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PLAINTIFF'S EXHIBIT
UC-363

## E. INGREDIENTS OF BRAKE LININGS (FRICTION PRODUCTS)

### I. COMPOUNDING TECHNIQUES

#### A. Balanced Crystal Structure

The typical good brake lining is a proper mixture of minerals held in a matrix of a reasonably heat resisting binder. Minerals invariably take the crystalline form. Therefore, the Balanced Crystal Structure consists of the proper combination of these crystals to provide the frictional action, the resistance to wear, and the gentle treatment of the brake drum which is desired.

Now, these crystals are desired and selected for these formulas not because of the chemical composition of the crystal, but because of the physical characteristics of the crystal. After all, the action of a friction material on a brake drum is a physical action. Therefore, we must take heed of the physical behavior of the mineral, or crystal, when it is rubbed against the brake drum.

The perfect brake lining, which has not yet been achieved, is one which has a high coefficient of friction and a friction which remains unchanged under all operating conditions of pressure, speed, temperature, and humidity. Such a perfect material will not score the brake drum. It will operate quietly and it will wear slowly.

It is obvious that if the brake lining is not to score or cut into the brake drum, there should be nothing in it which is harder than the brake drum itself. The brake drums in use today have a Moh Scale hardnesses which range from 4 to 5. That means, then, that linings which will not score on such drums must not contain particles which in themselves have Moh Scale hardnesses greater than 4. On those drums with a hardness of 5, the particle hardness can go up to 5. Thus we see that the raw materials, or minerals, which we can use in friction materials are limited by their hardness.

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I. COMPOUNDING TECHNIQUES (cont'd.)

A. Carborundum, with a hardness of 9, will cut the brake drum. So will Quartz with a hardness of 7. However, Bartyes has a hardness of 3.5 so it can be freely used in brake linings, if its other characteristics make it desirable.

Asbestos Fibre, also a mineral and a crystal, has a hardness of 4.5 - 5.5. We see immediately that this essential component of all organic friction materials has a hardness greater than that of most brake drums so it will scratch the drum and cause scoring. Because we have no better material to do the job required of the asbestos fibre, we must find a way to employ it successfully. So to control this scoring tendency of asbestos fibre, we introduce into the formula lubricants, both organic and inorganic, and thus the natural inclination of the fibre is adjusted to serve us better.

The heat resisting binder discussed earlier is today usually a synthetic resin or a drying oil of some nature. Linseed oil is one example of the type of drying oil which can be successfully used. The crystals, whose frictional characteristics we are really after, are held in this matrix of binder and are thus held against the brake drum in each application.

Crystals are found in all types of shapes and sizes - in the full range of hardness, from Talc with a hardness of 1 to the Diamond with a hardness of 10. There are flat crystals such as mica and thin, sharp crystals such as asbestos. There are rounded crystals such as Hematite and Cuprite. There are square crystals such as Galena. Others, like Calcite, are pyramid-shaped.

Then, some crystals will fracture easily. Others are Tough - leathery. Still others will lose their water of crystallization under the heat of braking - and

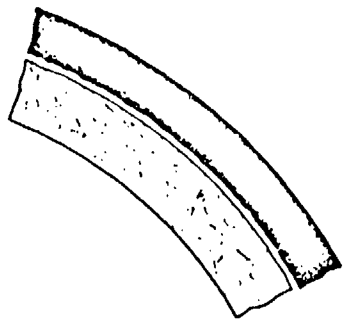
I. COMPOUNDING TECHNIQUES (cont'd.)

A. turn into amorphous state (powdery). Crystals such as those of Trichloroacetic Acid are hydroscopic and will actually turn into a liquid through absorbing moisture out of the air. Thus, we see that all kinds of behaviors and actions are available to us in crystal chemistry. With the proper blending of crystals in friction materials formulation, we can synthesize any performance we want to build into the lining. And we do this with materials which are peculiarly suited to friction materials use - not with ordinary materials usually most suitable for well lubricated bearings.

In the designing of a brake lining utilizing the Balanced Crystal Structure, the operating conditions of the lining being designed are carefully considered. Some of these operating conditions are:

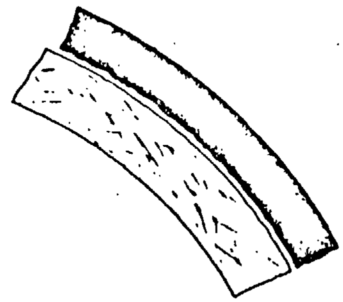
1. Coefficient of friction,
2. Brake temperatures being encountered,
3. Microstructure of brake drum,
4. Operating pressures between lining and drum,
5. Operating speeds between lining and drum,
6. Horsepower absorption per square inch of lining surface.

With the performance requirements in mind, the binder is selected. Then the crystals are added to the formula in the proper proportion to develop the performance which is required. Each type of crystal, the sharp and the flat, the soft and the tough, the round and the square, etc., is added in an exact quantity as determined by testing. In this manner, we end up with an exact prescription of ingredients to do the job for which the original performance specifications were established. These proportions of crystals are balanced with each other so that each type of crystal does the job for which it was intended and it also supplements the action in service, of other crystals in the formula and helps them do a better job.

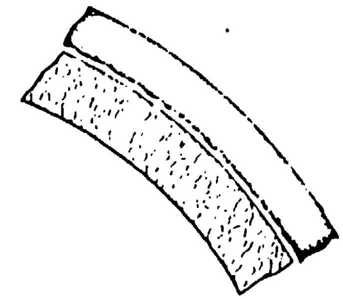


PARTICLES FORMING THE STRUCTURE OF MOLDED LINING

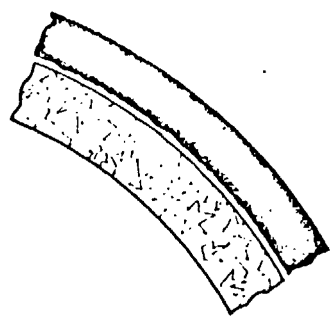
SELECTED FOR SHAPE & HARDNESS



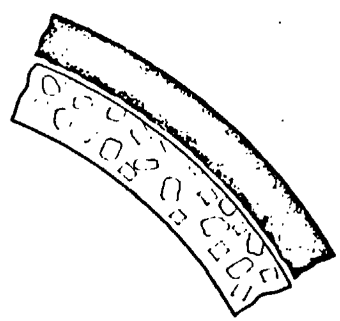
ASBESTOS FIBERS



MALLEABLE PARTICLES



JAGGED PARTICLES



BARREL AND CUBE SHAPED PARTICLES

SCORING

PARTICLE TORN FROM DRUM

PARTICLE FRACTURED FROM LINING

I. COMPOUNDING TECHNIQUES (cont'd.)

B. Volume Compounding

Usually friction materials are formulated on a dry WEIGHT basis; however, consider the surface of the friction material that is in contact with the metal drum. If, for instance, equal weights of rubber dust and barytes are used in the brake lining, then a greater percentage of the contacting surface is rubber rather than barytes.

Using this basic concept, another method of formulating has been developed and it is designated VOLUME compounding.

This method is based upon the inter-relationship between the mass and volume of a body.

Specific gravity is the ratio between the density (mass per unit volume) of a body and the density of some substance (usually water) that is assumed as a standard.

Specific gravity multiplied by 1000 gives approximately the weight of 1 cubic foot in ounces avoirdupois, or the weight of 1 liter (cubic decimeter) in grams.

Ascertain the percentage (by weight) of each ingredient and the total must be 100%. If 1000 grams of the stock is to be weighed, each individual weight (but could be grams, pounds, tons, etc.) would be the individual percentage times ten.

When that weight of each material (in grams) is divided by its specific gravity, then the quotient is the volume (in cubic centimeters) occupied by that weight of material.

This operation is repeated for each and every ingredient in that formulation.

The total of these individual volumes is the volume occupied by the 1000 grams of that stock.

I. <u>COMPOUNDING TECHNIQUES</u> (cont'd.)

B. Since specific gravity is the ratio between the weight of a material and the weight of an equal volume of water, it follows that the THEORETICAL density of the material is obtained by dividing 1000 by the total volume occupied by 1000 grams of that stock.

Knowing the total volume and the volume occupied by each ingredient, the percent by volume of each ingredient may be calculated.

For instance, in the following formula, to find the volume occupied by 50% (i.e. 500 grams) of asbestos simply divide by 2.55 which is the specific gravity of asbestos to get 196.08 cc.

This operation is repeated for each of the ingredients listed:

| Ingredient | Wgt.% | Sp.Gr. | CC/1000 g. | Vol.% |
|---|---|---|---|---|
| Asbestos | 50.0 | 2.55 | 196.08 | 42.05 |
| Graphite | 2.0 | 2.30 | 8.69 | 1.86 |
| Resin | 20.0 | 1.23 | 162.60 | 34.87 |
| Brass | 6.0 | 8.50 | 7.05 | 1.51 |
| Cardolite | 5.0 | 1.18 | 42.37 | 9.09 |
| Zinc Oxide | 8.0 | 5.57 | 14.36 | 3.08 |
| Coke | 8.0 | 2.35 | 34.04 | 7.30 |
| Red Lead | 1.0 | 9.1 | 1.10 | .24 |
| | 100.0 | | 466.29 | 100.00 |

Theoretical Density: 2.14

The calculated VOLUME percentages reveals a more accurate picture of the brake lining surface that is rubbing the brake drum.

5

## II. FILLERS OF BRAKE LININGS

Geology and mineralogy are the sciences in which is tabulated the fundamental knowledge of the history and resources of the minerals of the earth. The two billion years represented in the five geologic eras are only a small part of the life span of the earth. It does not extend back to the time when the earth was molten, but only includes the time when the earth was not significantly different in material structure than at present, that is, to little beyond the point when there appeared the first traces of life, which point is well within the period of the fixing of the present elemental materials.

A geolist is a historian whose archives and written documents are the rocks and formations of the earth. The mineralogist is one who tabulates the elemental materials that are in the rocks and earths, and designates those which are ores, or from which materials may be extracted commercially. But to a geolist, a rock or earth formation is a page from the earth's autobiography. The changes which took place, and the approximate length of time during which changes occurred, are determined by study of the types of formations and their relative size and positions, the animal and plant life as seen in fossil remains, and by the disintegration by crosions and by radioactive elements in the rocks. Geology is thus not an academic science, as the practical geolist can trace the probable location of metallic ores, petroleum, coals, and nonmetallic minerals.

There are three main types of rocks: igneous, sedimentary, and metamorphic. The igneous are the mother rocks which have carried all nonorganic mineral products from the original molten condition in the depths of the earth. Sedimentary rocks are the deposits from erosion of older rocks and from the deposits of organic matter. Metamorphic rocks are both igneous and sedimentary rocks which have been changed by intense heat and pressure within geologic times. They include the different chemical and physical changes caused by the upheavals in the earth's crust.

II. FILLERS OF BRAKE LININGS (cont'd.)

In geology, all minerals are classified by the MOH hardness scratch test as follows:

1. Talc (softest)
2. Selenite
3. Calcite
4. Fluorite
5. Apatite
6. Microcline
7. Quartz
8. Topaz
9. Corundum
10. Diamond (hardest)

In this hardness test, a mineral will scratch all minerals having a smaller numerical rating and in turn will be scratched only by minerals having a larger numerical rating.

It is obvious that if the brake lining is not to score or cut into the brake drum there should be nothing in it which is harder than the drum itself. The brake drums in use today will have a 3.5 to 4.0 average on the MOH scale, although an exceptionally hard drum may have an MOH hardness of 5. This means that all brake lining compound ingredients must have a MOH hardness of less than 4.0.

Amorphous materials are difficult to encase and keep in the brake lining.

Crystalline materials are rigid and enhances lining strength when sufficient binder is used.

Flake materials are rarely used in brake linings.

Acidic materials usually enhance friction whereas basic materials have little effect on performance.

In general, the reduction of particle size enhances the effectiveness of that ingredient and makes it easier to bond and hold in the brake lining. Most organic particles

II. FILLERS OF BRAKE LININGS (cont'd.)

used are in the range of 20-mesh to 100-mesh as these larger particles will last longer at elevated temperatures. On the other hand, inorganic particles are usually in the range of 200-mesh to 300-mesh.

Cube shaped particles impart density to the lining and make it possible for a brake lining to withstand high pressure. These materials never fracture with jagged edges but wear away very slowly. Barytes is such an excellent filler. In addition to imparting density, it tends to polish much like a cobblestone street instead of fracturing.

Particles with sharp, jagged edges when added to the lining structure will raise the friction. Soft materials like talc fracture with sharp edges, but "dusts". Hard materials like carborundum provide stable friction even at red heat because the particles do not fuse, but are seldom used because they are too hard and will score the drum. Occasionally, rottenstone, which has sharp edges and has an MOH hardness of about 5, is employed to control friction at low temperatures; but at elevated temperatures, these particles fuse and the edges become round permitting the lining to fade.

A. Non-Reinforcing Fillers

1. Inorganic Fillers and their Affects

a. Hydrated aluminum oxide (sp. gr. 2.4; hardness 3) polishes the drum giving a little fade and good wear resistance.

b. Anhydrous aluminum oxide (sp. gr. 3.1; hardness 9) polishes the drum when about 10 microns in particle size but will score the drum when 60-100 mesh. It is stable at elevated temperatures.

c. Barytes (sp. gr. 4.4; hardness 3½) is added for density, wear resistance and to

II. FILLERS OF BRAKE LININGS (cont'd.)

A. 1. c. lower friction. It polishes the brake drum and is heat stable to about 1200°F.

d. Brucite (sp. gr. 2.4; hardness 2) is a slippery, talcy material found in asbestos from certain areas. It is an undesirable contaminant because it lowers friction and the amount present varies from time to time.

e. Calcium carbonate or whiting (sp. gr. 2.7; hardness 3) and is considered nothing more than a cheaper filler.

f. Cast iron grit (sp. gr. 7.2; hardness 4) impart friction at high heats but tends to score the brake drum.

g. Black copper oxide (sp. gr. 6.4; hardness 3-1/2) adds density and stabilizes friction in the 400-500°F. range.

h. Green chrome oxide (sp. gr. 5.2; hardness 5) enhances friction and imparts a greenish color.

i. Clay (sp. gr. 2.6; hardness 1-1/2) is a cheap filler that usually induces more fade at elevated temperatures.

j. Albany slip clay has some iron that increases the life of living by polishing also it has some potassium salts that with the fatty acids in the oils from "soaps" that help lubricate during extrusion.

k. Coke (sp. gr. 2.3; hardness 2-1/2) is used to minimize wear because it is a medium-high temperature lubricant.

l. Corundum (sp. gr. 4.0; hardness 9) imparts friction stability at red heat but the particle size must be less than 325 mesh to avoid scoring of the brake drum.

II. FILLERS OF BRAKE LININGS (cont'd.)

A. 1. m. Galena (sp. gr. 7.6; hardness 2) imparts density and forms a heat-sink particle.

n. Graphite (sp. gr. 2.3; hardness 1-1/2) is usually a high temperature lubricant but some grades, especially when wet, have the opposite effect. Graphite is added to give a lubricating effect for smoother stopping. It can be incorporated in rubber or can be added separately. Some advantages are claimed for the former method in that the graphite is encased in the rubber and does not interfere with the flow of the resin binder during the curing operation, and is released for its lubricating action only after the rubber is softened by the high temperature resulting in the braking operation.

o. Hematite (sp. gr. 4.8; hardness 5-1/2) imparts density and helps the wear resistance. The iron oxide particle is barrel shaped and is used in small amounts as a frictional controlling element because it tends to have a self-polishing action but usually large amounts of such inorganic fillers are needed to produce friction effects.

p. Lime (sp. gr. 2.0; hardness 2-1/2) usually makes the brake lining hard and squeaky - whiting does not cause this.

q. Litharge and red lead (sp. gr. 9; hardness 3) usually lowers the friction and tends to prevent drum scoring. Moreover, these compounds promote the curing of certain binders as well as oxidation of unsaturated organic compounds. Sometimes leaded-litharge counteracts the fading caused by coke.

r. Magnesium oxide (sp. gr. 3.2; hardness 5) is alkaline in character and usually lowers the friction.

II. FILLERS OF BRAKE LININGS (cont'd.)

A. 1. s. Mica (sp. gr. 2.9; hardness 2) lowers friction and causes excessive dusting and is difficult to bond in linings.

t. Molysulfide (sp. gr. 4.7; hardness 1) is very unctuous and is very effective in lowering friction.

u. Pumice (sp. gr. 2.3; hardness 6) is used to stabilize friction at higher temperatures.

v. Quartz (sp. gr. 2.6; hardness 7) is very heat stable but is seldom used in brake lining.

w. Talc (sp. gr. 2.7; hardness 1-1/2) is used as a cheap filler but excessive amounts lower the friction. Talc is stronger than graphite. Certain domestic talcs have impurities that off-set the lubricating qualities.

x. Zinc oxide (sp. gr. 7.1; hardness 2-1/2) is used to help polish the drum and to impart wear resistance to the lining.

2. Organic Fillers and Their Affects

a. Usually large quantities of inorganic fillers are needed to produce frictional effects but smaller amounts of organic materials are required.

b. Anthracite (sp. gr. 1.7; hardness 2) contains about 10% ash and 10% volatile matter and acts as a medium-high temperature lubricant. Excessive volatile matter causes fade.

c. Carbon black (sp. gr. 1.8; hardness 2) is used in linings for color and not re-inforcement as in rubber compounding.

d. Cardolite (sp. gr. 1.18; hardness 1-1/2) is used in small amounts to impart resilience and

II. FILLERS OF BRAKE LININGS (cont'd.)

A. 2. d. help stabilize friction in the 600°F. Different grades and hardnesses perform differently.

e. Coal tar pitch coke is a by-product of distillation and the large cake of coke is removed from the still and pulverized; this material is a lubricant for medium - high temperature (most coal tars are solvents for the phenolics).

f. Cheap coke from low grade soft coal etc. usually lowers friction at higher temperature and 8-10 parts leaded-litharge counteracts this fading.

g. Petroleum coke is frequently used as a lubricant between 400°F. to 700°F.

h. At about 525°F. soft coal "Melts" (which causes extreme fading) then it "clinkers" and the lubrication and friction are then satisfactory but the initial fade cannot be tolerated and it is too expensive to preheat the soft coal past the "melting" stage.

i. Coal cokes via "solvay" process are usually too hard and dry for brake linings.

j. Cannel coal is a "special soft" coal very high in volatile matter; small lumps age and oxidize when exposed to air whereas large lumps cannot age as much and the excess volatile matter causes fade that are not as bad as regular "soft" coal.

k. Cork and certain organic materials add resilience to the brake lining (called soft pedal or "feathers") and they quickly burn out of the lining exposing new surfaces thus breaking-up polished films. Also when the auto is new, the

II. FILLERS OF BRAKE LININGS (cont'd.)

A. 2. k. cork provides the friction from the high spots before the lining is seated into the drum, later it burns away when its job is done.

l. Gilsonite (sp. gr. 1.1; hardness 2) is used to minimize water sensitivity. Gilsonite melts at about 300°F. and in the brakes it bleeds to the surface when hot and causes a mild fade which helps protect lining during a period of hard use as in city driving.

m. Flake graphite (sp. gr. 2.3; hardness 1-1/2) is used sometimes to conduct heat away from the friction surface. In the case of sintered-metal, it prevents galling.

n. Ground tire scrap functions as a friction modifier up to about 550°F. then it becomes more and more of a lubricant.

o. Mineral Rubber - a "blown" asphalt - is thermoplastic and is used to help processing because it acts like a plasticizer and extender.

3. Metal Fillers and Their Affects

a. Soft brass chips (sp. gr. 8.5; hardness 3-1/2) from free-running S.A.E. 72 is most always used. It is hypothesized that BRASS controls fade because zinc is driven off at high temperature leaving copper. Both the zinc and copper then form oxides which have only a slight tendency to polish. The copper oxide keeps the friction up but it has a tendency to score drums. The smaller brass particles get hot quicker, hence the coarser particles usually give better wear.

b. Copper (sp. gr. 8.9; hardness 2-1/2) powder is sometimes used for special types of linings. Copper is too soft to score drums but high per-

A. 3. b. centages in the lining increases friction because the copper smears onto the drum raceway. Any lining run on pure copper almost doubles in friction. Too, enough copper in lining to stop fade will cause drum scoring because the soft copper will pick up metal particles from the drum and will fuse with high heat - the imbedded steel then acts as a cutting tool.

c. Metallic particles such as brass and copper are sometimes added to give improved performance at high temperatures. The smaller particles become hotter and are always more effective than larger particles. Usually, from 12% to 20% of brass chips is required to break the continuity of the film formed in the friction surface at elevated temperatures. When hot, the copper in the brass forms the hard copper oxide particle that tends to raise the friction which counter-balances the fading due to the film. The success of "semi-metallic" or "bi-metallic" linings depends upon copper. The copper particle which is softer than brass tends to smear over the friction surface and transfer to the brake drum. Brake linings, such as those used in automatic transmissions, containing 35% or more of copper, smear readily and will almost double the coefficient of friction. This drastic increase is merely offset by submerging in oil.

d. Powdered lead is frequently used in small amounts to stabilize friction at elevated temperatures because it is an excellent lubricant. However, too much powdered lead will cause excessive wear and rapid shifting of the friction surface above 400°F., because more beads of melted lead are formed than needed. Lead may also be incorporated into lining compositions in the form of an organic salt. Under the

II. FILLERS OF BRAKE LININGS (cont'd.)

A. 3. d. influence of high temperatures, the lead is liberated when needed at the friction surface as finely divided lead in a reducing or inert atmosphere which prevents the oxidation of the metal to an oxide and the lead can then lubricate and protect the lining.

e. Metallic powders such as zinc and lead are sometimes added to give improved performance at high temperatures. A limitation of fine lead is that it easily oxidizes to litharge which promotes oxidation in unsaturated organic compounds. The exact function that metal powders play on a friction surface is not known. Some express the belief that they help to break the continuity of the film in the friction surface during braking action. Large amounts of metal (40%) such as brass chips are added to linings for very high temperature requirements.

B. Re-Inforcing Fillers for Brake Linings

1. Mineral Fillers

Origin of asbestos (sp. gr. 2.55; hardness 3). In the greenstone region of Canada (near Thetford) the present surface rock was at one time thousands of feet below its present elevation, and under very great pressure due to the weight of the overlying rock and soil.

This rock is a variety of olivine called peridotite and is composed of iron, magnesia and silica. In certain areas, this rock was acted on by hot ground waters, under high pressure, and carrying dissolved salts and carbon dioxide. These ground waters gradually changed the original rock from the iron-containing periodotite to the magnesia-silica-water mineral, serpentine. During the alteration, the volume of the rock increased, causing innumerable cracks. These cracks were filled with the hot

II. FILLERS OF BRAKE LININGS (cont'd.)

B. 1. ground waters. This underground water circulated through the cracks in the rock, descending slowly through the smaller openings in the rocks and ascending through the larger openings and cracks. This water was a very good rock solvent. The water rising in the larger cracks loses pressure and slowly cools, losing some of its solvent power and precipitating a small amount of the dissolved rock. This material deposits on the sides of the crack in the rock through which the water was flowing, tends to form regular crystal shapes, depositing the molecules in a regular rather than haphazard manner. Rock salt gives cubes, diamond forms in octahedrons, graphite in six-sided plates, gold in octahedrons or cubes. Asbestos forms in easily separable, closely packed filaments, which when teased apart, give the workable form in which asbestos is marketed and used. The size of the smallest fiber which can be separated is about 0.00003" in diameter.

a. Types of Asbestos

1) Amphibole Asbestos - Amosite is an iron-magnesium silicate and the fibers are exceptionally long but harsh and weaker than those of chrysotile. When fully opened or fiberized, it has a low density which makes it ideal for insulation.

Crocidolite or "blue asbestos" is an iron-sodium silicate preferred for making asbestos-cement pipe because of its strength.

Tremolite is a calcium-magnesium silicate and is more resistant to chemical action and hence is used as a filtering medium.

Anthophllite is a calcium-potassium silicate and the fibers are several inches long but lack strength and flexibility.

II. FILLERS OF BRAKE LININGS (Cont'd.)

B. 1. a. 2) Chrysotile Asbestos - This fibrous mineral constitutes the principal commercial type of asbestos and is hydrous magnesium silicate.

b. Properties of Asbestos

The important properties of chrysotile asbestos which make it a good friction material are heat resistance, chemical resistance, flexibility, low thermal conductivity, and a satisfactory hardness. Its reactions toward heat are particularly significant. The asbestos fibers begin to lose their water of crystallization at about 600°F. The rate of this loss increases with temperature and at 1000°F. the rate is rapid. When the water is driven off, asbestos loses its crystalline properties and becomes a powder. If the heat generated in braking a car, decomposed only the organic materials and was to change the asbestos into a hard inorganic fused layer, brake linings as we know them today would be impossible. The fact that the asbestos fiber will break down with heat to a powder makes possible the rejuvenation of the friction surface of the lining with use.

The fact that asbestos is a poor conductor of heat helps to keep the heat from penetrating deeply into the lining where it could cause chemical changes to take place in the binder materials which would be detrimental to the frictional characteristics and the life of the brake lining.

Mineral Wool

This is a fibrous material first obtained as a natural product from volcanic craters in Hawaii and was known as PELE'S HAIR. Synthetically, it is made by mixing stone and molten slag from blast

B. 1. furnaces and blowing steam through it. Slags from copper and lead furnaces are used also and this affects the friction. Fiberfrax, rockwool, rocktex, banrock are tradenames of sundry commercial variations.

This material requires a special treatment to "wet-out" and even then it is difficult to disperse with the other friction materials and the resulting heterogeneous mix is "spongy" and hard to handle.

Glass Wool

This is fine flexible fiber made from glass and has a definite recipe and in this respect it is distinct from mineral wool which is a random mix. Glass fibers are made by letting molten glass drop through tiny orifices and blowing it with a stream of air to attenuate the fibers. The usual composition is that of a soda-lime glass which has a lower melting point than mineral wool. Glass wool is difficult to process same as mineral wool and both cause excessive fading at elevated temperatures.

2. Metal Re-Inforcing Fillers

a. Steel wool (sp. gr. 7.5; hardness ). This material is made from low-carbon bessemer wire of high-tensile strength. The wire is drawn over a track and shaved by a stationary knife bearing down on it. Steel wool usually has three edges but may have four or five, and strands of various types are mixed. There are nine standard grades of steel wool, the finest of which has no fibers greater than .0005 inches thick.

This material has extensive application in European brake linings especially with an elastomeric binder because it imparts mechanical strength and conducts the surface heat into the lining interior.

II. FILLERS OF BRAKE LININGS (cont'd.)

B. 2. b. Chopped steel wool and chopped steel fibers (larger in diameter and harder) are normally employed in the States because of ease of handling in high speed mixers and the resulting stock is not as "spongy".

c. Other fibers such as zinc, lead, brass etc. are generally not used except to form the core of asbestos yarn.

19