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TUESDAY AFTERNOON SESSION

October 3, 1944

Presiding: General Chairman Paul Van Cleef, Van Cleef Bros., Chicago.

A Symposium—Safety in Processing Synthetics

Discussion Leader: Thomas H. Boyd, Safety Eng., The Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J.

A. Skin Hazards in the Manufacture and Processing of Synthetic Rubber

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When the war cut off our principal supply of natural rubber from the East Indies, it was necessary to find a substitute in order to successfully carry on the war. For more than twelve years before the war the Du Pont de Nemours Company had made Neoprene, the first of our synthetic rubbers. Shortly before we entered the war the Standard Oil Company of Louisiana obtained the German patents for making Buna S, the type of rubber now mostly used.

The principal types of synthetic rubbers now manufactured in this country are Buna S, Buna N, Butyl rubber, and Neoprene. Buna S, Butyl rubber, and Neoprene are the types now being made for our Armed Forces.

Buna S

Buna S is made from butadiene and styrene.

Butadiene can be made from alcohol and from butylene, a product fractionated from high-line gas and light pressure distillate taken from petroleum oil.

Butadiene from Alcohol

Ethyl alcohol is heated in closed kettles over a catalyst and converted to acetaldehyde. The acetaldehyde is heated over a catalyst to form butadiene.

These processes take place in closed kettles and there are no exposures of the workers to the chemicals because the operation is controlled from a control room. However, in cleaning the kettles and reactors, the maintenance crews come in contact with some of the chemicals formed during the conversion and cases of dermatitis have occurred chiefly from acetaldehyde. Among the other chemicals and byproducts which may be encountered in cleaning retorts and kettles the irritants are butylaldehyde, methylethyl ketone and acetic acid.

Tertiary butyl catechol is added to the butadiene in order to keep it from polymerizing while in storage. Tertiary butyl catechol is a skin irritant and workers opening the cans containing this product may develop dermatitis from splashes if they do not wear rubber gloves and impervious sleeves and aprons.

Butadiene is a volatile gas under ordinary conditions of temperature and any dermatitis resulting from it is probably due to the freezing effect of its evaporation.

In plants making butadiene from ethyl alcohol maintenance workers going into kettles, retorts, or pipes, for cleaning or repairing, should wear rubber gloves, goggles, airline respirators or gas masks, impervious coveralls and boots. They should step under the shower with all these clothes on immediately after completing the job in the retorts, and then remove the protective clothing and don their street clothes.

While handling tertiary butyl catechol, workers should wear goggles, rubber gauntlets, and rubber aprons, which should be kept close by the tank in which the cans are opened and melted.

Butadiene from Butylene

Butylene is heated to a high temperature in reactors in contact with a catalyst resulting in the formation of butadiene. The entire process is totally enclosed and automatically controlled. Skin hazards are only present to maintenance men cleaning or repairing the reactors. When such work is being performed the men should be protected as prescribed for maintenance men making butadiene from alcohol.

Styrene Manufacture

Ethylene is combined with benzene in order to form ethylbenzene. Aluminum chloride is used as a catalyst in this operation. The aluminum chloride is dumped into the hopper by hand and the worker is exposed to it twice during a shift. Since aluminum chloride is a skin irritant, the worker while engaged in handling it should wear rubber gauntlets, aprons, and goggles.

Sodium hydroxide is used in the process. Workers handling the caustic should wear rubber gauntlets, aprons, and safety goggles.

The waste discharged from the reaction of ethylene with benzene is a black tarry irritant substance. Therefore, workers handling this waste should also wear rubber gloves, impervious sleeves and aprons. They should be instructed to change their clothes immediately after they become soiled with this tarry material.

Ethylbenzene is heated over a catalyst to form styrene. This process is totally enclosed.

Tertiary butyl catechol is added to styrene to prevent polymerization while in storage. While handling this chemical, the workers should wear goggles, rubber aprons, and gauntlets.

Manufacture of Buna S

Buna S is made by stirring a mixture of butadiene, styrene, soap solution, an oxidizing salt, and a chain modifier in a polymerization kettle for about 18 hours. Hydroquinone is also used. The unreacted styrene and butadiene are recovered from the latex. The antioxidant is then added to the latex. The latter is coagulated by adding acidification and the rubber is screened out of the liquor, washed, dried, baled, powdered, and packed.

The butadiene and styrene are usually brought to the plant in tank cars. Workers engaged in emptying the styrene tank cars should wear impervious protective clothing to protect them from accidental splashes.

The process of removing tertiary butyl catechol from butadiene by bubbling it through a solution of caustic soda entails no hazard because it is totally enclosed. The red liquid, sodium salt of tertiary butyl catechol, is disposed of by burning.

Most of the occupational dermatitis occurring in the manufacture of Buna S is caused by chemicals added to the butadiene and styrene in order to make the reaction possible. These chemicals are as follows:

1. The per salt which is used as an oxidizer or catalyst rarely causes dermatitis.
2. The chain modifier which is added to the mixture in the polymerization kettle is a primary irritant and sensitizer.
3. Hydroquinone which is added to the latex in the polymerization kettle is a sensitizer.
4. The antioxidant usually consisting of phenylbetanaphthylamine is a sensitizer.
5. Bardol, a coal tar derivative, is sometimes added to the phenylbetanaphthylamine. Bardol is a primary irritant and photosensitizer.
6. Soapstone or talc is used to cover the bales of rubber. Dermatitis can result from coarsely powdered soapstone, especially in hot weather.
7. The compound which is sometimes used as a modifier instead of or in conjunction with the original chain modifier is also a primary skin irritant.
8. Sodium lignin sulfonate is sometimes used, and is a sensitizer.

Workers in the pigment room handling these chemicals should wear protective clothing in the form of rubber gauntlets, impervious sleeves and aprons. Workers dumping chemicals into reaction kettles should wear similar protective clothing.

Workers engaged in handling the baled rubber are exposed to soapstone and talc and often develop dermatitis. The talc and soapstone are usually coarse and contain sharp spicules which wound the skin, especially when it is perspired and macerated. Unless some method is devised whereby the dust exposure to the workers is eliminated, such workers should wear closely woven overalls and leather gloves, cleaned daily in the plant. They should also be compelled to take shower baths after work. In some plants a very fine grade of talc is used, fine enough to pass through a 300 mesh screen. In such plants there is no dermatitis from talc.

Dermatitis also occurs among workers making the coagulating solution. In warm weather this solution deposited on the perspiring skin of the arms can cause dermatitis. Protective sleeves will prevent this condition.

Workers engaged in making the soap solution may also develop dermatitis from the soap flakes. Protective sleeves and aprons will prevent this.

A considerable portion of the dermatitis occurs among the workers engaged in cleaning the driers. They are compelled to enter the driers and lie on their backs in closely confined spaces, removing from the traveling chain or belt the adherent, incompletely polymerized rubber. Dermatitis occurs on the body of these workers and is caused by the incompletely polymerized rubber and the uncombined chemicals which it contains.

About 0.5 per cent of the styrene remains unchanged in the rubber as it comes from the drier. The phenylbetanaphthylamine in the incompletely polymerized rubber combined with the Bardol, sodium lignin sulfonate, etc., are probably the principal causes of dermatitis among workers cleaning the driers. The faces of these workers should be protected by a protective ointment of the lanolin-castor oil type. They should be furnished with clean coveralls and gloves and take compulsory showers after each session in the driers.

The future driers should be roomy and so constructed that the workers can clean them in a standing position.

Samplers of latex in the reactor building should wear rubber gauntlets, impervious sleeves and aprons while drawing fluid from the reactors.

Workers dipping their hands into the slurry of rubber, brine, latex, and acid in the coagulation building should wear rubber gauntlets.

In some plants soda ash is added to soften the water used in making the soap solution and the brine. Workers coming in contact with soda ash should be furnished with impervious coveralls and rubber gloves, daily cleaned at the plant, and should be compelled to take showers after work.

Neoprene

There is comparatively little dermatitis in the manufacture of neoprene. The principal type of neoprene manufactured is called type G.R.M., and is made from acetylene. This is converted into vinyl acetylene by the use of a catalyst. The reaction takes place in retorts placed behind explosion-proof walls and is remotely controlled. Vinyl acetylene is a gas B.P. 5° C.

Vinyl acetylene is reacted with hydrochloric acid to form chlorobutadiene.

Chlorobutadiene is a liquid; B.P. 60° C. It is a primray irritant and accidental splashes cause erythema even if it is soon washed off with water.

Chlorobutadiene is mixed with sulfur and rosin, placed in a kettle of soap solution to which a per salt is added as a catalyst, and is agitated for about two hours to form neoprene latex. In emptying the kettles some of the latex spills on the floor and dermatitis occurs on the feet and legs of operators from contact with the latex. The latex contains unreacted chlorobutadiene, the pungent odor of which is present in the building. The latex has a pH 10 which also adds to its irritant properties.

About five per cent of the workers exposed to chlorobutadiene have some temporary loss of hair. It is not known whether this is caused by a local or systemic effect. The hair becomes normal after exposure ceases.

The neoprene latex is deposited into cooled revolving drums which coagulate the neoprene and roll it off in a thin sheet. The sheet is washed and then passed festoon fashion through a drier. After coming from the drier it is compressed into roll form, passed through finely ground talc, cut into lengths of about 12 inches, and packed into bags.

There have been no cases of dermatitis among the workers exposed to the finely ground talc.

Other types of neoprene are as follows:

Type G.N.
Type I.
Type K.N.
Type F.R.

These differ somewhat in composition.

Neoprene latex is made from type G.N. and is simply the uncoagulated latex. The latex liquor is made from rosin soap and has pH 9-10. It also contains a small amount of unreacted chlorobutadiene.

Butyl Rubber

Butyl rubber is made from isobutylene and isoprene. These chemicals are dissolved in methyl chloride and reacted over a catalyst (aluminum chloride.) The liquid is circulated and cooled in a reactor through metal tubes. As the rubber is formed it rises to the top of the reactor where it meets a stream of steam which carries the rubber away. Phenylbetanaphthylamine is added to the slurry of hot water and rubber. The worker adding the P.B.N. should wear rubber gauntlets, impervious sleeves and aprons.

The rubber is screened out of the slurry and then passed through a drier from which it is extruded in a continuous sheet. Xylyl mercaptan is added to the rubber before it passes through the extruder. This substance is a skin irritant and the worker at the extruder should wear impervious sleeves and aprons, and a protective ointment on the face.

The rubber after coming from the extruder is passed through a hot mill. The workers on the mill develop burns and blisters of the hands from the hot rubber and dermatitis from the fumes of P.B.N. and xylyl mercaptan. They should be provided with heatproof gloves and a protective ointment for the face.

Buna N

Buna N is made by reacting butadiene with acrylonitrile in a manner similar to that described for the manufacture of Buna S.

Buna N is partially dehydrated in a centrifuge or by passing between rollers before being passed through the drier. The temperature of the drier is higher than that for Buna S, and the time of drying is less. Practically all the unreacted monomers remaining in Buna N are vaporized in the drier and drawn off by suction. The driers are roomier and do not require as frequent cleaning as do the driers for Buna S, and the workers entering the drier are not required to lie on their backs and work in narrow spaces.

The raw chemicals used in the manufacture of Buna N are:

1. Butadiene
2. Acrylonitrile
3. Soap suds containing a wetting agent
4. A modifier
5. A catalyst which consists of oxidizing salts
6. An antioxidant which may be P.B.N. or P.A.N.
7. Sulfuric acid in a concentration of ½ to 1 per cent is used to coagulate the latex
8. A two per cent barium chloride solution may also be used for this purpose
9. Bone glue, and casein are used as emulsifiers

Dermatitis may occur from acrylontrile which may leak out of enclosed pipes and retorts.

The soap solution containing a synthetic wetting agent may cause irritation of the nose and throat.

The modifiers are primary skin irritants.

The antioxidants are sensitizers.

Barium chloride may cause a dry scaling eczema of the palms.

The whole operation of making Buna N is more enclosed than that for making Buna S, and despite the fact that acrylonitrile is a powerful skin irritant, there were no cases of dermatitis seen in the Buna N plant which was inspected.

Processing Synthetic Rubbers

The skin hazards occurring in the processing of synthetic rubbers are the same as those described for natural rubber, namely, from the chemicals used in the rubber, with the addition of hazards from the synthetic rubber themselves.

The chemicals to be used in the rubber are weighed out by hand. The worker comes in contact with all of them and should be protected with rubber gloves, impervious sleeves and aprons, and a respirator. The rubber, either synthetic, natural, or reclaim, and the chemicals, are mixed into master batches which contain a high percentage of the ingredients. These master batches are the ones used for compounding the actual rubber stock.

The chemicals to go in the rubber are mixed together either in a mixing mill or a Banbury mixer. The workers on the mixing mills come in contact with the chemicals and are exposed to whatever fumes may come off the rubber as it gets hot, and sensitization dermatitis may occur among them.

The mix mills should be well exhausted and those workers who become sensitized and develop dermatitis should be provided with a protective ointment of the water repellent type. Protective clothing is too hot to wear at this operation.

Workers on the Banbury should wear clean dustproof coveralls furnished daily by the plant.

Workers on the mix mills and the Banbury should take cleansing showers before going home.

In most factories the rubber after being compounded is sheeted out and passes overhead in a continuous sheet to the various departments where it is further processed.

Rubber which is going to be made into tires is extruded in the form of the tread. The fabrics, such as cotton, rayon, etc., going into tires, are impregnated with rubber either by calendering or by dipping into water dispersions. These operations are automatic and there are no particular skin hazards connected with them.

Rubber to be made into tubes is extruded through a tube-shaped die, cut off into suitable lengths and cemented into circular tubes. Workers engaged in this operation sometimes get dermatitis from the rubber cement, which consists essentially of rubber dissolved in a solvent. Workers at this operation who develop dermatitis should wear thin washable leather gloves and use a long-handled brush for applying the cement.

Tire builders handle fabrics impregnated with rubber and the various compounded rubbers which go into the tread and sides of the tire. They rarely develop sensitization dermatitis from the chemicals in the rubber.

The synthetic rubbers can be used in latex form. Thin rubber gloves may be made directly from latex in the same manner as they are made from natural latex. Dermatitis may occur from synthetic latex because it contains more of the uncombined and unpolymerized chemicals than does the coagulated dried rubber.

Patch Tests

Hundreds of patch tests were performed on workers having dermatitis in the twenty plants inspected. Of twenty-four chemicals used as patch tests, the following positive reactions were obtained:

- P.B.N.—Antioxidant
- Stalite—Antioxidant
- Hydroquinone
- Buna S from driers
- Neoprene latex
- Safex (2, 4 dinitrophenyl dimethyl thiocarbamate)—Accelerator
- Captax (mercapto benzo thiazole)—Accelerator
- Erie (bis- 4, 5- dimethyl thiazyl disulfide)—Accelerator
- Altax (benzothiazole disulfide)—Accelerator
- Santocure (benzothiazyl 2, monocyclohexyl sulfonamide)—Accelerator
- Asphalt
- G.R.S.
- Buna N type of synthetic rubber

Summary

There is comparatively little dermatitis occurring in the manufacture of synthetic rubber despite the many irritant chemicals used. This is explained by the fact that the factories making synthetic rubbers are modernly equipped with mechanical safety devices and most of the safety recommendations made in this paper are already being carried out.

We need to anticipate but little more dermatitis from the manufacture and processing of synthetic rubbers than we have had from natural rubbers provided future plants are erected with the same careful planning as the present ones, and the safety recommendations in this paper are carried out.

B. Accident Control in Processing Synthetic Rubber

GLEN D. CROSS
Safety Director, Firestone Tire and Rubber Co., Akron, Ohio.

In the manufacture of rubber products, either from natural or synthetic rubber, the various ingredients and rubber are carefully weighed into batches and mixed together in perfect dispersion. This mixing is usually carried out on a rubber mill or in a Banbury mixer. In many cases, both pieces of equipment are used to get better dispersion.

The rubber mill has been used in the Industry for years, and is used not only for mixing, but also in breaking down, cracking, washing, grating, refining, and warming of rubber and rubber compounds. The extensiveness of its use and the hazards involved, make it necessary that any discussion of safety in the Rubber Industry include safety in the use of the rubber mill.

The mill is a machine with two oppositely relvolving, adjacent chilled rolls. One revolves at a slower speed than the other, and the opening between them is adjustable. The rubber and other compounds are placed on the rolls and are carried through the "bite," or point of meeting between the two in-running rolls. The kneading action of the rolls warms up and plasticizes the material being milled and, by cutting part of the compound from the roll and feeding it back into the bank, it is possible to obtain a homogenous mixture of the various ingredients.

Realizing the inherent accident hazard of the milling operation, the United States Department of Labor, with the cooperation of the rubber companies, long ago drew up a "Safety Code for Rubber Mills and Calenders." A few of the high points in this code, with regard to mills, are as follows:

> Rule 103 states, "All mills should be installed so that the top of the front roll is not less than forty-six (46) inches above the working floor level or platform on which the operator stands, irrespective of the size of the mill."
>
> The importance of this rule is great since, by keeping this distance at least 46 inches and preferably 50 inches to 52 inches, the mill operator will do his cutting and stock handling on the side of the roll farther away from the "bite" of the rolls. If he should be caught in the stock, he has more time to operate the "safety stop" on the mill and stop the rolls before being carried to the "bite." Large diameter rolls also help in this matter.
>
> Other important parts of the code cover the location, use, and testing of the safety-trip controls and quick-stop facilities on mills. For example, the location of the safety-trip rod shall be not more than sixty-nine (69) inches above the working floor level on which the operator stands, and every mill having a diameter of the front roll up to and including sixteen and one-half (16½) inches and running empty at any speed shall be stopped within a distance of not more than ten (10) inches' travel after the safety is tripped.
>
> Realizing that the quick stopping of mills is a very important factor in safety, maximum stopping limits were set up in the code for the various sizes of mills. The code also states that safety stops should be tested daily and accurate measurements of distance of travel must be taken at least once every thirty (30) days.

Notwithstanding these safety features, on rubber mills, accidents continue to occur on them. However, they now occur with much less frequency and with less serious results than in the past. Various new safety devices, such as an emergency-stop actuating mechanism that extends farther down along the side of the mill roll, are being tried to determine their usefulness as a means of increasing the safety of mill operation.

A great many of the most serious accidents on rubber mills occur to employees who aren't authorized to operate mills or who are new employees insofar as the operation of mills is concerned. Such accidents, as the following, illustrate these points:

1. "A mill operator with only three weeks' experience was operating a 22" x 60" batch-off mill. Shortly before he com-

pleted his shift, he was stripping the last sheet of stock from the mill to the strainer conveyor. Only a small amount of stock remained on the mill. In fact, it was too small to trip to the conveyor and had to be cut from the roll. While the employee stated that he had made a horizontal cut preparatory to pulling the stock off the roll, it is the opinion of those who investigated the accident that he did not take a cut but tried to pull the stock off. In attempting to pull the stock off, his right hand became caught in it, and, although the mill was equipped with dynamic braking, the employee did not have presence of mind to trip the safety until his finger tips entered the bite."

This latter point clearly demonstrates how important it is to have mill operators trip their safeties frequently. Some firms have their operators use the safeties constantly to stop mills that are individually driven.

2. "A janitor, working around a wash mill, decided to take a piece of soap from his pocket and wash his hands in the water-spray from the wash mill. The janitor dropped the soap in the bite, and in attempting to recover it, caught his finger in the mill."

These two accidents emphasize the necessity of training new mill operators thoroughly and of making certain that only authorized employees are exposed to the hazards of mill operations.

All millmen should familiarize themselves with safe practices and follow such practices constantly. Some of the more important are as follows:

1. No one shall operate a rubber mill until he is properly trained in its safe operation.

2. Test the safety stop on the mill at the start of each shift or at any other time, before placing the machine into operation.

3. Before starting the mill, be sure that everyone is out of danger.

4. If shirt sleeves are long, they should fit snugly. Loose aprons, coat jackets, or long neckties must not be worn. Gloves should not be worn except when the stocks run hot and no torn gloves should be worn at any time. Gloves should be of the type that do not fit tightly at the wrists.

5. Do not cut rubber on the top of the rolls. Always keep the knife down and away from the bite.

6. Never stand in the mill pan. When loading mill, always put rubber in with one hand and hold on to the apron or safety bar with the other.

7. If, when cutting, you don't catch the cut—let it go—never try to reach for it.

8. When batching off, hold the end of the slab until it is cut off. Do not throw it back over the arm or shoulder.

9. If a tool (knife or shovel) slips from your hand and goes into the mill, do not try to catch it—let it go, and pull the safety.

10. Do not work on the back roll, unless it is absolutely necessary,—then be careful, and always lower the apron.

11. Learn the location and use of emergency equipment that is provided to release an employee from the rolls of a mill.

(a) Screw the rolls of the mill apart.

(b) If that is not possible, take the emergency wedges and by using the emergency sledge force the rolls apart.

(c) Do not reverse the mill.

Next, we will go into safety with regard to the use of a Banbury in the mixing operation.

Checked Frequently

Employees should make sure that the floor around the Banbury is kept free of slippery substances. All of the Banbury equipment should be checked frequently for defects. This inspection program is especially important in regard to the pin for stopping the floating weight.

After the mixing operation is completed, the compounded stock may be extruded into tubes, tired treads, or into other rubber products, may be calendered into thin sheets of rubber, or may be used to coats or impregnate fabric with rubber.

The extruding operation consists of placing the stock into a hopper and then into a cylinder with a screw located in it. The compounded rubber stock is forced through a warm head and a hot die. Caution should be exercised when feeding the hopper of the machine to make sure that hands are not placed below the top level of the hopper. A paddle should be used in forcing the rubber into the screw. This same safe practice should be used in feeding materials into the hoppers of other rubber machines, such as plasticizers, pelletizers, and strainers.

If it is necessary to remove material from the extruding machine or release a jam in any part of the machine, the power should be shut off at the switch and precautions should be taken to make sure that the power cannot be placed on prematurely.

If the rubber should be calendered instead of extruded, hazards encountered with inrunning rolls are involved. As in the case of rubber mills, a code has been drawn up to outline safe operating conditions on calenders. In fact, the same code, No. 447, covers both pieces of equipment.

High points of the section of the code on calenders are as follows:

"Rule 120. Safety-Trip Control

"(a) A safety-trip rod or a tight-wire cable shall be provided across the front and the back of all calenders, extending the length of face of rolls, to operate sensitively if it is pushed or if it is pulled. This rod shall be at a height not more than sixty-nine (69) inches above the working floor level or platform on which the operator stands and shall be within easy reach, with provision made for adjustment, either up or down, of three (3) inches in each direction.

"(b) On each side of all calenders and near both ends of the face of the roll there shall be a vertical tight-wire cable connecting with the bar-tripping mechanism at the top and fastened to the frame within twelve (12) inches of the floor. These cables should be positioned at a distance of not more than twelve (12) inches from the face of the roll and at a distance of not less than one (1) inch from calender frame."

Another important point in the code is the placing of a barrier across the full-length of the face of the rolls so that operator's fingers cannot come into contact with the bite, where sheeting, duck, or other fabric is fed.

As in the case of mills, stopping limits for calenders are given. These limits vary according to the speed of the drive roll of the calender, and not according to the diameter of the roll, as is true for mills.

Even though the various safety features are provided, safety in the operation of calenders depends to a great degree on safe practices of the operators. Some of the more important safe practices are as follows:

1. No one shall operate a calender until he has been thoroughly trained in its safe operation.

2. No clothing which can be caught in the calender—such as long sleeves, loose neckties, aprons, or unbuttoned jackets—should be worn.

3. Be sure that you are thoroughly acquainted with the safety devices on your machine. Test the safety stops each time before putting stock into the calender.

4. Before starting the calender, ring the starting signal bell and look into the mirror to see that everyone is in the clear.

5. Care should be taken in placing hands on the rolls to determine temperature. Always keep hands away from the bite of the rolls.

6. Do not grab for a mis-cut gauge. Cut another.

7. Keep hands away from guides and scrapers.

8. Calenders shall operate only at slow speed when starting fabric into the windup, and shall be slowed down at end of roll. Calenders are to operate at fast speed only when signal is given.

9. Do not force rubber into bite of rolls with hands. Use feed sticks.

10. Cleanliness about the machine is important. Do not allow oil, grease, or other refuse to gather on machine or floor.

11. The stationary hand-wheels on the wind-ups and let-offs must be used for adjusting the tension of the stock.

12. All operators must know what steps to take in case of an emergency.

Having covered the main safety items with regard to calenders themselves, it is important that we consider safety in the numerous operations in which fabric, liners, and other materials are wound on rolls at the discharge ends of calenders, spreaders, and other equipment. The use of dynamic brakes is advisable in each such operation, since a worker can easily get caught in the roll and receive a serious injury. Controls for all such brakes should be located so that they can be quickly and easily reached. Barriers, at inrunning points, also aid in preventing such accidents. Employees should be cautioned to start materials on rolls by hand and not with the power on.

After the rubber compound is extruded or calendered, the next steps vary greatly, depending upon the final product. In case of tires, the calendered tire fabric is coated with rubber cement and then cut to designated lengths on horizontal, vertical, or rotary bias cutters, the points of operation of which should be adequately guarded. The tire is then made on a tire-building machine. This machine consists mainly of a revolving drum which can be collapsed to remove the uncured tire. Tire builders must use care in starting bands on the drums, and in using pinch bars and other hand tools.

Since the number of other products, made from rubber, is so great, the hazards connected with their manufacture, between the extruding or calendering stages and the curing stage cannot be covered here. The next operation to be considered will be the vulcanizing or curing operation.

Some important safety features of vulcanizers are as follows:

1. Every vulcanizer should be equipped with a relief valve of sufficient size to relieve excess pressure quickly. Such valves should be tested frequently.

2. Pressure gauges and thermometers should be so located that they are within clear vision of the operator.

3. A pressure-reducing valve or automatic regulator should be provided to reduce the pressure to that required in the vulcanizer.

4. A steam trap for removing condensate steam from the vulcanizer must be one which will not be affected by soapstone or sediment from the bottom of vessel.

5. On horizontal vulcanizers, a bleeder valve should be provided near the front at the bottom of the vulcanizer for draining condensate or cooling water from it to prevent scalding of workmen when the door is opened.

6. On quick-opening doors of vulcanizers, a safety interlock should be provided so that the door cannot be opened while any pressure remains in the vessel.

As in the operation of all pressure equipment, safe practices on the part of operating personnel are most essential. Some of the most important will be given now.

1. No one shall operate a vulcanizer until he has been thoroughly trained in its safe operation.

2. Extreme care should be exercised to see that doors of the vulcanizer are fully closed and locked before steam is admitted or pressure applied. A circle, painted in a bright color around the lugs, which will be complete only when the door is completely closed, will help in this matter. Some of the newer jacket molds are so designed that the pressure cannot be applied until the covers are properly locked.

3. Operators should make certain that all pressure within the vulcanizer has been completely exhausted and hot water drained before any attempt is made to open the doors.

4. Care should be exercised by operators to avoid burns from coming into contact with hot surfaces.

5. Constant observation of all instruments should be made during the period of vulcanization to insure safe and proper operation of the vulcanizer.

In summarizing, I would like to again point out that safety problems in processing synthetic rubber are pretty much the same as those that have been encountered in processing natural rubber.

C. Fire Control in Processing Synthetics

H. C. JONES

Vice President and Engineer, Arkwright Mutual Fire Insurance Co., Boston, Mass.

The use of reclaimed and synthetic rubber for the manufacture of tires, shoes, belting and other rubber products presents greater fire and explosion hazard at certain processes than operations with natural rubber. Between 1941 and the end of 1943, the period when synthetics have been used in increasingly larger quantities, there has been an abnormal increase in the number of fires reported in spreading and coating. In 1943 these fires were more than 10 times the yearly average for the period between 1935-1939. The number of fires in rubber making processes, which include various operations in making tires, rubber shoes, belting and other rubber products, was nearly 4 times the yearly average for the period 1935-1939.

Fires reported from static sparks increased from seven per year prewar to forty per year wartime as the major cause of rubber occupancy fires. During the first six months of 1944 more fires from static sparks have already been reported than during the entire year in 1943. Most of these fires were at rubber cementing operations where synthetics were being processed. The annual number of friction fires, which include those from mechanical sparks, hot bearings, etc., was more than three times the prewar level, but these were probably due to continued full time use of machinery and equipment and reduced maintenance. The annual number of electrical fires, the major prewar cause, increased moderately during wartime, as would be expected with increased production. Most other causes remained at about the same level.

Larger Use of Flammable Solvents Increases Hazard

The study of the losses indicates that the use of low flashpoint solvents at certain operations in working reclaimed and synthetic rubber has resulted in an increase in the number of fires at rubber spreading, coating and making processes (except rubber shoe) since the start of the war (1941-1943). Fire experience in other rubber occupancies, possibly excepting grinding, constitutes a relatively small part of all synthetic rubber working and can be safeguarded without interfering with economical plant operation.

The fire and explosion hazards in the use of low flashpoint liquids are generally recognized in the rubber industry and good work is being done safeguarding the operations where hazardous liquids are used. This has been fortunate, for otherwise many serious losses from fire and explosion would probably have occurred during this early period of the processing of synthetics.

In spite of the yearly increase in the number of losses reported during 1941-1943 the total yearly amount of loss at the rubber plants has not increased greatly for the frequent fires have been put out with little or no damage. The average loss between 1935-1940 was about $450 while in the period 1941-1943 the average loss was only about $215. There is the danger, however, when the frequency rate is increasing that one or more of the numerous small fires will get out of control and do large damage. These frequent small fires also interrupt production and cause considerable inconvenience.

Rubber Cement Coating of Synthetics and Safeguards

Buna S is the synthetic generally used today in the manufacture of tires, shoes, belting and other products. While it has many properties similar to natural rubber, it does not possess the tackiness of crude rubber which keeps the layers of fabric together. It is therefore necessary to apply a film of rubber cement to surfaces of synthetic calendered stock.

Rubber cement coating machines of various types are used to apply this coating. The calendered synthetic rubberized cloth passes through a bath of rubber cement and then through a heated zone.

The proper isolation of the rubber cement coating and drying operations is of primary importance for rubber cement spreading. A detached, sprinklered, non-combustible building for the process is preferable. The sprinklers should cover not over 65 sq. ft. each. If the process must be within the main building, it should be located in a sprinklered area separated from other occupancies by fire walls or substantial fire resistive partitions with automatic fire doors at entrances. Pits or depressions where flammable vapors can settle must be avoided. A well drained, waterproof floor is needed to prevent water damage should fires occur and sprinklers open.

Explosion venting area in the ratio of 1 sq. ft. to each 50 cu. ft. of room volume is needed to lessen damage in the event of an explosion. This can usually be obtained by explosion venting windows, doors, or roof hatches.

Cement coating of calendered synthetic rubber fabric is being done in calender rooms at certain rubber plants. After calendering, the hot fabric immediately passes to a rubber cement coating and drying machine. The coating section of the machine is equipped with one or two rubber cement troughs where rubber cement (80-95% high test gasoline) is applied to one or both sides of the synthetic rubber sheet. From the standpoint of safety from fire and continuity of production, it is inadvisable to locate a rubber cement coating and drying process in an important area of a manufacturing building, especially when there are conditions which could result in serious injury to employees, large property damage and prolonged interruption of production if destructive fire or explosion occurred. Such a location should be avoided in favor of a detached, safe building or cut off area.

When the process is located in a calender room, the well recognized safeguards for rubber spreaders are of utmost importance for the safety of the process depends greatly on them. The coating and drying sections of the machine should be enclosed with fire resistive partitions and the enclosure equipped with explosion venting doors in the ratio of 1 sq. ft. for each 15 cu. ft. of enclosure volume. The explosion-venting doors need to be well braced to prevent damage to them in the event of an explosion and so arranged that they will close tightly after venting an explosion. The floor under the coating and drying sections should be waterproof and drained to a safe location.

Adequate ventilation is of utmost importance. The dryer evaporation rate usually runs from 1 gal. to nearly 4 gals. of solvent per minute. There is sure to be trouble if the ventilation is not sufficient and is improperly designed. The ventilation rate around the coating unit and drying table or in the dryer section should be sufficient to remove 10,000 cu. ft. of air at 70° F. through exhaust ducts which extend above the roof for every gallon of solvent evaporated.

Because of two fires in a rubber cement coating dryer at a rubber plant, an investigation was made to determine if adequate ventilation was being afforded by existing equipment and to devise practical means of preventing recurrence of such losses. The ventilation was found to be only 60% of the amount required for safe operation and about 50% of the amount believed to have been afforded by the existing fan. In numerous other cases where fires or explosions have occurred the ventilation was found inadequate or imperfectly designed. It is advisable to run tests to determine the rate of evaporation of the gasoline used to thin the rubber cement. The exhaust rate should then be measured to be sure that there is ample ventilation to remove the flammable vapors.

A serious fire and explosion hazard would quickly result from failure of the ventilation fan, for explosive vapors would pass into the calender room outside the coating and drying machine and if ignited an explosion with disastrous results might occur. The ventilation should, therefore, be interlocked with the machine operation by means of an approved air-flow switch so that failure or reduction in ventilation will immediately shut down the equipment. A time delay relay should also be provided so that the fan must operate at least three minutes before the machine can be started. When it is not practical to interlock the exhaust fan with the conveyor drive there should be an alarm which will sound in the event of ventilation failure.

The dryer section of the enclosure can be most effectively protected with an automatic water spray nozzle system with manually controlled spray nozzles or open sprinklers in the coating section. In addition, an automatic foam system or carbon dioxide equipment would provide dependable protection for the rubber cement troughs. A strainer and flushing connection is necessary in the water line supplying the spray nozzles to prevent plugging of the nozzles by foreign material in the water. Some plants have provided slide fitting brass blow-off caps to cover the spray nozzles to exclude cement residue and prevent obstructing the nozzles. Instead of water spray protection, automatic high temperature sprinklers on a close spacing of 6 ft. through the dryer and coating sections can be arranged to provide good protection.

For the quick handling of fires by employees, an approved water spray nozzle for use with 1½ in. hose is recommended with men in the department thoroughly trained to use it. Water spray is suggested because it is effective on both flammable liquids and ordinary combustibles.

The operation of the heat actuated devices and release controlling either the spray nozzle system or the foam or the carbon dioxide should automatically shut off the rubber cement supply to the troughs, shut off the ventilation fan motor and close fire dampers between the coating section and dryer section and in the ventilation ducts.

Removal of rubber cement accumulations on static collectors, spray nozzle blow-off caps and in the interior of the dryer, fan and exhaust system is needed at regular intervals. There should be a definite schedule for testing of the automatic fire protective equipment including dampers, releases and cement shut-off valves.

All electrical equipment at the coating process should be of the explosion-proof type with the exception of lights, which, if at the ceiling, may be of the vaportight type. It is particularly important that any motors located on the floor within 20 ft. horizontally of exposed flammable liquid be of the explosion proof type or be protected against flammable atmospheres, by complete hooding and separate ventilation to the outdoors. All wiring should be in rigid conduit. Explosion-proof, push button controls are needed or ordinary controls should be located a safe distance away.

The rubber cement should be supplied to the troughs in the coating section through a permanently piped system by direct pumping from a well cut off mixing room. In some plants 200 gal. rubber cement storage tanks supply the rubber cement by gravity to the troughs at the coating section. A gravity supply should be avoided if possible. Where a gravity system is used to supply the rubber cement, certain precautions must be taken. The tank should be enclosed by fire resistive partitions with automatic fire doors at all entrances to the enclosure. The floor inside the enclosure should be water-proof and be drained through trapped drains to a safe outside location. Curbs four to six inches high are needed at doorways. The electric lights must be equipped with vapor-proof globes and adequate ventilation provided to insure three or four changes or air per hour in the enclosure. The tank should be equipped with a 1¼ in. vent pipe to outdoors and protected by a flame arrester. The discharge pipe from the tank should have a fusible link operated valve at the tank and also at the point of use. The tank should be filled from closed portable containers of 40 gals. capacity equipped with screened vents and approved hand pump.

The finished cement coated fabric should be moved out of the calender room as rapidly as possible. The space around the coating and drying machine should be kept clear of all material subject to water damage.

Static Electricity as a Fire Cause and Preventive Measures

Static sparks start most of the fires at spreaders. Static charges of many thousand volts can be generated within one foot of the contact of the rubberized cloth with the equipment. While it is impossible to prevent the generation of static electricity, it can be neutralized or conducted to ground as fast as generated.

The methods used successfully at certain rubber plants to reduce trouble from static electricity at spreaders have been (1) adequately ground the entire frame of the spreader. The rolls of the machine have been connected to the frame by providing cone-shaped plugs made of a graphite impregnated metal inserted into a cone-shaped depression in the end of the roll bearings. (2) Grounded static collectors consisting of fine brass or bronze bristles on a twisted wire core have been provided. The brush extends across the full width of the fabric and is mounted with the ends of the bristles one-half to five-eighths inch from the fabric. The brush and its support are thoroughly grounded and one is located at every point along the fabric where static electricity is found.

Arrangements must also be made to remove static where the cloth is re-rolled after it leaves the dryer. The finished cement coated fabric retains an appreciable quantity of solvent and will be more or less flammable when spread out and exposed to ignition sources.

Periodic tests for static electricity on the fabric and on the operators should be made with a static tester. Employees who have a dry skin and consequently are prone to collect static charges should preferably be given other work, although it is possible to discharge the static safely by means of grounded nonferrous floor plates and safety-type shoes.

The maintenance of at least 40%, or preferably 50%, relative humidity is important to help prevent static sparks at rubber spreaders. Much higher humidity has been applied in some cases. This higher humidity is probably not needed if all the static collectors necessary are provided and if they are maintained and kept clean.

The practice of filling the rubber cement troughs with a pail from a metal drum is not safe. This operation can create static electricity on the drum and on the operator. If portable containers are used, the cement tank should be filled by use of an approved drum pump or directly from the drum, which should be electrically bonded to the tank during the filling operation. The drum should be equipped with a self-closing valve so that if a fire does occur while the cement tank is being filled and the operator is driven away, the contents of the drum will not be discharged into the tank during the fire.

Trouble from static electricity has also occurred with the handling and unrolling of the coated cloth. Arrangements should be made to remove this static charge at the point where the cloth is unrolled and also where it is re-rolled.

Other trouble has occurred in tire factories where fires have started from static sparks on bias cutting machines. These fires can be eliminated if the machines are completely grounded, including spring brush contacts on the roller shafts and continuous drag chains on the fabric where necessary, and if sufficient humidity is provided. Fans blowing an air stream directly across the machine parallel to the let-off and rewind rolls have been effective in eliminating trouble at one plant.

Fires have occurred at tables used in connection with cementing jobs. Such tables should have grounded conductive tops, grounded conductive floor around the tables and the employees working at cementing jobs should wear conducting footwear. The maintenance of at least 40% relative humidity will also help eliminate trouble from static. The grounds must be regularly inspected and properly maintained.

Safeguards in Preparing Rubber Cement

With the greater amount of rubber cement required when processing synthetics, certain plants will have to increase their facilities for preparing it. Rubber cement mixing involves similar hazards and requires safeguards similar to those discussed above in connection with rubber spreading. The process should be carried on in a detached or well cut off, non-combustible, well ventilated, sprinklered location. Preventing the escape of vapors into the room is essential. This requires storing the solvent in outdoor buried tanks and pumping it through pipes attached directly to closed churns. Good room ventilation is desirable. The most common source of ignition, static electricity, is prevented by grounding belts and machinery and by maintaining at least 40% humidity. Safe electrical equipment and the elimination of mechanical sparks and open flames are also important. Explosion venting windows are needed to reduce damage in case of an explosion.

General Remarks

The safeguarding of each particular process where there is rubber cement spreading of synthetic rubber requires special study as to details, but an adaptation of the principles discussed above for protection of rubber cement coating and mixing can be used as a guide in determining the safeguards that are needed.

A program for educating operators in the potential hazards of occupancies using flammable liquids is desirable. Rubber cement and similar hazardous solvents should be brought into the buildings only in safety cans or properly designed portable containers with approved hand pumps and should be removed to an outside safe location for refilling.

The symposium closed with a discussion led by Thomas H. Boyd.

WEDNESDAY MORNING SESSION

October 4, 1944

Presiding: General Chairman Paul Van Cleef, Van Cleef Bros., Chicago.

A Symposium—Safety Problems Created by Limited Labor Supply

Discussion Leader: J. E. Lovas, Safety Supvsr., U. S. Rubber Co., Passaic, N. J.

A. How to Use the Handicapped War Veteran Safely

CASSIUS E. HOSTETLER

Chief, Vocational Rehabilitation and Education Division, Veterans Administration

A short time ago I discussed postwar planning with the gentleman who was President of the Chicago Association of Commerce during World War I. This gentleman told me that the sum total of all postwar planning during World War I would probably not add up to what we had discussed during the luncheon hour. This is not true today. We are doing much thinking and much planning, looking forward to the postwar period.

We speak glibly of what industry must do to furnish employment opportunities. I think all of us will agree that industry can not in itself make jobs—jobs are made only to the extent that the public can and will buy the goods produced by the manufacturer. I have heard outstanding men of the country say that industry must furnish employment for forty-five to fifty million men in the postwar period. I think we should revise our thinking in connection with the possible employment opportunities in America in the postwar period.

May I call your attention to the following chart showing employment in different fields since 1870.

Occupation	1940	1930	1920	1910	1900	1890	1880	1870
Tot. Wkrs.	45,166,083	48,829,920	42,433,535	37,370,794	29,073,233	23,318,183	17,392,009	12,924,951
Agricul. — including Forestry and Fishing	8,474,432	10,722,467	11,718,984	11,833,573	11,121,337	10,120,678	8,682,093	6,910,003
	19%	22%	28%	31%	38%	43%	50%	54%
Industry — including Mfg., Mech. and Building Industries	12,629,116	14,110,652	12,860,914	10,656,545	7,199,208	5,525,691	3,841,487	2,643,417
	28%	29%	30%	29%	25%	24%	22%	20%
Service — including Transport., Commun., Pub. Util., Trade Finance Insurance Real Estate Profess'nal Service Real Est. Personal Service Busi. & Rep. Serv. Clerical Gov't. Mining	24,062,535	23,996,801	17,833,637	14,880,676	10,752,488	7,671,814	4,868,519	3,371,531
	53%	49%	42%	40%	37%	33%	28%	26%

Let us break down these various fields of employment briefly to bring out the points I have in mind. In the manufacturing field we furnish employment to those skilled in crafts, etc., while those in the service field furnish employment to millions of workers in what we might term non-manufacturing activity. I am thinking of such fields as teaching, the ministry, sundry service occupations, transportation, etc. As our standard of living increases, we demand greater services. The use of refrigerators, vacuum cleaners, motor cars, electric lights, radio, etc., has been brought about as the result of the demand to supply these services which in former years we got along without.

In 1870 agriculture furnished employment to approximately 54% of the workers in the country; industry or manufacturing 20%; services 26%. In 1940 this figure was changed to 28% in manufacturing, 53% in the services, and 19% in agriculture. Technological progress has made it possible for industry to increase tremendously its production without an appreciable increase in the percentage of workers employed. The same thing is true in the field of agriculture. The mechanization of the farm has made it possible to increase production, at the same time reducing the percentage of workers in this field. The demand for additional services from year to year furnishes employment to a larger number of persons than in either agriculture or manufacturing.

There does not seem to be a united effort to present an overall picture of what the postwar employment requirements will be except to say that we must furnish employment to fifty million or more workers after the war. In attempting to set up an understanding program it seems to me that we should start on a community level. Let each community of the state analyze its postwar employment possibilities, something after the fashion of the city of Albert Lea, Minnesota. Here they attempt to present a picture of the employment of the various activities in the area. Then we need to present a state level possibility; after the development of the state level employment possibility, we need to present a picture of the national possibility.

One of the problems we can under no circumstances overlook in this program of dealing with employment problems is the part the veteran will play.

When I was assigned to my present duties, I decided that it might be desirable to make an investigation to ascertain what industry had been doing in recent years regarding the employment of disabled workers. In this brief investigation I learned that some years ago the proprietor of a large industrial enterprise established a definite policy of employing disabled workers. He had learned that the loss of certain abilities did not mean the total loss of all abilities and that through the proper utilization of the remaining abilities a person could be trained to do a normal day's work. As a consequence he organized an adequate staff of medical men and personnel specialists to put his plan into operation. In brief, the plan works something like this: When a disabled person applies for a position, he is turned over to the medical department for study. His disabilities are analyzed from the standpoint of occupational pursuits which will utilize to the maximum his remaining physical abilities without aggravating his disability. After this analysis has been made, the personnel specialist is consulted to determine the kind of job the man can do in the light of medical findings. A shop foreman is brought into the picture to assist in directing and supervising the actual employment of the man. This policy has been proved so sound that the management proposes to expand the present program of employing handicapped persons. I use this illustration to show what can be done when we organize thoroughly for a given task.

As of December 14, 1942 there were emloyed in one plant 11,163 disabled persons. Of course many of the disabilities listed are minor, but others are quite serious.

For example: They had employed 91 persons with one arm amputated and 3 persons with both arms amputated. These men act as watchmen, attend doors, operate elevators, pick up papers and work on salvage. Some of the one-armed workers are aided by the use of an artificial arm.

One hundred and eleven deaf mutes were employed; these men are allowed almost any type of employment. They are, however, kept in buildings where there are no overhead cranes; this is to protect them from falling stock.

One hundred and thirty-five epileptic persons were employed; these men are placed on sweeping, light bench work, inspection and the like. This is most encouraging. Those of you who have attempted to secure employment for epileptics know what a difficult task this is.

Thirty-five totally blind persons were employed in such work as packing small stock for shipping, assembly work and inspection.

Three hundred and eighty-two persons blind in one eye were employed on bench work, sweeping and similar jobs but are not permitted to work on machines where there is a possibility of eye injury or to pursue any other occupation barred by the Safety Department.

Three hundred and ninety-seven persons with finger amputations were employed in varying occupations depending on the extent of the disability. Many of these workers are on regular production work on benches or machines; others work on salvage, cleaning departments and so on.

Two men with both legs amputated were working at such jobs as permit sitting; they pack stock, repair electrical equipment and do inspection and clerical work. There were 157 persons with one leg amputation. With the aid of an artificial limb some of these men do full time standing work at machines and production benches; others work at jobs similar to those pursued by workers with both leg amputations.

I am not going to attempt to cite workers falling in all of the seventy-one categories, but I have attempted to give a few to show what a carefully organized program based on such a policy can accomplish.

Visits Plants

A short time ago I visited one of our large industrial plants in Chicago. Here I found two blind workers, veterans of World War I; they were performing responsible functions. The official who was showing me around made the statement that *these men spread more happiness and inspire others to a greater production* than any one else in the plant. Both of these men had developed a high degree of skill in their work and were considered most essential in the war production of this plant. The foreman told me that the production of one of these workers was above that of most workers doing similar work. I asked the blind worker how he accounted for this increase in production. His reply was a simple one—"I can't see all the foolishness that goes on around me and I just keep on working."

Some time ago I heard about an employer by the name of George Barr, who has employed in his plant about 92% disabled workers. George is appearing on another program at this convention. I appeared with him in a panel discussion some time ago, before the Illinois Manufacturers Association. He accused me of "stealing his stuff." I want to say to you here and now that no one can steal his stuff. He has had a most unique experience, and I know you will enjoy reading his story.

A few years ago it was thought that disabled workers would add to the difficulties of the employer; that there would be a high rate of absenteeism; that they would not carry their share of the load; that they would not reach production standards; and that they would be prone to accidents. None of these things has proved true. Inquiries made of more than 100 employers of physically impaired persons brought replies from 56.6 per cent that the handicapped had a lower accident rate than the ablebodied; and from 41.4 per cent that their rate was the same as that of the ablebodied. With respect to labor turnover, the handicapped had an unfavorable record as compared to the able bodied in only 1.3 per cent of the cases, and in 82.9 per cent they had a lower rate. In 54.6 per cent of the cases their absenteeism rate was lower, and in 40.2 per cent no higher than that of the ablebodied. In production, they were above the ablebodied in 23.8 per cent of the cases, and equal to them in 65.7 per cent. The Civil Service Commission in a recent report gave an equally favorable picture of the disabled. Back in 1931, J. W. Dietz of Western Electric, conducting an experiment with a group of workers having physical handicaps but normal health, found that there were fewer absences because of illness and fewer accidents compared with the records of normal workers. Certainly these facts alone should encourage the employment of our handicapped veteran, even if all social and patriotic motives were disregarded.

We have ample evidence that disabled workers can develop a high degree of efficiency. The whole question of successful retraining and reemploying the disabled lies in *adequate training and proper placement.*

In considering a program of rehabilitation of a handicapped veteran we need to recognize five factors:

First. It is very important that we know in what way and to what extent the disability of the veteran limits his ability to work. If a veteran has lost a leg, an arm, or an eye, there is nothing we can do to replace this loss; it is true that the veteran's disability may be lessened by applying prosthetic appliances, but that is all.

Second. It is important that we have full knowledge of the physical abilities remaining and what the veteran can do with these abilities. What we are in a position to do with a disabled veteran will depend on his intelligence, occupational experience, interests, aptitudes, developed skills and the additional knowledge that can be acquired. In many instances it is possible to capitalize on the veteran's previous training or experience. In other cases we need to select an entirely new field of activity.

Third. We need to know the requirements of the job. After a thorough analysis of the veteran's physical impairment and what abilities he has remaining, we must know the physical as well as the scholastic requirements of the job for which the veteran is to be trained. In connection with the requirements of the job we must know the type of training that is necessary to achieve the employment objective that has been established.

Fourth. Training facilities of educational institutions, industrial establishments, farms and governmental agencies are utilized in training these veterans for employment. Training into employment is our chief aim. This employability may be attained by institutional training, training on the job, or both institutional and job training.

Fifth. The attitude of the man who will employ the veteran after he has been trained is vital. I think all of us recognize that the difficult problem in connection with securing employment for our physically disabled veterans arises from the attitude of the employers toward employing persons with disabilities.

The successful employment of the disabled is the result of careful study on the part of government and industry, a study which looks forward to a determination of suitable kinds of work for disabled persons. This may require the reconstructing of certain jobs so that the disabled persons can perform them properly. All of us recognize that there are certain jobs that persons with disabilities can not do, but there are relatively few jobs that can not be performed just as well by properly trained disabled persons as by able bodied persons.

One large plant made a careful classification of disabilities and the types of jobs that persons with disabilities could perform. In this study were listed 2,170 jobs. I am sure you will be interested in the breakdown of the disabilities that were listed in connection with this study:

257 jobs could be performed by deaf-mutes;
240 by those with leg disabilities;
66 by those with only one hand or arm;
155 by those with back or spinal injuries;
150 by those with heart disease;
67 by those with defective vision;
207 by those with pulmonary disease.

This is approaching the problem on a well organized scientific basis. Similar studies are being made by many other industrial plants throughout the country. Their contributions will be invaluable in our efforts to make employers "handicap worker conscious."

The disabled may be able to do a specific job as well as an able bodied person, but they can not do as many different jobs. Sometimes this makes it difficult for small industries to give employment to handicapped persons because it becomes necessary to shift workers from one job to another. But even in small industry there are many jobs suitable to persons with various types of disabilities.

Asset Value

As I have stated before, there is a definite asset value in rehabilitated persons. Let us look at the record to see what this problem really is. The losses through injuries in industry, for example, stagger the imagination. The compensation for injuries in industry in Illinois was 7 per cent greater in 1942 than in 1941. In Illinois alone during 1942 we had a total of 43,107 injury cases with an aggregate compensation of $9,065,357, compared with 41,454 cases shown in 1941 involving $8,502,930 compensation. These figures, of course, do not include many injury cases in and out of industry. For example, injuries in which disability terminates within a seven days waiting period are not compensable in Illinois and are not recorded. If all these disabling injuries were recorded, we could add to the 43,000 another 116,000, and if we were to add to this figure those injuries sustained in the home, the figure of course would be much larger. Now these figures are for Illinois alone. If we had available the figures for the entire United States, we would have a fuller realization of the tremendous economic losses caused by accidents and subsequent physical disabilities.

Let us see what the record is with respect to the known number of disabled persons throughout the United States. In a recent survey it was estimated that there was a total of approximately 2,500,000 people in the United States with orthopedic handicaps, 3,700,000 with heart disease, 680,000 with tuberculosis, 114,000 totally blind and 65,000 totally deaf. These are more or less major disabilities. If we add the veterans coming out of this war with disabilities, to civilian disabilities, it will be possible to get some notion of the magnitude of this problem—a total of approximately 8,309,000 disabled persons. This is a problem industry cannot close its eyes to. The loss of manpower to industry if these veterans go untrained staggers the imagination. If we do our duty and train these veterans adequately, so that they can carry on successfully on a comparable basis with the normal worker, the asset value to industry and society is incalculable.

The notion that everybody must be physically perfect to do a job is rapidly disappearing. Job qualifications that have no relation to the specific work are being scrapped as signs of managerial inefficiency. Jobs are being analyzed from the point of view of the physical abilities required to perform them. It is true that in the past there have been analyses to show work operations for the purpose of job improvement. But the use of such analyses for the purpose of discovering jobs suitable to individuals with different forms of disability, or the redesigning of jobs so that they may be performed by the disabled, have been rare to date. The greatest amount of experience in redesigning jobs to make them suitable for persons of varying abilities has been in industries employing large numbers of new women workers. With some six million women drawn into industries, it was found necessary to restructure jobs so that the light parts could be done by women and the heavy parts could be done by men. The companies analyzed the jobs into unitary skills and recombined the elements into new jobs suitable to women on the one hand and to men on the other. A number of firms found that this redesigning resulted in improvements which have cut down costs.

Some day a new science of work will solve the problem of suiting jobs to people, including the handicapped, but while industrial engineering is experimenting with new work concepts, it is probable that the problem of the handicapped of this war can be handled by selective placement following relatively simple surveys of plant operations as they now exist to see where the abilities of the handicapped of various types may be utilized.

It would be a fine thing if management could reach some resolution setting forth a positive policy on the training and employment of disabled veterans, and include in it a determination to secure a revision of the workmen's compensation laws in those few states where there still exist penalties for the employment of the disabled, and also a decision on an employment ratio for the disabled.

Naturally we are unable to give any facts or predictions concerning the number of the war disabled. It will be large. A place *must* be found in our society for all of those disabled who can be rehabilitated. The problem which I have presented to you and which the Veterans Administration faces with you constitutes a stirring challenge. American business has proved it can rise to a challenge. It has worked the miracle of production by which the tide of battle has been turned. When the war is ended "and the battle flags are furled," there will be, among others, this task. I am certain that American business will have the imagination, the courage, and the patriotism to meet it.

B. Psychology as an Aid to the Foreman

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I. Introduction

In coming here to discuss psychology as an aid to the foreman, it would be presumptuous to imply that much of what we may say will be either new or startling to you, for if we define psychology as the study of human nature, it is clear that any human being who deals with human nature must in some sense be a psychologist. Most especially it is a large part of the foreman's job to deal with human nature, and he is thus forced to become a psychologist, in this practical every day sense. The successful life insurance salesman who makes the "Million Dollar Round Table," the successful politician and the successful supervisor must all be successful in part because of their ability to deal intelligently with human nature.

It has not, then, been the contribution of scientific psychology to discover any startling ways to deal with human nature which were unknown to the successful practical handlers of men. That contribution has been rather in the laborious observation of these successful dealers with human nature and in the careful recording of what works and what doesn't work—the sifting of the truths from the half truths and the falsehoods in the common lore of mankind. Despite the core of truth in our common knowledge of humanity, our every-day beliefs about human nature are actually full of contradictions, as is well illustrated by many of our proverbs. For example, "out of sight, out of mind" sounds true enough until we remember that "absence makes the heart grow fonder." "Look before you leap" seems to be a worthy precept until we recall that it is also said that "he who hesitates is lost."

The point is that the expert handlers of men are *not* always expert in pinning down just what it is they do that works; and it has been the task of the students of human nature to observe, record, and summarize the formulas of success in dealing with people.

Let us examine a few of the recently emphasized principles of dealing with people, with full recognition that in the main these principles are familiar to all of us, but with the hope that their repetition may be of some help in carrying out the major responsibility of all of us: that of dealing capably with the human problems that confront us as supervisors.

In choosing the particular items we are to discuss, I have not attempted to make an outline which would provide thorough coverage of the supervisor's job from the psychological standpoint. They have been chosen almost entirely because they seemed individually to be important and because it seemed possible to say something about these matters which might give them a new emphasis in our thinking.

You will note also that in the choice of items to be discussed, there has been no effort to point them specifically toward the problem of safety. The fact is that the psychology of human nature does not suddenly change when the problem is one of safety. The procedures which are useful in dealing with human nature are about the same, whether we are thinking of safety, wages, promotions, efficiency, or any other matter in which the foreman may find it necessary to take account of the characteristics of people.

II. Why People Work

One of the most frequently discussed topics in industrial psychology is that of "motivation." There has been much armchair speculation and considerable scientific study of the factors that lead people to work and which stimulate them to work effectively. I suppose we are all tempted to dismiss the whole topic of motivation to work by citing the obvious fact that "most people work because they have to." But beyond the level at which people will work because they have to, there are, of course, much *higher* levels to which they can be stimulated by having additional reasons for good performance. We shall not attempt to cover the field of motivation exhaustively, but there is one factor that has received much recent emphasis that may be worth some discussion. That is that *perhaps the most important thing that a worker wants from his job and his company is a "sense of belonging."*

Not so many years ago in our discussions of the factors affecting efficiency and morale at work, we used to talk a great deal about the physical conditions of work. There were studies of the effects of illumination, ventilation, temperature, hours per day, days per week, and rest periods on the efficiency and morale of workers. There is no doubt that these factors were of some importance. Nearly all studies of these matters, wherever conditions could be controlled sufficiently to warrant any conclusions at all, showed that there are "optimum points" with respect to such variables, at which points efficiency tends to be at a maximum. However, possibly the most striking finding of these studies has been the discovery of the power of the human organism to adjust to conditions and to perform with good efficiency even under relatively adverse circumstances, provided only that the *will to do the job* is present.

It is evident that as distinguished from the physical factors just enumerated, psychological and sociological influences are vastly more powerful in determining the extent to which people can function with effectiveness and satisfaction on their jobs. Among these factors, none is more powerful in its effect on people's behavior than what we have referred to as the "sense of belonging." In a broad sense, the "sense of belonging" pertains not only to man's work situation, but also to his position in the entire community in which he lives. This sense of belonging is illustrated perhaps more by our sentiments toward our home town by our attitudes toward any other matter. Those who do not develop a feeling of participation in their communities, a feeling of being "at home" with their fellow-residents of the community, tend to become the unconventional people, the non-conformists, the maladjusted ones, the ones who are "out of tune" with the world in which they live.

The sense of belonging is equally important in determining a man's effectiveness at work. If he refers to the company as "we," if he identifies himself with the organization in which he works, if that organization is a part of him and he feels he is a part of it, a great deal of the basis for effective performance is present. If, on the other hand, he thinks of the company as "they," his interest in performing his job to the best of his ability is probably not deep enough to motivate him to put forth his best efforts.

As we look at the phenomenal success of the firm of Jack and Heintz, we are struck chiefly by the extent to which the employees of that organization apparently have acquired a sense of participation and belonging.

Some of the factors contributing to the fostering of this attitude may be enumerated.

A. There must be clear-cut procedures for the handling of personnel matters such as wage adjustments, promotions, transfers, etc., and these policies must be known to the employees. Such policies enable the employee to recognize that he is being treated in accordance with the "rules of the game" rather than on the basis of an arbitrary edict of invisible management. Such policies add to his sense of stability and security. They enable him to believe that he is living in a world that "stays put" rather than a world that is "subject to change without notice."

B. The employee must be able to see that he has a recognized function, that his function is important, and that it contributes to the success of the company. In this connection, you will recall that Bill Jack, of Jack and Heintz, has set up a public address system in all departments of the organization and that he personally takes occasion at frequent intervals during the day to tell employees about the progress of their work. If a new order has just come in which will require increased effort, or if yesterday's production was particularly high or particularly low, this information is relayed to the people at once.

C. Perhaps most important of all, the employee must feel "at home" with his fellow employees and supervisors in his own immediate organization. Fundamentally, it is so evident that people should be led to feel at home in the job situation that the point may seem too obvious to mention. Nevertheless, it is common knowledge that the attempt to settle technical, production and organizational problems so often absorbs the whole attention of supervisors that, in actual fact, little systematic provision is made to enable employees to adjust to their work situation. For example, it is certainly clear that a new employee, particularly in a large organization, is bound to feel confused and bewildered in his first days on the new job. He doesn't know how to punch his time clock, where the wash-rooms are, where the restaurant is, or where to hang his hat. He may not even know how to get in and out of the premises, except by following the procedure of trial and error. Such confusion and bewilderment lead to heavy turnover in the early days of employment; and the unpleasant experiences of these early days may be difficult to correct at a later date. Despite the fact that this is so obvious, it is more often true than not, that new employees are left to learn these things as best they can.

We set up facilities for the maintenance of machinery in good working order because we are aware that they will not have sense enough to maintain themselves. Somehow, we assume that the multitude of little things which contribute, day by day, to the feeling of participation and the sense of belonging on the part of employees can be neglected on the basis that they will have sense enough not to be influenced by such apparently trivial matters. The fact is that no matter how trivial the sense of belonging may sound and no matter how trivial the factors that contribute to it may appear to be, these matters have a more powerful influence on the efficiency and stability of the human machine than all the air-conditioning and fluorescent lighting which might be installed as a substitute.

III. The Job of the Foreman as Supervisor

Having considered one aspect of the problem of motivating the individual worker, we may turn now to an entirely different topic: that of the job of the foreman as a supervisor. Obviously, the foreman has many responsibilities other than those which are directly supervisory. He is responsible for technical and organizational problems which do not necessarily involve his ability to handle men in the supervisory relationship. Looking specifically at his supervisory job, it involves basically two activities. First is his job of *communicating* up and down his line of authority. It is necessary to communicate problems and proposals up the line, as well as to communicate problems and assignments down the line. Second is his responsibility for *making decisions* as to actions which are to be taken. With respect to these supervisory responsibilities, you may be interested in some principles which were once arrived at by a group of supervisors who met to discuss these problems. The materials presented in this section were organized by the Training Department of the Hawthorne Works, Western Electric Company, and are based upon a series of conferences with department chiefs at the Hawthorne Works. You will note throughout this list of principles how completely they revolve around the two chief responsibilities of communication and decision.

1. Listen to the whole story as brought to you by your subordinates rather than "jumping to conclusions." Arrive at a decision based on all the facts.

2. Make definite decisions so that your subordinates are in no doubt about where you stand.

3. Make decisions promptly. Don't sit on a decision beyond the time when action is urgently needed.

4. Give reasons for your decisions so that subordinates can understand the whole situation and thus act more intelligently.

5. Back up your decisions in every respect under your control. One comment made concerning this point may be worth quoting: "After we have pitched in and done a 'hot job' for the boss, we hate to have it sit on his desk for weeks or months without getting any action. Half of our satisfaction in doing a job well is lost unless the job goes some place."

6. Be able to change your mind in case new facts are brought to light which show that a previous decision requires modification.

7. Develop a consistent policy of your own. See that it is clearly understood by subordinates so that they keep their own organizations in line without running to the boss too often.

8. Base your policies on the best interests of the organization and the company, rather than engaging in "political footballing."

9. Delegate to subordinates as much responsibility as possible.

10. Keep subordinates informed concerning all activities which have a bearing on their work or their organization.

11. Keep subordinates informed as to broader phases of company policy, business outlook, etc., so that they may guide their activities accordingly.

12. Evaluate subordinates fairly and impartially on the basis of their work.

13. Take an active interest in the progress and advancement of subordinates.

14. Maintain a sincere personal interest in subordinates as individuals. Extend that personal interest as far as possible to the individuals in the entire organization.

15. Avoid taking your position too seriously—feeling too much self-importance.

IV. The Importance of Listening

We have just discussed the job of the foreman as supervisor—that is, as one whose task is to make assignments and coordinate the work of others in achieving a company objective. In addition to this task which is to a considerable extent psychological in nature, every supervisor is also required to deal with the personal and emotional problems of his people, as distinct from the objective and concrete problems involved in his normal supervisory relationship. In this connection, one procedure has been developed during recent years which has received so much favorable attention that it merits some discussion at this time. This procedure suggests that *in our day-to-day handling of people, the most important thing we can do is to listen.*

Perhaps no single technique for the capable handling of human beings has received the emphasis during the past ten years that has been accorded to this simple principle of wise and thoughtful listening. Although the principle of listening is implied in much of the literature of clinical psychology and psycho-analysis, the industrial implications of the method have been profoundly influenced by the thinking of Professor Elton Mayo of the Harvard University Graduate School of Business Administration. Many of you will be interested in reading Professor Mayo's book, *The Human Problems of an Industrial Civilization,* if you have not already done so. Professor Mayo's thinking is also reflected in the well-known "Hawthorne experiments" which have been reported in Roethlisberger and Dickson's, *Management and the Worker.* In the academic setting, Professor Carl Rogers of Ohio State University has used the method in counseling college students, and you will be interested also in his book, *Counseling and Psychotherapy.*

I should like to emphasize further that this method is not really the one which we commonly think of in attempting to help people. It is really a new and significant tool, in the sense that many expert practical handlers of men do not commonly employ it to its fullest extent.

What is our common way of attempting to help people when they come to us with problems? Well, first we do listen to them for a while, of course, in order to form some notion of what they say their problem is. Second—and before they have even begun to talk themselves out—we formulate our own notion of what they ought to do to solve their difficulties; and third, we proceed to give them what we believe to be some good advice. We tell them what we think they ought to do. A moment's reflection will convince us that this is the almost universal way of attempting to help people.

Sadly enough, this method is based upon at least three major fallacies. First, it assumes that the person is really able and willing to give us a reasonably accurate picture of his difficulties. Second, it places the advisor on a high and precarious pedestal in assuming that his notion of what ought to be done would really be best for the person who needs help; and third, it assumes that the person who needs help can and will take advice and act upon it.

The futility of giving good advice is so obvious in the experience of all of us that I suppose we must all sometimes wonder why we continue to give good advice. Even in cases where we are pretty certain that we know what the real problem is and believe that we can see quite clearly what would be best for the individual concerned, it is discouraging to see how ineffectual our pleas, exhortations, and advice really are.

By contrast with this method of giving good advice, what happens if we simply listen, patiently and intelligently, as the individual who needs help continues to give us his story? What happens is that as you encourage him to continue talking, *he works out a solution to his problem himself.* He may never state very clearly just what his real problem is, and he may not arrive at a solution that *you* feel was right—though ordinarily this will be the case. But the important fact is that *he will determine upon a course of action,* whereas he was formerly confused, bewildered, and unable to decide what to do. And since this course of action is one that *he* decided—one which grew out of *his* experience—it is one which he can go out and carry into action.

Let us consider now just how one goes about it to help people by intelligent listening. Basically, of course, the procedure is very simple. It consists simply in giving reassurance to the speaker that you understand what he is saying and that you are interested. If your relationship with him is good and if he is engrossed in what he is saying, this reassurance sometimes involves no more than a nod. Professor Rogers says that the method is so simple that he has sometimes been accused of fostering the "uh-huh" school of psychology. However, there are a number of practical rules which may be given to help us in listening to other people's problems in such a way as to keep them talking without embarrassment or fear as to how we may be reacting to what they are saying.

The major rules for carrying on this kind of helpful interviewing have been summarized by Roethlisberger and Dickson and by Professor Rogers, and the following list represents a very free paraphrasing of the suggestions given in these two sources.

1. *Don't be concerned at all as to whether the statements made by the interviewee are true or false.*

It should be recalled that in the interview we are trying to keep our attention focused on what *he* thinks and how *he* feels. The question as to whether what he says is factually correct or incorrect is irrelevant. Note that this doesn't mean that we have to "believe everything he says." Conversely, it doesn't mean that we have to "take everything with a grain of salt." It simply means that if we are keeping our attention faithfully on an understanding of *his* problems, *his* opinions, and *his* feelings, the question of the truth or falsity of his remarks does not concern us.

2. *Don't be concerned as to whether his reasoning is logical or illogical.*

Once again, it may be repeated that as a listener, we are interested in how *he* is looking at his problem; and if we begin to concern ourselves as to whether he is thinking logically or not, we are allowing ourselves to depart from the role of listener.

3. *Don't be concerned as to whether his present or contemplated behavior is ethically or legally to be sanctioned or condemned.*

Obviously, this rule involves the same point of view we have been emphasizing in previous rules. That is that your approval or disapproval of his conduct is irrelevant. The moment your approval or disapproval is injected into the interview, you have thrown the interviewee into a position where he must justify his conduct to you and you in turn must argue your position with him. The important point is for *him* to arrive at a re-evaluation of his conduct rather than for you to attempt to force such a re-evaluation on him.

4. *Don't even sympathize with him in his struggles and difficulties to solve his problem.*

Sympathy he can get from any kind-hearted soul who is willing to listen. Sympathy will only strengthen him in his present course of action, which obviously must not be entirely satisfactory, inasmuch as he still has a problem. Thus, such comments as "you certainly got a bad break out of that deal and I don't blame you a bit for acting as you did" may make him feel good at the moment, but they break his struggle toward a solution of his problem by offering approval of his present behavior.

Obviously, we should not be unsympathetic, either. By way of a fourth and final emphasis, the critical point is that if we are to maintain our role as listener, it is not *our* opinions and values that count. It is *his* opinions and values that are important.

Recognizing that the above list may sound too negative in approach to be complete, we may enumerate three positive suggestions which may be helpful in carrying on the listening interview.

5. *Maintain an honest and sincere interest in the interviewee's problems, opinions, and feelings.*

As long as this sincere interest is present in the interviewer, the pitfalls which have been enumerated above may be avoided without too much difficulty.

6. *Be particularly interested in his feelings and opinions, as distinguished from the subject matter that he is discussing.*
7. *The technique of "restatement" is most commonly used in helping the interviewee to continue his talk, whenever it is necessary to comment at all.*

The technique of restatement consists simply in putting in your own words the feelings which he has just been expressing. It is at these points of restatement that the interviewer gives the clearest indication as to whether he has really understood what the interviewee has been trying to say. Be sure that you restate what he was really trying to say, with no interjection of your opinions or evaluations of his conversation.

It will no doubt occur to you that the listening method has been used mostly by professional counselors, in industry, in school, or in clinical practice. This is true insofar as the handling of really difficult problems is concerned. Deep-seated problems may require prolonged interviewing, extending over a considerable period of time. However, the technique of listening is equally applicable to the more immediate problems of bewildered employees who come to supervisors with some fancied slight or frustration which has arisen in the work situation. Our common procedure is to point out to the employee, rather early in the conversation, where he has been looking at the problem in a wrong light, and to suggest to him what we think he should do. But in these small and not very deep-seated problems, it has been impressive to note the success of the listening method as contrasted with the method of giving advice, in leading the employee to take effective action to solve his problem.

It is recognized that, as a supervisor, you will have many problems brought to you which require action, in an area in which it is your responsibility to act. In these cases, it is not meant to imply that you can always dodge this responsibility by the simple expedient of listening. It does seem true, however, that even in many cases, where at the outset, action seems necessary, there is really no action which you could take that would solve the employee's real problem. Thus, *more listening* may ultimately lead to *less action,* in the case of those problems where the difficulty lies within the employee himself rather than in the circumstances which surround him. The method, therefore, has a real place in the supervisor's job as a method for helping him to smooth out the human problems of his organization.

V. Summary

There is no brief way to summarize a discussion such as this, in which we have not attempted to reach a single conclusion with respect to a single topic. However, we can at least enumerate, by way of conclusion, the areas which have been discussed.

1. We have discussed the importance of the "sense of belonging" as a factor contributing to the day-by-day effectiveness of people at work.

2. We have indicated that the job of the foreman *as supervisor* is to a large extent a job of *communication* and *decision*; and we have presented some rules which may be helpful in assuming these supervisory duties.

3. Recognizing that the supervisor must deal intelligently with the personal and emotional problems of his subordinates, we have discussed a recently emphasized procedure for the handling of such problems. This method is the *method of listening.*

It is hoped that this discussion of some of the psychological and social aspects of supervision may be helpful as a basis for reviewing the human elements of the foreman's job.

The symposium concluded with a discussion led by J. E. Lovas.