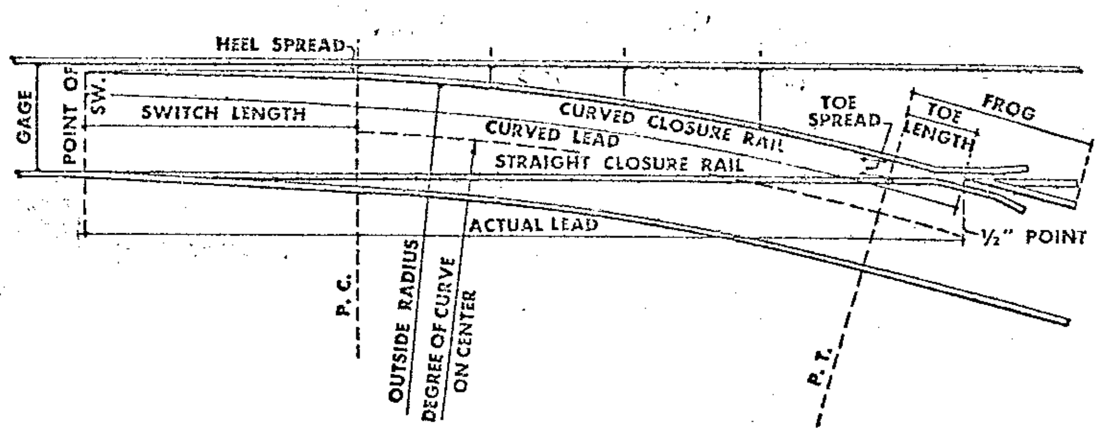
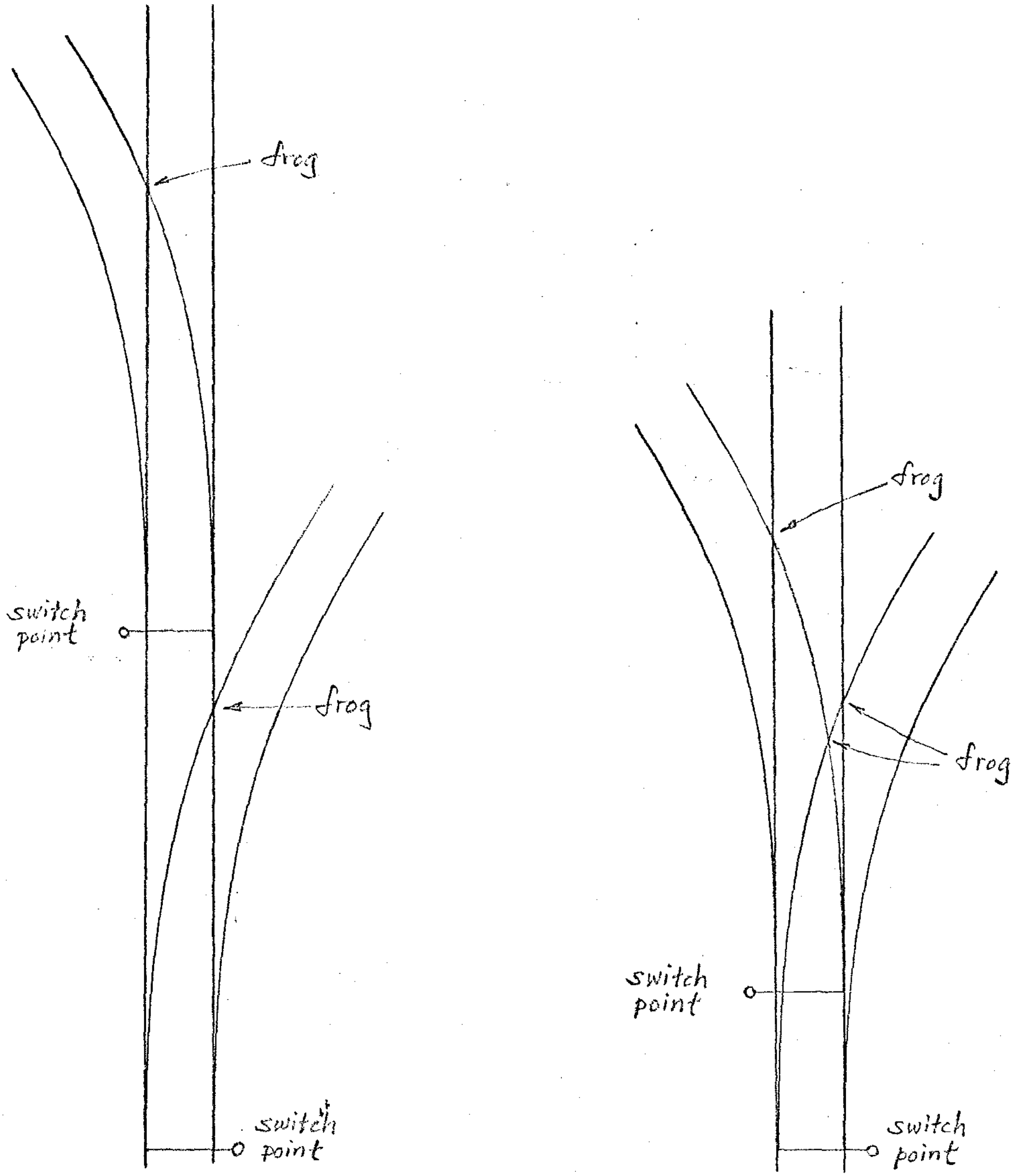


Figure 1 Simple Split Switch



Two Split Switches

Lap Switch

Figure 2 Lap Switch Versus Two Split Switches

At a track crossing, when there is a need to switch cars from one track to another in either direction, a double slip switch will have to be employed. Figure 3 shows the alternatives available at a crossing where a double slip switch is installed. If a switch is designed to perform alternatives 1 and 3 only, then it is called a single slip switch. At a first glance, it would appear that the slip stitches would find extensive use in a yard. In reality, however, they are rarely used in a yard. The reason is because of their complexity; which makes them not only costly to purchase, but also expensive to maintain. The complexity of a double slip switch can be seen in Figure 4.

In our discussions with consultants, flip switches were mentioned. It is certain that the term refers to the type of switches which does not have active throw mechanisms. Instead, the switch is activated by oncoming cars. It is not clear, however, at what type of track junction is the flip switch used, and whether it operates in both directions. The literatures we have do not give any information about flip switches; which led us to believe that this type of switches is not commonly used.

There exists a three-way switch called three-throw point (see Figure 5). It allows symmetrical branching of one track into three. Again, the complexity of it limits its use to certain special circumstances such as in the herringbone track arrangement.

Before leaving this section on switches, we would like to mention the switch point lock and the tandem switch design, neither of them is a type of switch. A switch point lock is an accessory device that temporarily locks a switch into one position so that it would prevent an unwanted locomotive or train from entering a particular track. It is, in reality, a safety device. A tandem switch design, by no means a universal terminology, is a special type of track layout (see Figure 6). This layout allows the switches to lie closer to one another, thus saving the steps and time of the switch operators. The tandem switch design is mostly used in flat yards.

2. Wheel Detector

A wheel detector is a rail web mounted device that detects the passing of a wheel. Wheel detectors are indispensable in the performance of a number of automated functions in a yard. They are an integral part of the ACI system, in-motion scale, power switch, or hot-box detection system. They are also installed to perform car-velocity measurement and many other tasks.

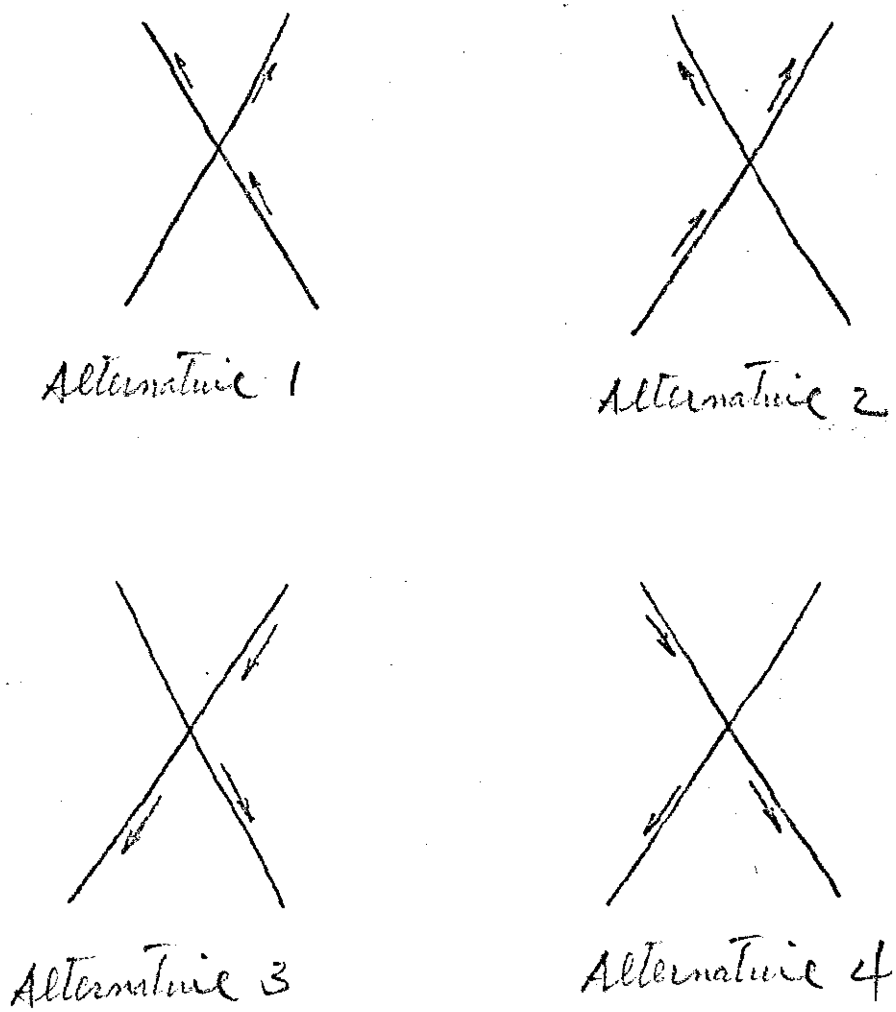
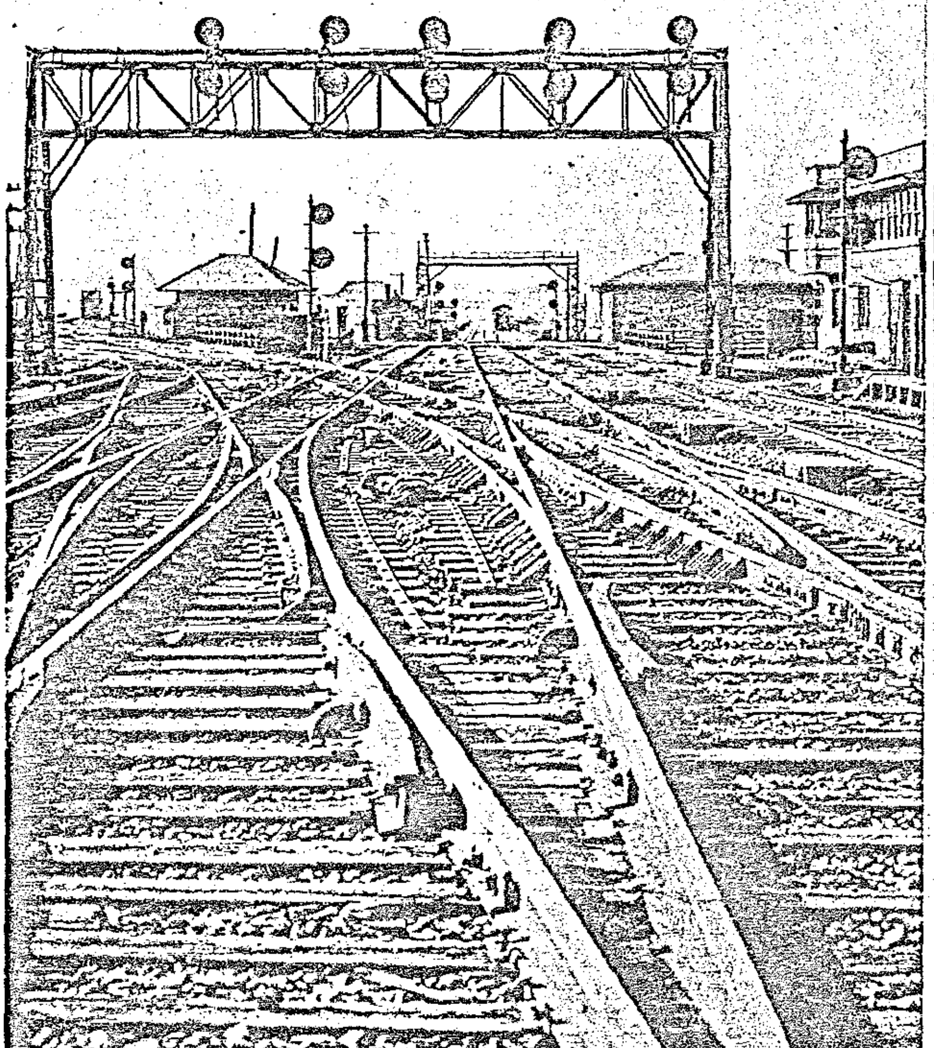


Figure 3 Function of a Double Slip Switch

ABEX CORPORATION



DOUBLE SLIP SWITCH

Racor slip switches are made in accordance with A.R.E.A. plans and specifications and are recommended for use in yards and terminals where a minimum of space is available for switching movements. Added safety and economy can be obtained by using Racor Type "SMJ" and "MF" vertical rods, Racor adjustable braces and Samson switch points with undercut stock rails.

Detail plan will be furnished upon request.

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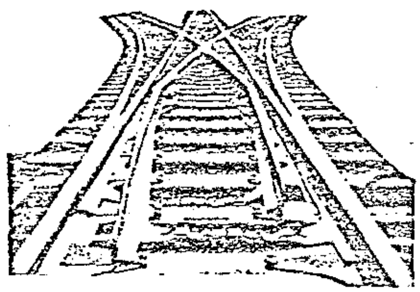
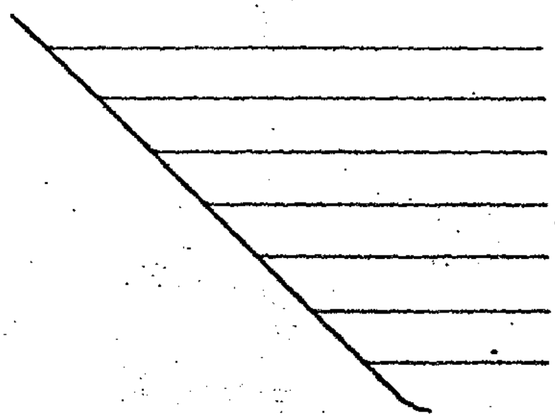
Figure 4

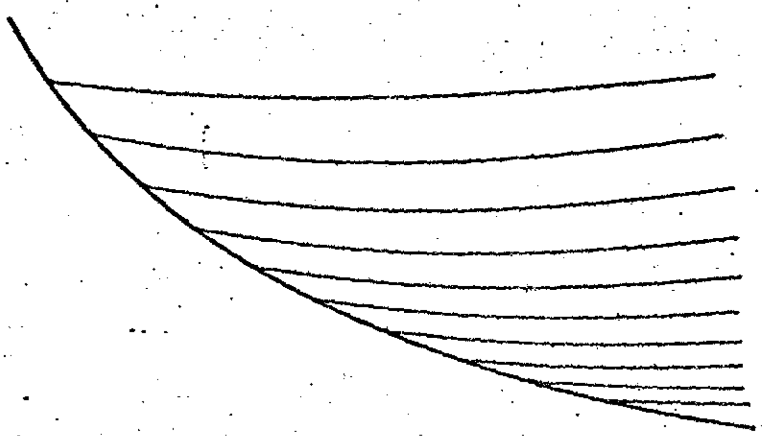


Three-throw point

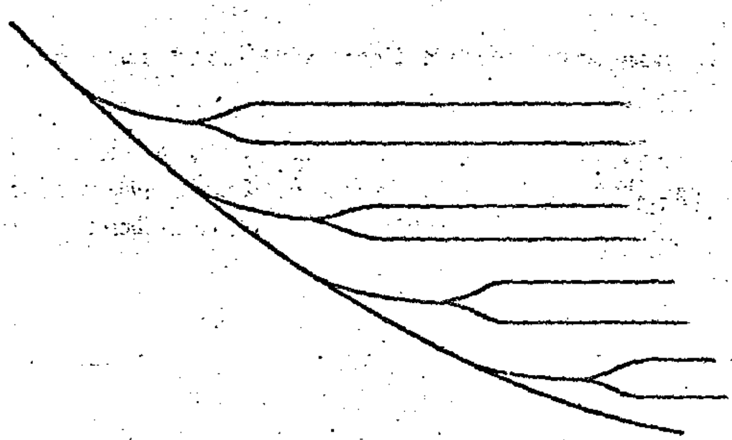
Figure 5



(a) STRAIGHT-LADDER CONFIGURATION



(b) CURVED-LADDER CONFIGURATION



(c) TANDEM (Combination) CONFIGURATION

FIGURE 6: FLAT YARD SWITCHING AREA DESIGN ALTERNATIVES

The operation principle of a wheel detector is simple. The passage of a ferric wheel will alter the magnetic field that exists in the neighborhood of a rail section. The change in magnetic field will then induce a current in a nearby coil, and electronic detection of this induced current signifies a passing wheel. In a wheel detector made by General Railway Signal Company (GRS), the magnetic field is supplied by a permanent magnet. The pickup coil and the permanent magnet are enclosed in a single package mounted on one side of a rail. The WABCO wheel detector features an electromagnet. It has a transmitter section that houses a field-generating coil and a receiver section that contains the pickup coil(s). The two sections are bolted on opposite sides of a rail. Two pickup coils are embedded in the receiver section in WABCO's directional wheel detector.

The simplicity of the magnetic wheel detector should make it a very rugged and reliable instrument. Surprisingly, however, the SRI project team has heard a number of complaints about its frequent failures. Although the statistics of the breakdown frequency and the nature of these failures are unknown, we suspect that they may be the result of physical damage such as that caused by dragging equipment. Another common complaint is excessive initial cost.

3. Presence Monitor

This is an electronic device designed to detect the presence of railroad cars and locomotives on a short length of track (30 to 100 ft). The operation principle of the WABCO device is a wire loop in a figure-eight configuration which is an inductive element that controls the frequency of an oscillator. The presence of a car, or any metallic mass, over this wire loop reduces the inductance of the loop, thereby increasing the frequency of the oscillator.

The amount of frequency shift is typically 1 to 2 percent. This small frequency shift is more easily detected by a heterodyne process that capitalizes on the phenomenon of beat frequency.

The figure-eight loop is fastened to the ties. Unlike a track circuit, it requires no electric connection to the track. Common applications of the presence monitor are electric switch locking, switch-lock release, and track-occupancy or track-clearance indication.

B. Tools Available to a Yard Designer

A list of the available tools, by no means complete, is given below. As will be seen, many of the tools have been developed into well refined systems.

- Locomotive speed control system
- Retarder speed control system
- Track circuit
- Movement indicator
- Cut length measuring system
- Track block indicator
- Car space system
- Retarder occupancy relay
- Movement indicator
- Shove indicator
- Clearance track circuit
- Approach track presence
- Stall indicator
- Closed-circuit TV camera
- Flashing lamp
- Audible alarm.

As before, only a few of the above items are chosen as samples to be discussed in this paper. They are: (1) Retarder speed control system, (2) Track circuit, and (3) Cut length measuring system.

(1) Retarder Speed Control System

In a modern automated hump yard, the master, the group, and the tangent-point retarders are controlled by a computer oriented feedback system. In order for the process control computer to control the squeezing force of a retarder so as to achieve a desired exit speed of a car, the following information is needed.

(a) The presence or the imminent presence of a car in the retarder

(b) Actual car speed in the vicinity of a retarder

(c) Weight of the approaching car

(d) Rollability of the approaching car

(e) Distance to go before coupling in the case of the tangent-point retarder, or in the absence of a tangent-point retarder, the group retarder.

The hardware components that could be used to obtain the above information are described as follows:

The presence of a car can be determined by either a presence monitor, a track circuit, or a wheel detector. The speed of a car can be determined by a pair of wheel detectors and a clock (the process control computer usually has an internal clock). More commonly, the speed of a car is measured by a doppler radar. The advantage of using a doppler radar is that it will give continuous speed information within the operating range of the radar. The disadvantage is that the radar can sometimes be "confused" by weather element, the presence of other cars in the line of sight, etc. The weight of a car is usually measured by a weigh rail installed between the crest and the master retarder. The rollability measurement is also done between the crest and the master retarder. It can be measured either by two pairs of wheel detectors or by a radar and one pair of wheel detectors. A number of factors would influence the rollability of a car. Among them are weather elements such as wind and rain, condition of the track, and curvatures along the track. Since the effects of many of these factors are difficult to predict, the rollability information is always the uncertain link of the system. Finally, the distance-to-go measurement is usually made by a track circuit.

Utilizing the weight, rollability, and distance-to-go data, the computer would calculate a desired exit speed from the retarder, which then establishes a desired speed profile within the retarder. By comparing the actual car speed with the desired speed profile, the computer would determine the appropriate squeezing force required of the retarder.

The above is a simplified description of the retarder speed control system. Detailed information can be obtained from the suppliers. Since the system is well developed, future yard designers need not concern themselves with the intimate details of the system.

(2) Track Circuit

A major element of most automatic retardation systems is the determination of how far a car must travel before coupling with another car on its designated classification track. This information is used to calculate a retarder exit speed, which will ensure that coupling speeds are below an appropriate level and, at the same time, will minimize the number of card that stop short before coupling.

This distance-to-couple measurement is usually made by track circuits on the classification tracks. One method for determining the distance to couple is to measure the impedance of a classification track from the clearance point to the nearest axle of the car that last entered the track (the axle acts as a shunt across the track circuit). Because the impedance of the rails varies directly with the distance from the circuit origin to the nearest shunt, it is possible to correlate impedance with distance to douple.

(3) Cut Length Measuring System

When a cut of cars is routed through the classification area, it is necessary to know the length of the cut. This measurement is easily made by using a radar to obtain the speed of the cut and by installing an interruptive optical system (consists of a light source and a photocell situated on opposite sides of the track) to measure the transit time of the cut. Like many of these available-tool systems, the necessary calculations are done in the process control computer.

C. Potential Tools

In this category, we include the state-of-the-art components or systems. Items that fall into this category include:

- Advanced wheel defect sensors
- Advanced speed control devices
- Automatic pin puller.

As an example of the type of information we choose to disseminate, the Dowty System, which is a distributed speed control device will be discussed.

1. Dowty System

This is a non-clasp-type device first devised by Dowty Mining Equipment, Limited of England. It is also called an "oil pressure" retarder. It consists of a series of hydraulic cylinders bolted to the gauge side of the rail. A sliding piston in each cylinder contacts the approaching wheel flange. As the piston is depressed by the moving flange, oil is forced to flow from one chamber to another within the cylinder unit, resembling the action of a shock absorber.

A unique feature of this device is that it has a speed-sensing capability that allows presetting of an adjustable threshold. If the car speed is below this threshold, the piston will depress with virtually no resistance; otherwise, an internal valve is automatically closed and oil is forced to flow through small orifices, thereby creating resistance to motion. These two operations are illustrated in Figure 7 which is a simplified drawing of the cylinder unit to show the principle of operation. As the piston is depressed slowly, oil flows from the cylinder to the cavity in the piston via the speed-control valve openings. These openings are large enough so that there is virtually no resistance to the oil flow. If the piston is depressed at a speed above the threshold, which is determined by the loading of the calibrated spring and the openings of the speed-control valve, these openings will be closed. Further depression of the piston increases the oil pressure in the cylinder, which raises the pressure-relief valve. Exposure of the orifices allows oil to flow again to the cavity in the piston but with increased resistance.

The Dowty unit illustrated in Figure 7 acts only as a retarder. With a modified unit called a "booster" retarder, cars can be propelled as well as retarded, and such a system has full control over car speed. A high-pressure hydraulic pump is required. This is demonstrated at Tinsley Yard near Sheffield, England, which consists of a main yard and a secondary yard with its own hump 3300 ft away from the main yard. Cars are moved from the first hump to and over the second hump without locomotive assistance. The Dowty booster-retarder system installed at Tinsley, however, has developed many problems related to the leakage of hydraulic fluid, and the newer yard installations generally do not use these units.

The Dowty system has been installed in classification yards in England, Australia, South Africa, and Japan. The Burlington Northern (BN) has also experimented with these retarders on test tracks in flatyards at Spokane and Denver. Their operational use

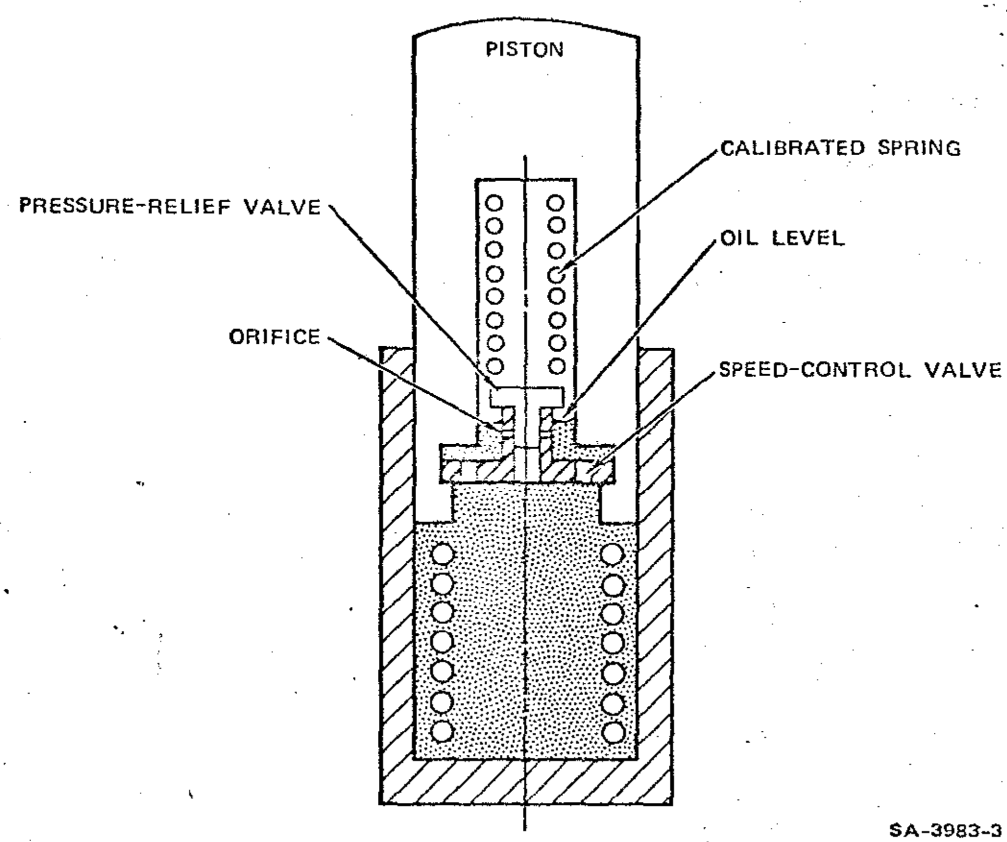


FIGURE 7 DOWTY CYLINDER UNIT

has led to some modifications and improvements in the design and specifications, and these have reportedly increased the service life and reduced the maintenance cost of the units. The special features and merits of the Dowty system are that it:

- Is non-clasping
- Is uninfluenced by wheel contamination
- Emits no wheel-squeal noise
- Has adjustable threshold speed
- Can boost as well as retard speed with the addition of a booster-retarder.

Distribution

Project 6364 team & file
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