Locomotive Maintenance Correspondence Forum

1943

J. E. Goodwin, President

C. M. Lipscomb, Sec.-Treas.

The L. M. O. A. sponsors roundtable discussions of six timely problems —Supplemented by a study of the railway machine tool situation

THE leaders of the Locomotive Maintenance Officers' ssociation decided early this year that because of the ressure under which the members of that organization re working, it would hardly be advisable to attempt carry on committee work during the current year. On e other hand, there was a pronounced feeling that ever was there a time when it was more important r the members of the association to give thought and udy to the many difficult problems and situations involved in attempting to keep the motive power in prime ndition, with the shortage of critical materials and anpower.

Meanwhile, the rather remarkable success that has llowed the Roundtable discussions inaugurated by the *ailway Mechanical Engineer* last April, suggested the ea that the equivalent of committee reports in a "Convention-in-Print" could be achieved by having the Association sponsor a series of intensive roundtables, rough correspondence, of a number of questions of pecial interest, a solution or better understanding of hich would be helpful at this time. The fine spirit in hich railway mechanical officials participated in these oundtables is a matter of deep gratification.

The editors of the *Railway Mechanical Engineer* have pplemented this with a study of the machine tool requirements on the railways, which was made possible through the generous co-operation of the railway mechanical departments.

Officers of the Association

The officers of the Locomotive Maintenance Officers' Association are: President, J. E. Goodwin, assistant chief mechanical officer, Chicago & North Western, Chicago; first vice-president, F. J. Topping, master mechanic, Chesapeake & Ohio, Hinton, W. Va.; second vice-president, S. O. Rentschler, mechanical superintendent, Southern district, Missouri Pacific, St. Louis, Mo.; third vice-president, C. D. Allen, master mechanic, Chesapeake & Ohio, Silver Grove, Ky.; and secretary-treasurer, C. M. Lipscomb, assistant to production engineer, Missouri Pacific, North Little Rock, Ark. The members of the executive committee are F. J. Topping (chairman); George Crowder, superintendent motive power, Georgia & Florida, Douglas, Ga.; W. P. Buckley, shop superintendent, Chicago, St. Paul, Minneapolis & Omaha, St. Paul, Minn.; W. E. Vergan, supervisor air brakes, Missouri-Kan.-Tex., Denison, Tex.; G. A. Silva, supt. locomotive maintenance, Boston & Maine, Boston; and G. E. Bell, gen. for. Ill. Cen., McComb, Miss.

The association's advisory board consists of P. O.

Christy, general superintendent equipment, Illinois Central, Chicago; D. S. Ellis, vice-president, Lima Locomotive Works (formerly chief mechanical officer, Chesapeake & Ohio, Pere Marquette and Nickel Plate); O. A. Garber, chief mechanical officer, Missouri Pacific; J. Roberts, managing director, National Railways Mu[illegible] tions, Ltd. (formerly chief of motive power and ca[illegible] equipment of the Canadian National Railways); and Daniel J. Sheehan, superintendent motive power of the Chicago & Eastern Illinois.

Roundtable Discussion on Flame Hardening

Question—Have you used flame hardening on locomotive parts? Has this process helped to solve mater[illegible] shortage problems?

Anticipates Longer Life Of Parts Subjected to Wear

It was not until a short time ago that the Boston & Maine started to experiment with flame hardening. The first step was the construction of a machine which could adequately take care of the great variety of work naturally associated with the back shop. The machine, constructed in the shop, was built after plans supplied by the vendor, with few changes.

Up to the present time experimental work has been done on crosshead guides, radial buffers, chafing irons, stoker conveyor screws, stoker screw racks, spring saddles, motion links, lead truck rockers, gun iron shoes and wedges, valve crosshead guides, valve guide plates, valve crossheads, union link pins, driving box wearing plates and hammer dies. Plans are being made to flame harden multiple wear guides as soon as special heads are available.

Considerable work has been done on guides to determine deformation and necessary corrective heating, but as yet definite conclusions are not available. On valve crossheads it has been found most advisable to first harden the sides, which have the larger surfaces, and then the top and bottom, being careful to raise the flame while passing over the combination lever middle pin hole. By following this procedure, the hazard of cracking is greatly reduced. Some of the work has been done on material built up with Oxweld M & W steel, which seems to respond quite well to the treatment.

In working with various kinds of material it has been found that cast iron responds most favorably to flame hardening, and at the present time seems to present the most promising field.

As to the shape of the work hardened, a certain amount of trouble has been encountered with thin sections, where deformation has been quite considerable at times. On large bodies there has been almost no trouble of this kind.

Of considerable interest has been the flame hardening of No. 4 Nazel hammer dies. Dies so treated have stood up with negligible wear for a considerably longer time than the conventional die.

Aside from the work on dies, we have nothing to report on wear characteristics of work flame hardened in our shop, as the service has been too short. We are constantly changing our procedure and should soon have developed a quite satisfactory set of data from which to develop interesting conclusions. All the work enumerated above has a large bearing on the saving of material. We are anticipating long life of flame hardened parts.—*W. H. Ohnesorge, Shop Superintendent, Boston & Maine, North Billerica, Mass.*

Results Demonstrated

We are working on and making up a flame hardening set-up for our smith shop. We expect to have it completed and installed shortly.

However, we had a demonstration within the past year by the Oxweld Railroad Service Company, at which time we flame hardened the following: Steam hammer die block, top and bottom guides, two stoker screws, stoker pinion gear, stoker gear, spur gear, spring saddle, rocker seats for engine truck, and valve crosshead.

I believe that steels that contain at least 0.35 per cent carbon and over ca[illegible] successfully flame hardened. After a[illegible] flame hardening is only surface hard[illegible] and the surface to be treated must be [illegible] from seams and laps, pits and blow h[illegible] If we hold our flame hardening to ma[illegible] chined steel parts, such as links, [illegible] blocks, wrist pins, knuckle pins, [illegible] crossheads, engine truck rocker [illegible] guides, cradle hangers, gears, etc., I [illegible] that longer wear resulting in less fre[illegible] renewals of parts will be obtained.—*E. [illegible] Koschinske, Superintendent of Shop[illegible] L. & W.*

Used Extensively on T. & P.

We have had flame hardening equipment [illegible] use at our shops at Marshall, Tex., [illegible] several years. We are continually [illegible]

Operations Using Oxweld Flame Hardening, Texas & Pacific

Operation	Brief Description	Remarks
Harden top and bottom engine truck and trailer rocker seats	Machine to undercut seats, build up with ¼ inch "MW" steel and harden to 500-575 Brinell	Originally necessary to re[illegible] heavy power each shopping. E[illegible] returning to shops with flame [illegible] ened seats in good conditio[illegible]
Harden wearing surface of passenger car truck bolster wear plates	Cut spring steel 6 inch x 8 inch and harden one side to 550-600 Brinell	Wear plates of flame harde[illegible] terial on cars returning to [illegible] in good condition. Origina[illegible] sary to renew each shopping
Passenger car center plate wear liner	Cut boiler plate ring on shape cutting machine. Specially treat by packing in box of Quicklite case hardening compound and heat 5 hr. at 1600 deg. F. Remove from furnace and let cool in box before removing. Flame harden to 500-550 Brinell and grind to smooth surface.	Rings now under test made [illegible] manner. Original steel rin[illegible]
Flame hardened knuckle pins and case hardened bushings	Knuckle pin flame hardened to 500-550 Brinell. Bushing pack hardened	Knuckle pins and bushi[illegible] under test on several engines. [illegible] indicate satisfactory perform[illegible]
Driving box hardened steel hub liner on wheel center	.45 to .50 carbon steel liners flame hardened to 500 Brinell	Several engine sets applied [illegible] results
Hardening of teeth in ratchet track jacks	Build up teeth with Oxweld "MW" steel and harden to 650 Brinell	Previously built up lip wit[illegible] steel and not hardened
Manufacture of hardened flue rumbler bands	Flame hardened band for use in removing scale from flues	Originally purchased from [illegible] turer. Necessary to repla[illegible] few months. Flame harde[illegible] now in service 2 years
Manufacture of gear for pile driver	Scrap axle steel flame cut out on flame cutting machine and teeth flame hardened	Several gears in service [illegible] factory service. One [illegible] bought new cost $195 from [illegible] turer. Cost of gear as [illegible] $21.00
Flame hardened links for test of roller bearing link block	Flame harden link block bearing surfaces	Test now being conducted
Flame hardening of valve crossheads and crosshead guides	Cross heads and guides flame hardened to 500-550 Brinell	Several engines now equipped [illegible] good results
Flame hardening of guides	Flame hardening wearing surfaces of main crosshead guides	Standard practice. Results [illegible] tory

…e of this machine on locomotive and car …ts, as well as on parts of work equip…nt. We have found the practice of flame …rdening parts materially increases the …e of the part, decreases maintenance cost, …d also assists in solving the shortage of …terial problem. Accompanying this is a …t of a number of typical items on which …e have secured very satisfactory results.—*…J. Prendergast, Mechanical Superinten…nt, Texas & Pacific.*

…ear is Reduced …n Critical Parts

…ame hardening is the name given to a …at treating process which hardens the …rface of metal to a depth of 1/16 inch to … inch. The center, or core, of the piece …s not altered in any way.

The fundamental principles of flame …ardening do not differ in any way from …y other method of hardening. The first …d most essential requisite for any hard…ning process is the chemical composition …f the metal to be hardened and this may …e expressed as the "hardenability" of the …etal.

We have applied flame hardening to sec…ons of parts requiring surface hardness and a tough, ductile core; such parts as gear teeth, engine truck rockers and seats, trailing trucks and seats can be successfully flame hardened on the wearing surface provided the carbon content of the steel is in the vicinity of 0.35 per cent. This carbon element is the principal hardening element in steels and in the plain carbon steels the carbon content must be 0.25 per cent or above, before any appreciable hardenability can be obtained. Alloys may be added to increase the hardenability of the steel and these alloying elements may be added individually or in combinations of two or more. The most commonly known alloying elements used to increase the hardenability of steel are chromium, manganese, tungsten, vanadium and molybdenum. Nickel and silicon will increase the hardenability to some extent but they are principally toughening elements.

In flame hardening, the carbon content of the steels as a whole must be sufficiently high to harden; a low carbon steel cannot be hardened by flame hardening. Also, in flame hardening as in any other method of hardening, severe stresses are set up by the rapid quench, and these stresses are often sufficient to cause warpage. When heat is applied rapidly, thermal checks will result; these checks often progress and cause failures, and all of this must be given close consideration in the selection of parts for flame hardening.

We have in the past and are now applying flame hardening to such items as driving box saddles, engine truck rockers and seats, trailing truck rockers and seats, as these are the only items for which we have jigs and suitable tips at this time.

However, even these few items to which we are now able to apply flame hardening have effected a considerable saving of critical material for us, in that it has reduced the wear on these critical parts.—*S. O. Rentschler, Mechanical Superintendent, Missouri Pacific.*

Alleviates Material Shortage

We are now flame hardening the following locomotive and car material with good results: Guides; wearing parts on engine trucks; tender equalizers for 4-8-4 type (Class T), 2-10-2 type (Class R) and 4-6-2 type (Class K) locomotives; chafing castings between tender and engine; stoker conveyor worms and spring saddles. It is felt that this flame hardening has contributed to some extent in alleviating the material shortage.—*A. H. Mitchell, Superintendent Shops, Lehigh Valley, Sayre, Pa.*

Roundtable Discussion on Engine Terminals

Question—Has any improvement been made in reducing the turning time of locomotives in your terminal in recent years? What facilities or methods have been responsible for this improvement?

Speeding Up Operations

For a number of years, a campaign has been carried on to reduce locomotive terminal time at all major terminals of the New York Central, to keep the power in actual road service as much of the time as possible and reduce the number of units in service to a minimum. This program served as a training period prior to the emergency, and has proved invaluable in handling the present business.

Formerly, the terminal facilities were thought adequate to handle the power rapidly. However, with nearly double the number of dispatchments, it is recognized that some changes, such as additional cinder pits and trackage in terminal territory, could be made which would speed up the handling of this extra load. Due to material and man power shortages, these improvements are out of the question at this time, and the situation must be met by taking up all the slack and speeding up the maintaining procedure.

Locomotives arriving on the coal dock are looked over immediately by the machinery and air brake inspectors, who phone their report to the work report clerk. The incoming engineer is required to make his report immediately on arrival. Thus the work report is completed as soon as possible, in order that the dispatching foreman may have this information well in advance of the locomotive coming into the house, thus giving him time to line up his forces for the necessary repairs and servicing. He can also give an early estimate as to the time the locomotive will be available for service.

A hostler, stationed at the coal dock, assists the inspectors in testing for pounds, steam leaks, etc., and when inspection is completed, he supplies the locomotive with sand, coal and water and delivers it to the cinder pit.

All fires are dumped on main line power to permit inspection of flues and firebox, as normally locomotives dispatched run from two to six divisions before entering another terminal. The boiler inspectors or hot men enter the firebox as soon as the fire is dumped, make a close inspection and take care of any minor repairs necessary, including cleaning off the flue sheet, hooking out flues that may contain clinkers, and making repairs to the arch.

The success of this program depends on the ability of the dispatching foreman to plan his work and instruct his forces so that his plans are carried out smoothly and all the slack is taken up as the locomotive progresses from one operation to another from coal dock to ready track. A well balanced, thoroughly instructed terminal force under an alert, capable foreman who knows what he wants and understands how to make his wants known to his men, produces surprising results. An average terminal time of four to five hours per locomotive during a twenty-four hour period is not uncommon. This average includes washouts, flue blowing and any other work requiring more than twenty-four hours to complete, so in many cases locomotives leave the ready track in one and one-half to two hours after their arrival.

Another highly contributing factor in reducing terminal time is the amount of work performed at monthly and quarterly inspections. A policy of close inspection and extensive repair at the time locomotives are cut out at these periods puts them in condition to run through the intervening time with very little attention of a time consuming nature.—*R. F. Batchman, Asst. General Foreman, New York Central, Toledo, Ohio.*

"A Stitch in Time Saves Nine"

There are several items that enter into the turning of engines at terminals, such as the program of quarterly tests for rods, pistons, crossheads, valves, etc., which parts are removed and sent to the main shops, where they are Magnua-fluxed and worn parts replaced. Stokers, drawbars, injectors, boiler checks, etc., are cleaned, inspected, and the necessary work performed. Engines are serviced not at the time of despatch, but when they arrive from the cinder pit. Washing of superheater units has reduced the maintenance, in that the sludge build-up in the units is removed at the time of each washout period. With the power in good condition, under the above program, it is now possible to turn an engine in *30* minutes by cleaning the fire and servicing the engine on the despatch track.—*Foreman.*

Factors That Have Demonstrated Their Value

There has been the greatest improvement made in reducing the turning time of locomotives in this terminal in recent years, due to the application of roller bearings on freight and passenger engines, locomotive and tender.

The force feed lubricator, as applied to Missouri Pacific engines—both passenger and freight—has been another important factor in reducing the turning time of locomotives and allowing us to get more miles in the aggregate per month. Also there must be taken into consideration the reduction in the roundhouse running repairs brought about by proper force feed lubrication.

New power, with complete roller bearing applications, is also equipped with the 4-in. superheater tubes where type E units have been used; this is one of the greatest improvements that could be made to a locomotive. The change from 3½-in. to 4-in. tubes makes possible several round trips between St. Louis and Kansas City in fast freight or passenger service, without boring flues.

Another factor of prime importance which has been responsible for cutting down the time the locomotives are held out of service in the engine house, is the provision of adequate drop pits.

The Lidgerwood as used and properly handled in the turning of tires, with a competent man in charge of the work, has reduced the time out of service of our passenger and freight locomotives.—*Joseph M. Whalen, Master Mechanic, Missouri Pacific, St. Louis, Mo.*

Roundtable Discussion on Finishing Cylinders

Question—Which is better—boring, grinding or honing—such parts as air brake pumps, feedwater heater pump cylinders, reverse gear cylinders, etc.? Why?

Is Honing Necessary?

Honing is a super finish for grinding, but is it necessary? Grinding gives an excellent finish and leaves microscopic areas for the oils to cling to. Our pumps under normal operating conditions run their mileage and are in good condition when dismantled. Ring wear is very slight, which proves they must be moving over a smooth surface.—*Machine Shop Foreman.*

Grinding, Accurate and Smooth

We are grinding our air brake pumps and feedwater pump cylinders, as well as our reverse gear cylinders, and we feel this is more accurate and a much smoother finish than the boring.

We do not have a honing machine of sufficient capacity to do this same class of work, but personally I feel the honing is one step further in the perfection of the work performed.—*Bernard Cook, General Foreman, N. & W., Roanoke, Va.*

Favors the Boring Process

Although we grind such parts as air pump cylinders, feedwater heater cylinders, reverse gear cylinders, etc., in some of our shops at present, I am advocating the following practice which we have tried out and found entirely satisfactory.

On compound air pumps we place the pump cylinder attached to the center casting on a revolving table on a horizontal boring mill, and use a double spindle boring bar which is geared to drive both spindles at the same time at the correct speeds for the large and small cylinders and pilot the bar through the stuffing boxes; if these are out of line, we true them up. The pump is set true with the proof lines on the cylinders at both ends by checking with the spindle at the front end and the back end with the outer support. The cylinders next to the spindle are bored first. The table is then revolved and set true with the bored cylinder from the outer support by using a plug in the outer support bearing, to which an indicator is attached. After this is done the table is locked and the other cylinders are bored. We then lap all four cylinders with an expansion lap. This method is faster than grinding and we have increased the mileage on our pumps, as compared with other methods. The finish obtained in the cylinders by this method is equal to, if not better than grinding.

The lapping is done on the horizontal boring mill by the use of a shop-made expansion lap, which automatically centers itself and gives us a perfectly round hole and parallel full length of bore.

The same method can be used on the other type of equipment referred to.

The reason for this method being an improvement is that stock necessary to remove is taken out faster than grinding and although a boring tool can be used on a Micro grinder, it is a slow operation as compared with using a horizontal boring mill, where you have the necessary power and feeds. Carboloy is used to further speed up the boring operation.—*J. I. Stewart, Supervisor of Shop Machinery and Tools, N. Y. C.*

Manufacturer Prefers Boring

It is our experience that boring is the preferable process in finishing the cylinders of air brake pumps for the following reasons:

We, as manufacturers, must start with a rough casting and this, of course, requires boring, initially, irrespective of the finishing process. By the boring of parallel cylinders simultaneously, the matter of holding to center tolerances and alinement is simplified from that which would obtain, should grinding one cylinder at a time be practiced. Railways, when maintaining these units, have the center spacing set for them, that having been determined by the manufacturer, and their only interest is in truing up the diameter. They can, then, *grind* or *hone* where it would not be feasible for us to do so. We have no difficulty in holding to the limits of plus five thousandths and minus zero, and the surface finish which we obtain is giving satisfaction. Therefore, we feel that to change from the boring process would be economically unjustified. —*L. K. Sillcox, 1st Vice-President, The New York Air Brake Company.*

The Smoother, the Better

Honing, grinding and boring, in that order, in our opinion, are the best methods of finishing bores of cylinders on reverse gears, feedwater heater pumps and air compressors.

Basically, to reduce wear it is necessary to maintain an oil film between the surfaces in contact. An oil film can be maintained most effectively on a smooth finished cylinder bore. An evidence of the value of smooth finishing has been demonstrated by results obtained from "super-finishing". The smoother and better finished cylinder will prolong the life of the piston packing.—*K. D. Read, Asst. Supt. Locomotive Shop, N. Y. C., Beech Grove, Ind.*

Considers Grinding Best

We consider the grinding of air brake pumps, feedwater heater pumps, cylinders, reverse gear cylinders, etc., superior to boring, for the following reasons:

1—The frequency of dismantling air cylinders and center pieces on air compressors is very much less than the dismantling when the boring bar is used.

2—Less material taken out of the cylinders at the repair periods, due to the finer adjustment of the grinding wheel.

3—No trouble to fit pistons and rings, due to the fact that ground cylinders are perfectly parallel, resulting in increased life of air compressor between shopping periods.

4—Increased output of pressure has been proved by average orifice tests which have been made on air compressor test racks.

5—Less time is taken in testing air compressor. At times it is necessary, after fitting pistons and rings closely to a bored cylinder, to run the pump six or eight hours. For ground cylinders, closely fitted pistons and rings, one-half to one hour is all the time necessary for running in an air compressor with ground cylinders. This also concerns feedwater heater pumps.

It is very necessary to maintain cylinders of the reverse gear to as close a limit of 10 in. as possible, to take care of a standard 10-in. packing cup. This can only be accomplished by the grinding method.—*A. H. Williams, General Supvr. Apprentice Training, Canadian National.*

Roundtable Discussion on Welding and Cutting

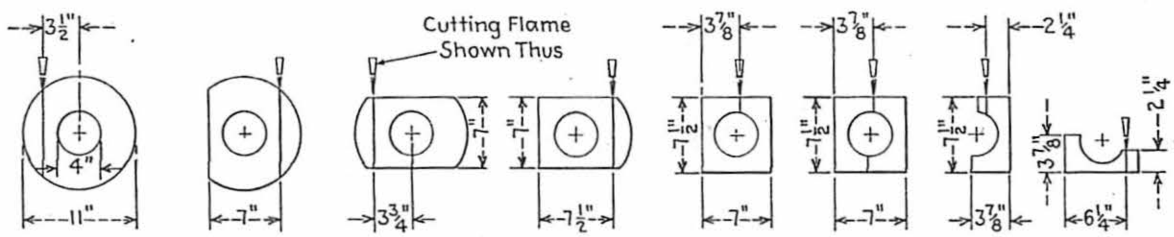
Question—What new applications of welding and cutting have you developed to meet the lack of materials and replacement parts? For instance, on driving boxes, crossheads, brackets and to replace various small forgings and castings?

Welding Proves Profitable

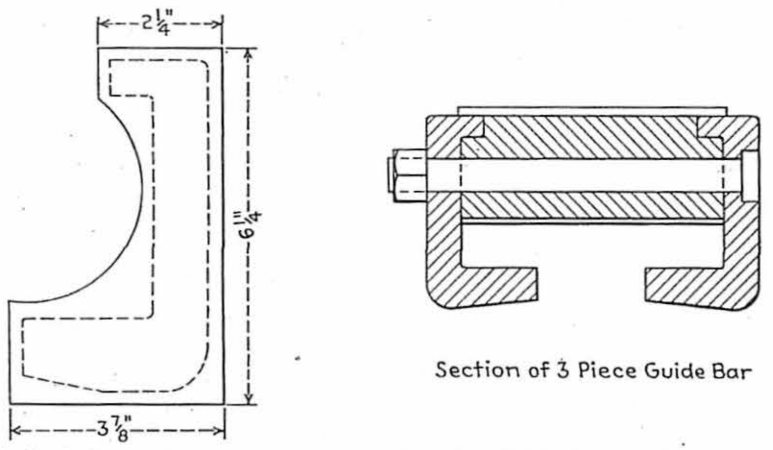
The wartime emergency has caused unusual demands for certain materials, making them critical items. In order to meet the need for replacement parts it has been necessary, due to lack of materials, to fabricate locomotive parts.

Brackets of all descriptions are now fabricated by cutting, bending, and fitting the necessary pieces of plate, which are then welded. Brackets thus fabricated invariably require less machining than the cast part and proper development of the fabricated part often results in greater strength and reduction in weight, as compared with the casting. Crosshead shoes are now fabricated from steel plate and welded construction; the weight is thus reduced to approximately one-quarter that of bronze shoes. The strength of the shoe has not been sacrificed and in the case of bronze shoes, a critical material has been released.

Fabricated parts in general have proved to be economical and practical to the extent that, in our opinion, many have taken the place of castings permanently.—*K. D. Read, Asst. Supt. Locomotive Shop, New York Central, Beech Grove, Ind.*



Sequence of operations in cutting an 11-in. diameter axle with a 4-in. bore to form the material from which the guide bar side plate is made



Left: Indicates how the finished plate is made.—Right: Cross-section of the three-piece guide bar assembly

Necessity is the Mother of Invention

Owing to the difficulty in securing materials and labor, I doubt whether any of us have been able to follow established practices in the repairing of locomotives and cars. I doubt, also, whether any of us want to go on record as to some of the practices we have been compelled to follow in order to keep our power on the road. On the other hand, many short cuts and new methods are here to stay, the same old story being still true that "Necessity is the mother of invention."

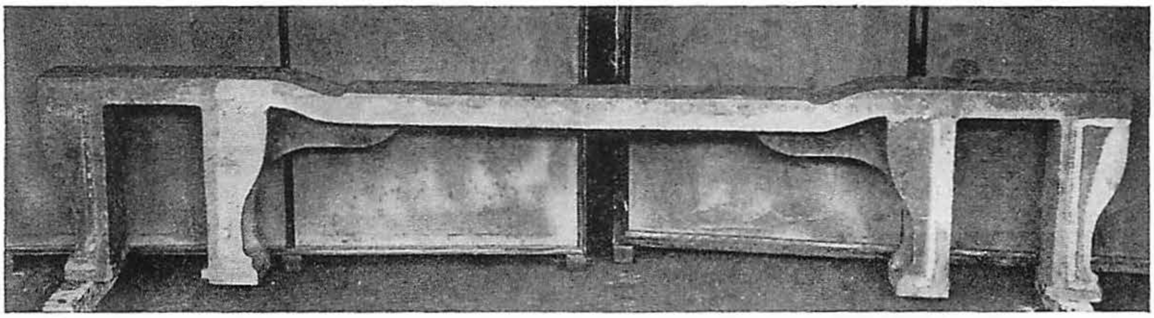
To save both labor and material, three-piece single guide bars are being made from old driving axles. The top or center section is forged from a 9½-in. axle and the sides are cut on an Oxweld cutting machine from hollow 11-in. axles. One axle makes two sides. The sketch shows the sequence of the different operations.

All railroads have more or less trouble with fixed rod bushings in side and main rods working loose in the rods, especially the cast iron and steel bushings. A good saving can be shown by metal-spraying a few thousandths of an inch on the outside of the bushing to get the required tonnage pressure. A good operator can do a job that does not require machining afterwards.

It is surprising how many parts can be fabricated with success from scrap materials, some of which will no doubt be continued after the emergency is over, such as the following: Smoke stacks out of boiler plate, valve bodies or spools out of boiler plate, pump and other brackets out of scrap material, and locomotive bells out of boiler plate.—*Shop Superintendent.*

Flame Cutting Extended

It has been our practice for some considerable time to flame cut bar stock or flame cut such items as brake beam hangers and tender truck swing bolster hangers, and all other such parts as can be economically produced by the flame cutting process. We have found it necessary to considerably extend the flame cutting in certain parts as a substitute for castings, owing to the difficulty in obtaining castings of all kinds the steel castings became critical, we had no hesitancy in substituting welded parts. The following are typical of some of these items: Air reservoir brackets, roller caps for Devoy trailer truck, guide yoke, reverse gear frame extension, coupler pocket for front end of steam locomotive, air pump large extent in reducing machining required on almost all items of main and side rod and other motion work forgings. On one class of locomotives we were able to make a saving by cutting engine frames from rolled steel plate even though suitable patterns for cast steel were available.



Welded side frame for Woodard engine truck, C. M. St. P. & P.

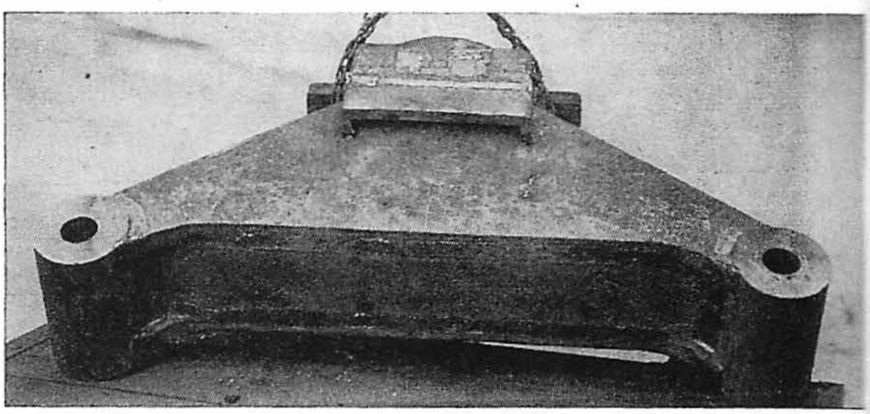
during the war. We do considerably more reclaiming of worn and broken parts by welding and bronzing, due to not being able to obtain any new material.—*A. H. Williams, General Supvr. Apprentice Training, Canadian National.*

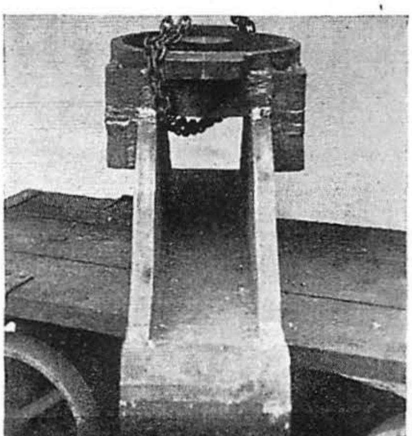
bracket, frame filler brackets, bracket for bell stand, power reverse gear bracket, air reservoir bracket and bell crank for Baker valve gear. In the matter of substituting flame cut parts for forgings or castings, we now, as a matter of practice, cut the majority of our brake hangers, spring equalizers and the like direct from hot Frame sections for repairs are now all flame cut from plates. At the present time the use of cast steel locomotive frame binders has virtually been abandoned and these are all cut direct from suitable billets.

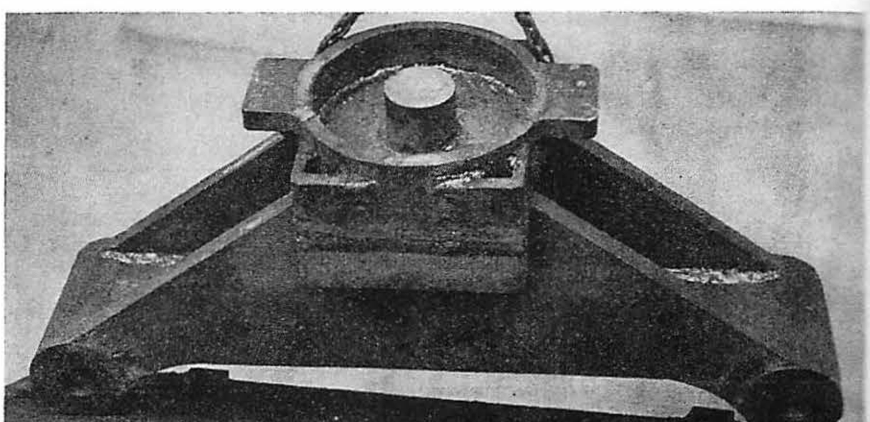
While not at liberty to disclose the details, nevertheless, as a part of our war effort we fabricated a large machine part

Welding-Minded; Flame Cutting Also

In the locomotive department, even prior to the war, we were distinctly welding-minded. For example, when the reverse gear order was put out we found ourselves with a considerable number of different classes of locomotives coming within the scope of the law requiring reverse gears. Under ordinary circumstances, brackets for such gears would be made of cast steel, but in view of the considerable number of types of brackets required, a decision was made that all reverse gear brackets would be fabricated from steel plates and bars. Also, prior to the war we were, as a matter of







Three views of welded swing bolster for electric locomotive engine truck, C. M. St. P. & P.

standard practice, manufacturing crank beds and upper crank cases for our Model 120 Winton gasoline engines.

With this background, therefore, when rolled plate of suitable composition. Such equalizers and hangers in some instances were formerly steel castings; in others, steel forgings. Flame cutting is used to a by welding, which was formerly a casting, the rough weight of which was 29,000 lb., with entirely satisfactory results.

I might say that we have found very few

items normally made in cast steel which could not be suitably reproduced by welding.—*K. F. Nystrom, Mech. Asst. to Chief Operating Officer, Chicago, Milwaukee, St. Paul & Pacific.*

Welding Locomotive Cylinders

Due to the inability of manufacturers to supply us with new main cylinders, it has been necessary to develop a procedure in welding where cylinders have dangerous fractures. After several methods had been tried we decided on the gas welding with the use of bronze welding rod. All of our cylinders are either cast grey iron or Ni-iron. Our method has proved equally successful on either, and to date we have welded main cylinders that in ordinary times we would have relegated to the scrap pile. Our procedure is as follows:

1—Sand blast the entire outside of the cylinder and determine if there are additional fractures that escaped attention.

2—Vee out all fractures, keeping the V about 1/4 in. wide at the bottom and 1 in. to 1 1/4 in. at the top.

3—Place the cylinder in an oven and preheat with charcoal as fuel, for a period of about eight hours, to a temperature of 400 to 500 deg. F. This is usually done at night, so that we may start on the weld in the morning.

4—Once the weld is started we never stop until it is completed. We use from two to four welders, depending on the size of the weld, with the idea that the welder should not weld over 15 minutes at one time and have sufficient rest between welds, so that there will be no nervous tension if the job should take 12 to 15 hours.

Our oven is constructed as follows: The base is of circular construction, 7 1/2 ft. in diameter, with a 1/2-in. by 4-in. iron band filled with firebrick, laid on the flat side and supported on suitable concrete base. Old rails are used as a support for the material to be welded, and also to anchor rollers on which the oven sets. The oven is constructed in cylindrical shape, 7 ft. in diameter, and 8 ft. high, of 3/16-in. scrap plates. Doors are cut in several places through which to weld, and are swung on hinges and latched. Two short pieces of tubing are welded to the sides of the oven opposite each other, so that a four-foot length of pipe can be inserted to turn the oven. This makes it possible to turn the doors to the weld and eliminate the uncovering of the material to be welded, thereby decreasing the danger of chilling. The top of oven is removable, as in some cases where welding is done toward the center of the material the heat will be unbearable and the top must be removed. The material is then covered to the fullest extent with sheet asbestos and the weld is made, replacing the top as soon as possible.

No. 3101 or 3500 welding rod is used with an adequate amount of flux. All welds are made in vertical position, if possible. There are several small openings in the sides of the oven, through which we can place a hand pyrometer to ascertain the temperature.

We have sometimes found it necessary, in cases where channels are fractured, to remove a piece from the saddle to reach the fracture which is welded on the inside of the channel; the piece is replaced in the saddle and welded in place.

After all the welds are completed the oven is closed and brought to a temperature of 500 deg. F. and allowed to cool down without further attention. This usually requires 48 hours, after which the cylinder is removed, the excess welding material machined off and the cylinder replaced on the locomotive. Seldom is any warping noticed.—*George E. Bennett, Shop Superintendent, C. & E. I., Danville, Ill.*

Roundtable Discussion on Training Methods

Question—Have you employed special training methods for supervisors and mechanics? What results have you obtained from these wartime measures? What features of this training do you think are suitable for your post-war training program?

T. W. I. Courses Beneficial

About one year ago the War Manpower Commission established a branch in San Francisco to conduct classes in "Training Within Industry." Since that time 285 of our shop supervisors have taken a course entitled "Job Instruction Training," and 47 have taken a course in "Job Methods Training." These courses consist of a ten-hour program spread over five days, two hours each day. We have found them very beneficial. — *B. M. Brown, General Superintendent Motive Power, Southern Pacific.*

Special Training For the Supervisors

The present critical situation brought about by the unusual work load, incident to the present high traffic volume being handled by the railroads, has clearly shown the need for the use of some improved special training methods designed to better fit the present and prospective supervisors to handle effectively the problems pertinent to that situation.

To better judge the special training necessary, some study of the needs therefore is paramount. Those needs are known to arise primarily through the following:—

1—Shortage of help.

2—The necessity to train quickly new or unskilled men to fill positions requiring skill beyond their past experience.

3—The need to understand how quickly to adjust daily routine to compensate for abnormal absenteeism.

4—How to handle and maintain discipline among female employees.

5—How to minimize unrest which is permeating all the railroad organizations due to dissatisfaction with the present wage schedules.

6—How to obtain greater effectiveness of production from the available help in order to offset the present shortage, and at the same time raise production to meet the demand for increased output of railroad equipment.

The achievement of this special training has been attempted through three general classes of instruction:

1—Those sponsored by government agencies, including Job Instruction Training, Job Relations Training, and Job Methods Training.

2—Foremanship conferences, sponsored by management, but based on courses offered by national training institutes, and

3—Foremanship conferences sponsored by state universities.

All of these methods have been found to be of value and each to have its merits and its limitations.

Experience has shown that the success of any one of the methods depends largely upon the following factors:

1—The interest and enthusiasm displayed by management's general supervisors in the welfare of their subordinate supervisors and the support given to them during their training period, together with proper recognition of the activity and progress shown by those receiving the training.

2—The selection of well qualified leaders to carry on this instruction.

3—The proper training of these leaders before they are allowed to undertake the promulgation of the instruction.

4—Careful selection of the subject matter and the method used in its presentation to the trainees.

Some of the pitfalls found to have been responsible, to a large extent, for the failure of the trainees to get the most out of the special instruction are:

1—Any attempt to coerce supervisors into taking part in these instructions and conferences instead of presenting the matter to them in such a way that their participation is voluntary and enthusiastic.

2—Careless selection of instructors and conference leaders.

3—The use of subject matter and job illustrations not particularly adapted to the industry in which these trainees are employed. Definitely, lack of interest and enthusiasm can be expected if the problems, the jobs and the methods used for illustrative purposes are not a part of the everyday work-life of the trainees. The railroad supervisor or prospective supervisor cannot be expected to maintain an interest and enthusiasm during a discussion on some problem or job which may be of vital interest to, say, the automotive industry, but which has no definite application in his shop.

4—The teaching of one thing in the conferences and continued practice of another in the actual operation of the shop quickly breaks down any good obtained through the conferences.

5—The failure on the part of management to take proper recognition of and action concerning constructive suggestions procured through the conferences.

Hundreds of mechanical department supervisors and prospective supervisors have now completed training courses, some of which have been highly successful, and many of which cannot be so classed. The need for continuation of special training is as great, or greater, than was the need for its original institution.

It is time to take stock of the situation and revise these programs so as to exclude the bad, include the known good features, inject such new material as a change in the national picture may require, and then make available to those who have not yet had the opportunity, instruction which they are, as a whole, anxious to obtain.

From the experience gained during this emergency it is probable that a training system which is made from the cream of all the present experimental systems will be of continual value to the railroad mechanical departments after the present emergency is over.—*F. K. Mitchell, Asst. G. S. M. P. & R. S., New York Central.*

Testing Training Methods During the War Emergency

We have been very much concerned with the methods used in the training of both supervisors and mechanics, and have resorted to the following procedures in an attempt adequately to train our personnel.

Training of Supervisors

At the present time we have a number of new supervisors on our railway. They are good mechanics and know their work, but some of them are weak in handling men; they lack the ability to teach other employees to do the job quickly, and some of them are lacking in the ability to handle grievances properly. To correct these deficiencies, we have tried the following:

1—We sent our master mechanics and shop superintendent a weekly letter, published by a reputable company, on management information. The master mechanics and shop superintendent were to use this as a basis of discussion in their staff meetings. It was thought they might be able to glean from this weekly letter some good ideas and policies to be used in directing subordinate supervisors. This method was tried for sometime, but was abandoned as we did not think we were justified in continuing this service.

2—We next tried a series of manuals on foremanship training. The supervisors were asked to study the manuals and then a discussion was held once a week in connection with other matters. This method was unsatisfactory because the supervisors were, in a large number of instances, too busy or too tired to study the manuals; and the text matter in these various manuals was largely a reiteration of what the supervisors already knew. Since we did not consider that we were gaining anything from the study of these manuals, the discussions were discontinued.

3—At one of our larger shops we recently tried the "Training Within Industry" program as put on by the War Manpower Commission. We selected three of our key supervisors and they attended lectures given by the assistant district representative of the War Manpower Commission for a period of one week. The supervisors who attended this conference felt that the training which they received was beneficial and worthwhile, and we decided to extend it to all of the supervisors in this particular shop. So far we have not definitely determined the value of this "Training Within Industry" program.

4—Another method used in training supervisors is by making use of Voca-films on subjects relating to safety, maintenance problems, and labor relations. These films are scheduled for showing at various shops at a definite time, and all supervisors are notified. We have our assistant superintendent motive power-personnel make a short talk before showing the films. This method has been particularly effective, and has a more lasting impression upon the supervisors than the lectures and discussions we have had heretofore. The fact that our assistant superintendent motive power-personnel takes these pictures around to the various shops creates the desired impression of their importance. We think this method of training supervisors will be useful in post-war programs.

Training of Mechanics

The regular apprenticeship training system is of long standing, and is covered by rules with the shop craft labor organizations. We have two forms of apprenticeship training—regular apprenticeship, and helper apprenticeship.

Regular apprentices serve four years, and are selected from young men between the ages of 16 and 21. Our requirements are that they must be high school graduates. We have, however, in some cases hired sons of employees as regular apprentices who have not completed their high school education. Approximately 50 per cent of our regular apprentices are the sons of employees.

Helper apprentices are selected from helpers who have served not less than two years as helper. Helper apprentices serve three years, and are given the same general training as regular apprentices.

Heavy inroads have been made on our apprentices by the Selective Service Act, and we are no longer training young men as regular apprentices. We are now appointing our mechanics from helper apprentices and from qualified helpers who have served four years or more as helper. We are also upgrading qualified regular apprentices to mechanics after they have completed two years or more on their apprenticeship.

Our practice, which is of long standing, is to promote laborers to helpers. We are now conducting a shop training school as a wartime necessity and in order to better qualify men to perform railway shop work. The trainees of this school are laborers employed in our shops and non-employees who desire employment in our shops. The non-employees attending this school get the same instruction as employees. This school is conducted three times a week, at night. One of the requirements for the non-employee trainees is that they be not immediately subject to the draft. The purpose of this school is to instruct trainees in the fundamentals of shop work, to stimulate their thinking, and by means of lectures, increase their general knowledge.—*G. S. M. P.*

On the Pittsburgh & Lake Erie

We have had some experience with the government subsidized job instruction training and job method training of our supervisors at McKees Rocks. A number of the supervisors completed these courses and have certificates of graduation. It is obvious that the men who received this training gained some personal benefit from it.

The difficulty lies in the practical use of this knowledge for the purpose of training new and inexperienced men. The Pittsburgh & Lake Erie has agreements with the shop crafts providing for a stipulated number of apprentices to be graduated, also a stipulated apprentice schedule—both helper and regular—in order to assure them an all-around knowledge of the trade by the time they graduate. This system has been in effect for years and every foreman whom these apprentices contact during their apprenticeship has been their instructor for the respective time allotted to each department. We consider that this system has been very successful and will continue to be successful as long as we are mutually subscribing to the kind of labor agreement mentioned. We also, at times, assign a special apprentice instructor, who assists the apprentices when needed.

This method is recommended for the future, also for the post-war reconstruction period. Regardless of the working conditions mentioned, we do not wish to minimize the importance of having supervisors trained along some approved standard lines with reference to their contacts with apprentices, as well as other employees under their jurisdiction. It seems important that such standard methods and instructions should in all cases be given by highly experienced men who themselves have a considerable amount of familiarity and experience along the lines of work on which they are giving instructions.

With reference to new employees, such as laborers, helpers and mechanics, other than those who enter the rosters on completion of apprenticeships, we also call attention to the fact that shop craft agreements provide that the already established employee may select or bid in his assignment, having preference over a newly hired employee. It is therefore impossible to know beforehand any details of the kind of work a new employee is to do, and it is necessary to give him the required instructions after he has been allocated to the particular job or place that he is permitted to take, after priority rights of older employees have been satisfied. These rights, granted by the agreement, are guarded very closely by the employees, and no deviation is generally found.

At the present time and for the immediate future, we will, no doubt, be compelled to train new employees in the above prescribed manner, male and female, in order to give them the necessary knowledge of the job after being placed in their respective positions.—*K. Berg, Supt. Motive Power, P. & L. E.*

Supervision Benefited

The State of Michigan assigned a group of instructors, available to all industries, to give a course of lectures and demonstrations, free of cost to the participants, this instruction program being termed "Training Within Industry." All of our local supervisors and some of the lead men were enrolled. Without going into details, it has proved to be of considerable value to them in the handling and training of men on new jobs. As one foreman remarked, "The way to find out how little you know about the details of some equipment is to try and explain it to someone else."—*Shop Superintendent.*

Special Training For Machine Operators

Toward the close of last year we were having considerable difficulty in keeping our machine tools continuously in operation, particularly in our large machine shops at Juniata, because of the number of men who were being furloughed for military duty, or who for other reasons were not continuously at work.

In order that we might meet the demands of the railroad for repair parts for locomotives and provide the necessary machined parts for new locomotives under construction, it became necessary to correct this situation. Accordingly, we arranged to set up a training program for machine operators on the various types of machine tools. The men selected for this training are given experience on a number of machine tools of the respective types, with machine operators selected on the basis of their ability to instruct new men. The training period covers a definitely specified time which, as above indicated, is allocated to selected machines and operators. For example, trainees for positions as engine lathe operators are given experience on five different size lathes during the training period.

The progress of these trainees is followed up by a supervisor who has been assigned to that particular duty and who reports currently on their progress.

This program has provided us with trained operators available for filling temporary vacancies which occur on account of sickness or for other reasons, and makes available men for permanent vacancies as they may occur. It has worked out very satisfactorily and has very much reduced the idle machine tool hours which were lost prior to its adoption. The trainees are paid on an hourly basis during the training period.

Our method for training supervisors has been in effect for many years and has proved entirely successful. It is our practice to develop from among our working forces, by constant observation, those who possess the necessary mechanical ability and supervisory qualifications to lead and direct the work of other employees. This method has been employed continually and up to the present time there has been no occasion to adopt new or different methods during the period of this emergency because of lack of trained persons among our working forces to promote to supervisory positions.—*F. G. Grimshaw, Works Manager, Pennsylvania, Altoona, Pa.*

Two Methods of Training Supervisors

It has been our privilege to enjoy the benefits derived from two special training methods for supervisors. The Job Instructor Training course offered by Training Within Industry, an agency of the War Manpower Commission, was first completed by our supervisors. This was a ten-hour course, divided into five two-hour sessions. This wartime measure proved successful in teaching supervisors how to break in new workers and instruct old workers how to do a job properly. A noticeable result from this training was the realization on the part of each supervisor that better results could be obtained more easily when instructing employees, by following the methods set up in the Job Instructor Training course. This training proved to be a revelation, as it demonstrated the inadequacy of our method of instruction to workers.

We are convinced that the application of this training by our supervisors in instructing their men how to do a job has paid dividends in conservation of man-hours. Heretofore, an excessive number of hours was lost by both the supervisor and employee in learning the job; and a higher degree of efficiency has been obtained by the workmen. This has resulted in increased production and improvement in quality of workmanship.

All features of this training are applicable for our post-war training, as the principles are sound and will apply at all times.

Our supervisors have also had the privilege of attending a series of "roundtable" discussions conducted by the state director for Vocational Training for War Production Workers, under the title of "Foremen Improvement Conferences". This was a series of conferences held weekly at the shop. A choice of subject matter was offered, with a suggested list of topics deemed particularly adaptable to our railroad problems. These conferences were led by a duly accredited leader who was particularly qualified, being a student of trade and industrial education. All conferences were conducted on the plan of every member participation.

Such topics as safety first, teamwork and co-operation, introducing new employees to the organization, how to correct or reprimand workers, the foreman as a leader, and costs of locomotive repairs at shops as related to foremen and supervisors, were among those discussed, and much value was derived from the facts developed in these human relations and operating problem topics.

A definite plan was followed in conducting these conferences in order that worthwhile conclusions would be reached. It was customary to follow this outline: State topic, define its purpose, discuss topic, draw conclusion. Pertinent information brought out by the group was recorded and developed into a composite report at the conclusion of each conference, each member being provided with a copy for his personal file at the next meeting.

We are convinced that much value was gained from these conferences, as evidenced from the interest manifested, the after-meeting groups which voluntarily formed to continue discussion, and the active participation of every member. Direct application of the many suggestions brought out in these conferences has resulted in an increase in efficiency of effort, better control of waste and scrap, substantial reduction in operating costs and closer interdepartment co-operation.—*K. D. Read, Asst. Supt. Locomotive Shop, N. Y. C., Beach Grove, Ind.*

Visual Methods Coupled With Conference Discussions

The problem of setting up special training methods for supervisors and mechanics is of accepted importance in these days of scarcity of manpower.

Training programs that worked in normal times can only be successful today on an accelerated basis. The Railway Educational Bureau is applying the fundamentals of practical instruction which we have developed through the years to this problem. We are adapting visual training methods to our present programs. Sound slide films, 16 mm. motion sound and silent films are being used in conference discussions among supervisors to present visually a statement of certain specific problems.

A few of the problems so presented are: training understudies, statement of a supervisor's responsibilities and duties in wartime, specific training aids for machinists, welders, electricians, etc.

We are utilizing the conference and visual methods of training more and more daily, correspondingly diminishing the use of text material. Apprentice instructors representing seven major railroads agree that the results being obtained through the new training plan are very gratifying not only with apprentices, but with mechanics and foremen. Frankly, this new method is merely the application of good selling and advertising tactics to a sound training program.—*R. C. Buell, The Railway Educational Bureau.*

Baltimore & Ohio Practices

The Baltimore & Ohio has three groups of apprentices—regular, helper and special. Regular and helper apprentices are instructed in all branches of the work of a particular craft. Special apprentices are instructed in all branches of the work handled in the maintenance of equipment department, and are required to have a technical educational background.

Those who are adept in the work which they are performing are considered for supervisory positions after they have completed their apprenticeship. It might be said, therefore, that supervisors are "hand picked."

We are continually urging all of our employees, both workmen and supervisors, to avail themselves of all means of securing additional knowledge that is available—by attendance at courses in schools and colleges conducted by the various states and municipalities, as well as those sponsored by the federal government. Any lectures that are called to our attention are given wide publicity. We also urge all to take advantage of the instruction through the various correspondence school courses, such as the International Correspondence School and others.

We have also instituted job instructor training sponsored by the War Manpower Commission. The course has not been extended to all supervisors through the system yet, but instruction is progressing. In view of the comparatively short time since it was started, we are not in a position to make a definite statement as to the results that are obtainable.—*A. K. Galloway, General Supt. Motive Power and Equipment, B. & O.*

Roundtable Discussion on Diesel Maintenance

Question—What particular problems are giving you concern in the servicing and maintenance of Diesel locomotives? Have you found it necessary to provide special facilities and organization other than those required for steam locomotives? What?

Labor Problem Is Serious

There are still many perplexing problems to be solved in the operation and maintenance of Diesel power road locomotives. One of the most concern is the labor problem; it seems that the enginemen continuously want to do less work and demand more pay.

The maintenance problem has not been so acute in that practically all of our maintenance forces are willing to perform their duties to the best of their ability; but the trouble is again in the labor organization, because when a certain mechanic or an electrician with outstanding ability is in line for advancement, he cannot be assigned to the job for the reason that others who have greater seniority demand that they be given that place, even though it is known that they do not possess the desired qualifications Nevertheless, such men must be trained, or at least tried out for several months, regardless of the unsatisfactory service rendered. Of course, any outstanding employee can be promoted to supervisor or foreman, but it is just out of reason to employ all of them in such a capacity. Someone actually has to do the work in a careful and precise manner, which is not always done when forced to use men who are more or less indifferent to new ideas and standard practices.

Repairs and current maintenance of Diesel electric locomotives are entirely different from the work performed on a steam locomotive, in that the Diesel demands closer attention to its many moving and intricate parts, all of which must be accurately fitted and assembled to within at least .001 inch. Some parts, such as fuel injectors, etc., are finished with still greater precision, all of which demands the attention of specialized and highly skilled mechanics.

As time goes on and Diesel power begins to predominate on the railways, the special maintenance facilities will gradually be improved and perfected, all of which will be an incentive for the younger and mechanically-minded men to study and fit themselves for such work. Right now we have a special committee making surveys on other lines, with the intent and purpose of making recommendations for modern maintenance facilities, which we intend to establish as soon as the committee completes its assignment.—*E. F. Weber, General Supt. Automotive Equipment, Burlington Lines, Chicago.*

Suggestion on How to Minimize Dirt Nuisance

One of the most obstinate problems in connection with the maintenance of Diesel switching locomotives is that of keeping the working parts clean. Dirt is the root of all evil on a Diesel. This is true of the electrical equipment, as well as the mechanical. It would be no exaggeration to state that 50 per cent of the routine work on a monthly inspection consists of cleaning operations.

Diesel switchers usually work in a dirty industrial section of town. To the dirt from adjacent factories and steel mills is added the smoke and cinders from steam locomotives. The dirt is drawn into the engine compartment, after which it is blown down into the traction motors. The engine room is always under a partial vacuum and therefore tends to draw in any soot or sand in the air.

It is possible that this condition might be reversed. Instead of sucking the cooling air into the engine room it could be blown in. This would tend to keep the air in the engine compartment at slightly over atmospheric pressure, which would automatically prevent the infiltration of dust. There could be one large blower fan located at the front of the locomotive. This fan would receive its supply of air through filters and would deliver clean air to a pressure compartment. From the latter there should be suitable ducts leading to the traction motors, to the air compressor, to the engine room and possibly to the radiators also. By the introduction of nothing but clean filtered air to the various working parts, a material reduction in maintenance could be expected.—*J. E. Kloss, New York, Chicago & St. Louis, Buffalo, N. Y.*

Special Facilities Required

We have difficulty in securing men for servicing and maintaining Diesel locomotives who have sufficient training in both electrical and mechanical work to take care of both the Diesel engine and the electrical traction motors, generators, control equipment, batteries, etc. Especially where there are only a few locomotives at one station, it is desirable that the service men be qualified in both the electrical and mechanical work. At larger centers this can be taken care of in much the same manner as steam power; that is, electricians taking care of the electrical work and machinists handling the mechanical maintenance.

We have found it necessary to have men with special training in Diesel electric work to supervise the operation and maintenance, and certain special facilities also have had to be installed. Tools specially designed to take care of the work on the pistons, cylinders, cylinder heads, fuel system, etc., have had to be provided and it has been found desirable to furnish holders for the smaller tools, so that they are available to all concerned. Also, the cleaning filters on the lubricating oil system and the apparatus used for filtering the air for the Diesel engine have required tanks and cleaning apparatus not commonly provided for the steam locomotive work. Where the number of locomotives in service warrants the use of apparatus for changing wheels, we have installed a drop table to permit quick change of wheels or traction motors.—*A. H. Williams, General Supvr. of Apprentice Training, Canadian National.*

Extensive Railroad Demand Developing For

New Shop Equipment

Having entered the war period with shop facilities from 25 to 40 years old the pressure of history-making traffic and high speeds are showing up the old tools

When the United States entered World War I in 1917 the repair facilities of American railroads were in far better physical condition to take on the burden imposed by the peak loads of wartime transportation than they were when we entered World War II in 1941. A large part of the most important railroad repair shops, engine terminals and car repair shops were either built new or rebuilt and equipped with up-to-date machinery in the early years of this century. As a result, when war broke out in 1918 most of our more important railroad repair plants were relatively new and well equipped to do the job of that period. While no record is available of the average age of all machine tools in service at that time it is a reasonable assumption that it was not excessively high.

The purpose in making the above statements is to direct attention to the fact that the 10 years after the end of the last World War marked the end of a long period of repair shop construction and major installations of machinery and equipment. Since 1930 expenditures for new shop equipment have been sporadic and, except for one or two scattered instances, have been definitely limited in any one year to total amounts considerably below previous 10-year averages.

In 1934, during the regime of the Federal Co-Ordinator of Transportation, surveys were made to determine the possibilities of effecting economies by the replacement of obsolete machine-tool units with modern machines. In the course of these investigations it was found that in the typical locomotive repair shop of that period the average age of all machine tools was 20 years and that in 75 per cent of the machining operations performed in the course of locomotive and car-repair work the replacement of 20-year-old machines with the new tools of that period would effect savings, in many instances, of as much as 80 per cent of the cost of doing a specific job.

Nine years have gone by since those studies were made and while there have been several instances of major replacement programs the volume of such installations has not been great enough to stabilize the average age of tools in most of our shops. Result: in 1941 the roads faced the greatest traffic in all of their history with a shop machinery inventory, in most cases, considerably in excess of a 25-year average age. It is no wonder, then, that in the 22 months since we entered the war those who are charged with the responsibility of operating our repair shops and engine terminals have become more and more conscious of the inability of 25- to 40-year-old machine tools to hold up their end in a production battle such as present-day traffic imposes on those shops. It is surprising how many of the machine-tool units installed in shops built between 1900 and 1915 are still the mainstay machining units in the plant.

In those instances where specialized departments were completely modernized with new machinery and where new units have been installed in departmental groups the value of the new machines and the handicaps of the old machines have been especially marked. There are numerous instances where units and groups of new machines have paid for themselves in five years or less and when they were purchased there was no expectation that they could be amortized in even two or three times that period of years.

When a situation in which the demand for machine tools for equipping defense plants practically made it impossible for the railroads to secure new equipment was immediately succeeded by the establishment of the priority system that added to the difficulties many mechanical men began to realize that possibly the intention to replace obsolete tools with new ones had been postponed somewhat beyond the point of safety. Only by the exercise of latent ingenuity and the most intensive utilization of shop equipment were many roads able to keep up with the ever-increasing demand for motive power and car equipment. It is not surprising, therefore, that many shop men who may have previously been somewhat indifferent to the value of new equipment should develop an interest in the acquisition of new facilities such as has not existed for some years. In all fairness it should be admitted that not until the past two years have shop operations been at a sufficiently high load rate to show up the major shortcomings of old machinery and the obvious advantages of modern machinery. In any event, wartime traffic has created a vast demand for new railroad shop equipment and there is now no longer any doubt that this demand must be supplied if the standard of wartime transportation service is to be maintained.

Results of a Broad Survey

Early in this year two things became evident: that the railroads must have new shop equipment if they were to keep motive power and cars in first class serviceable condition; that the needs of defense industries, passing as they were from the construction to the production stage, were lightening the demand for machine tools sufficiently to make it easier for other industries, particularly the railroads, to obtain badly needed units.

With the idea of finding out exactly the nature of these needs the *Railway Mechanical Engineer* made a study of conditions and requested brief and specific information from 43 of the most important Class I roads, 39 of which co-operated by making known their requirements for shop machinery. These railroads represented 71 per cent of the route mileage, 80 per cent of the steam locomotives, 74 per cent of the Diesel-electric locomotives, 97 per cent of the electric locomotives and 74 per cent of the freight cars.

In approaching a study of this kind it was our desire to find out as much about the underlying reasons back of the demand for new equipment in car and locomotive shops as it was to determine the character of the equipment required. This for the reason that there have been an increasing number of indications over a period of several months that our railway repair plants are destined to become a factor of first importance in the continuing ability of the railroads to carry the wartime load, and that the capacity of these shops to do this job is now reaching a stage where machines may be more important than manpower. Such a statement may seem like a contradiction except for the explanation that when the supply of manpower is static or diminishing and hours of work have reached their practical maximum the remaining solution to increased output is new facilities of greater productive capacity.

This assumption is definitely borne out in the replies that were received to the question, "For what reason are these machine tools needed?" The greatest number of roads, 28 out of the total, gave the necessity for increased output a place of prime importance while close behind this reason, in importance, was that of the need for greater accuracy in machining operations. This reason was given by 26 roads. Relief for an increasing manpower shortage was the reason why 21 roads needed new equipment and 16 of the 39 roads gave the desire to decrease the cost of machining as a reason. It seems superfluous to add that the replacement of obsolete machine tools with modern equipment will accomplish all of these objectives simultaneously.

We have had a suspicion for some time that extended periods of high-speed and heavy-tonnage operation of both freight and passenger trains would have a definite effect on specific shop operations. For that reason we asked these roads to tell us what shop departments were most in need of new tools and the replies on this basis were:

Car wheel shop	24 roads
Turret lathe department	20 roads
Driving wheel work	19 roads
Rods and rod bushings	16 roads
Piston and crosshead work	13 roads
Driving box departments	12 roads

There is significance in the fact that wheel work is right up at the top of this list and bears out many observations that wheel shops are having more and more difficulty in keeping up with their output schedules because of the inability of old machine tools to turn out accurate work in large quantities. It is ironical that modern locomotives and cars, operated at high speeds, should demand infinitely higher standards of accuracy in wheel, axle and bearing machining from shop equipment of a character and condition least able to furnish it. The mounting tempo of the demand for new wheel shop machinery is not, therefore, in the least surprising when these conditions are taken into consideration.

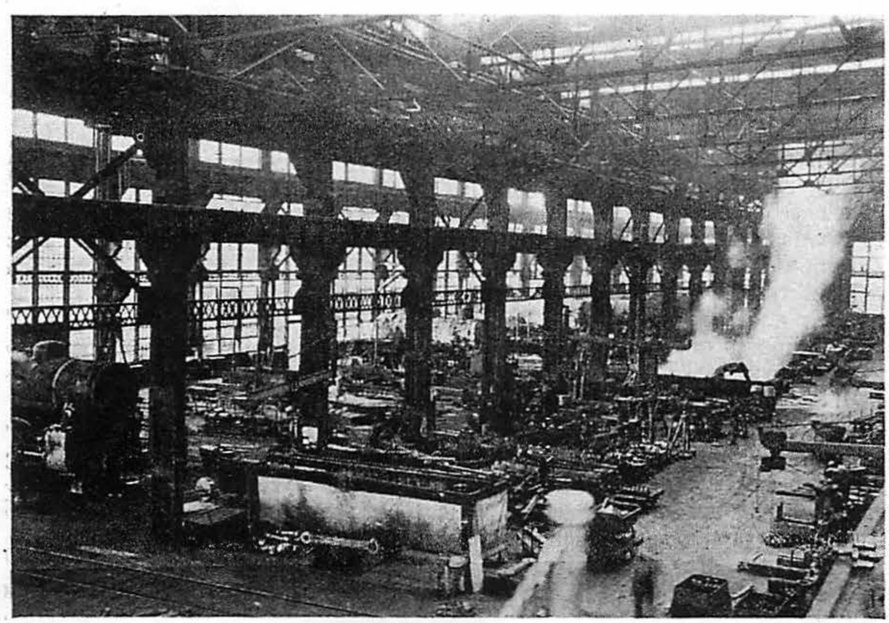
What Type of Machines Are Needed

An analysis of the types of machines needed reflects a growing need for new engine lathes, turret lathes, vertical turret lathes and boring mills, vertical and radial drills, grinders, milling machines, shapers and horizontal boring machines. The scope of the demand and some indication of relative importance of demand can be seen in the accompanying tabulation of the number of roads out of a total of 39 reporting, asking for machines of the specific types listed.

Demand for Specific Types of Machines

Engine lathes	27 roads
Turret lathes	20 roads
Drilling machinery	21 roads
Vertical boring and turning machines	21 roads
Grinding machines	21 roads
Milling machines	18 roads
Shapers	12 roads
Horizontal boring and milling machines	10 roads

It is rather difficult to draw specific conclusions from an analysis of types of machines required but there is one that seems reasonably safe from contradiction. For years, one of the major obstacles to the installation of new machines, particularly those of the more expensive variety, has been the lack of volume in machine work from the standpoint of the number of parts required. Lack of volume has operated to forestall opportunities for maximum economies in machining. Wartime traffic has provided volume in locomotive parts production far beyond anything previously experienced. Those roads with new machines have watched with amazement the ability of these modern machines to take on a seemingly limitless burden of new work and do it in a manner and at a cost that establishes a violent contrast to the mediocre ability of the 25- or 30-year-old machine. Here, before the eyes of every shop supervisor, is eloquent proof of what the production industries have known for years. While the picture of modern machine-tool efficiency is fresh in the minds of railroad shop men there should be established the means of making it necessary for every old machine tool either to justify its existence or be thrown on the scrap heap.



The concluding part of our survey was the question "When are these machines needed—now or in the postwar period?" All but four roads stated emphatically that the need is *right now*. Some roads reported that they had programs for the replacement of shop equipment in the postwar period in addition to their needs at the present time.