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OPERATION AND MAINTENANCE EQUIPMENT AND PROCEDURES

RELEASE NO. 49

JULY, AUGUST, AND SEPTEMBER 1964

CONTENTS

Cover Sheet. The cartoon is an attempt to emphasize the six rights of lubrication: The right type and right quality of lubricant, in the right amount and right condition, in the right place, at the right time.

OPERATION AND MAINTENANCE EQUIPMENT AND PROCEDURES
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INTRODUCTION

With this release of the Operation and Maintenance Equipment and Procedures bulletin, a change is to be made. Beginning with the next issue, which will be our Fiftieth, the name of the publication will be changed to Irrigation Operation and Maintenance. The format will remain unchanged. We hope the bulletin under its new name will continue to be of service to irrigation operators everywhere.

There is reprinted in this issue an article on Lubrication of O&M Equipment. This article was assembled by Gerald Fitzgerald, Chief, Property Management Branch, Office of Property, Regional Office, Billings, Montana. Mr. Fitzgerald has edited this material to broaden its appeal to all irrigation project operators responsible for operation and maintenance equipment. The discussion deals with engine oils, gear oils, and greases and their use.

This issue of the bulletin also includes an article on the development by the Yuma County Water User's Association, Yuma, Arizona, of a fuel oil-compressed air weed burner head; an article on the control of Canada Thistle; and an article describing an improved idler wheel for a trash collector on the Yakima Project, Washington. A drawing of the trash collector originally installed is included.

The Operation and Maintenance Equipment and Procedures bulletin is published quarterly, for the benefit of irrigation project operation and maintenance people. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. It is hoped that the labor-saving devices or less costly equipment and procedures developed by the resourceful water users will be a step toward commercial development of equipment for use on irrigation projects in a continued effort to reduce costs and increase operating efficiency.

To assure proper recognition of those individuals whose suggestions are published in the bulletins, the suggestion number as well as the person's name is given. All Bureau offices are reminded to notify their Suggestions Award Committee when a suggestion is adopted.

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Division of Irrigation Operations
Office of Chief Engineer
Denver, Colorado

LUBRICATION OF O&M EQUIPMENT

Introduction

Proper lubrication of operation and maintenance equipment is of utmost importance in the effective utilization of the modern machines in common use on present day irrigation projects. It is with considerable satisfaction, therefore, that we present this dissertation which was prepared by personnel of Region 6 of the Bureau of Reclamation in the form of a lubrication handbook for use by Bureau employees.

We are particularly indebted to Gerald Fitzgerald, Chief, Property Management Branch, Office of Property, Regional Office, Billings, Montana, for his excellent work assembling the data and adapting it for general field use. Since there were so many excellent ideas given, it was felt that the information should be made available to all of our readers, the material was edited to broaden its appeal to all irrigation project operators responsible for operation and maintenance equipment.

The discussion deals with engine oils, gear oils, and greases and their use. The recommendations covered have been compiled from bulletins issued by the Defense Petroleum Supply Center (DPSC), U.S. Naval Supply Office, Corps of Engineers, Society of Automotive Engineers (SAE), petroleum manufacturers, equipment manufacturers, and the American Petroleum Institute (API). The recommendations are intended to serve as guides in the selection of proper lubricants for irrigation project equipment. It will be noted that Military Specifications are referred to frequently as a means of identifying particular types of lubricants. This is for convenience only and your oil dealer should be able to tell you whether or not any particular oil meets the specifications given.

The proper selection and application of lubricants is of primary importance in the maintenance and servicing of equipment. The specifications for petroleum products used by the Armed Services are developed through universally accepted standards of testing and are available for use by other agencies. The purpose of this article is to make available information regarding lubricants available under DPSC contracts as well as in the open market in understandable form so irrigation projects may identify lubricants under the specifications under which they are purchased.

Crankcase Oils

The American Petroleum Institute's classification of engine oils was developed to define the types of service under which an engine would be operating, and does not correspond to any particular grade or military symbol.1/ These service classifications, listed and defined below,

1/See Bibliography.

cover all internal combustion engines except aircraft, large stationary, marine, and railway diesel engines. Briefly, Classifications ML, MM, and MS describe light and favorable, moderate to severe, and severe to unfavorable gasoline (also liquified petroleum gas) engine operating conditions, respectively. DG, DM, and DS represent a similar range of service classification, respectively, for diesel engines. These letter designations provide a convenient means for the engine manufacturer to indicate service characteristics of his various designs and hence their lubrication requirements. Similarly, oil companies use the letter designations to indicate for what class or classes of service each of their several grades is suitable.2/

Gasoline Automotive-type Engine Oils

Service ML indicates service typical of gasoline and other spark ignition engines used under light and favorable operating conditions, the engines having no special lubrication requirements and having no design characteristics sensitive to deposit formation. Most moderate service conditions are: moderate speed driving or moderate load operation with no severe low or high engine temperature conditions.

General Quality Level	Recommendation
Straight Mineral, Regular	This is an inexpensive non-detergent oil. 3000 series oil under DPFC contract.

Service MM indicates service typical of gasoline and other spark ignition engines used under moderate to severe operating conditions, but presenting problems of deposit or bearing corrosion control when crankcase oil temperatures are high. More moderate service conditions include short trips at high speeds, longer trips at moderate speed, atmospheric temperatures warm. Does not include extensive stop-and-go operation.

General Quality Level	Recommendation
Moderate detergent and/or oxidation or corrosion inhibited, Premium	OE-10, OE-30, and OE-50 under DPFC contract.

Service MS indicates service typical of gasoline and other spark ignition engines where there are special lubrication requirements for deposit, wear or bearing corrosion control. The severity of these special lubrication requirements varies with operating conditions, with fuel characteristics, and particularly with engine design factors which in themselves may vary with different makes and models. Most severe service conditions include stop-and-go operation particularly in cold weather and sustained high-speed driving particularly in hot weather or in hilly country.

General Quality Level	Recommendation
MIL-L-2104A and Am. 1, heavy duty, Premium	OE-10, OE-30, OE-50 DPFC Contract.

Diesel Automotive-type Engine Oils

Service DG indicates service typical of diesel engines in any operation where there are no severe requirements for wear or deposit control due to fuel, lubricating oil or to engine design characteristics. Normal operation at rated speeds and loads where fuel sulfur content is low.

General Quality Level	Recommendation
MIL-L-2104A and Am. 1, heavy duty	OE-10, OE-30, OE-50 under DPFC contract. When diesel fuel sulfur content is less than 0.4%.

Service DM indicates service typical of diesel engines operating under severe conditions or using fuel of a type normally tending to promote deposits and wear, but where there are design characteristics or operating conditions which may make the engine either less sensitive to fuel effects or more sensitive to residues from lubricating oils. Service conditions of lower severity than Service DS are: high load, high temperature operation of normally aspirated engines particularly where fuels of moderately high sulfur content are used.

General Quality Level	Recommendation
Former U.S. Army 2-104B Supplement 1 - MIL-L-9000E (Ships)	9000E series under DPFC contract. When diesel fuel sulfur content is less than 1%.

Service DS indicates service typical of diesel engines operating under very severe conditions, or having design characteristics or using fuel tending to produce excessive wear or deposits. This includes high load, high temperature operation, particularly where high sulfur fuels are used, or where engine supercharging or engine installation considerations contribute to high engine temperatures.

General Quality Level	Recommendation
Superior Lubricant, Series 3, MIL-L-45199A	Open Market Item. Use when specified by the manufacturer, such as caterpillar engines, or supercharged engines. Also when diesel fuel exceeds 1% sulfur content.

Specifications

MIL-L-2104A Amendment 1. To qualify, a motor oil must pass two specific engine tests (the CRC L-4-1252* and the CRC L-1-6149) in addition to other chemical and physical tests. The CRC L-4 test is conducted in a 6-cylinder gasoline engine. The CRC L-1 test is conducted in a single-cylinder diesel test engine using fuel with a minimum sulfur content of 0.35%. Oils meeting the requirement of this specification are also suitable for use in gasoline powered engines operating under moderate temperatures and severe conditions such as might be encountered in suburban and intercity bus and truck service. 3/ It is generally classed as a "light detergent" oil (OE-10, OE-30, and OE-50 under the DPSC contract).

For API Service Classifications, MS and DG
Available in SAE Grades 10W, 20-20W, 30, 40 and 50

MIL-L-2104A Supplement 1. "Supplement 1" is an industry wide term, but at present does not refer to any specific military or engine builders specification. An oil is listed as a "Supplement 1" oil if, in addition to passing the CRC L-4 test, it also passes special L-1 test of the MIL-L-2104A Amendment 1 specification which is conducted with a high sulfur (approximately 1%) diesel fuel instead of the normal 0.35% sulfur content. 3/ A diesel fuel with 1% sulfur content is equivalent to 70 pounds of sulfur in each 1,000 gallons of fuel. This must be digested by the engine. That part not digested which is deposited in the engine results in an abrasive action that cuts rings and piston liners. This is a high detergent oil for heavy duty service. It provides excellent engine cleanliness under both high and low temperature service conditions. It is recommended for use in gasoline and diesel engines in trucks, busses, industrial, and construction machinery, operated under extremely heavy duty condition or with lower quality diesel fuels and where engine manufacturers specify the use of a Supplement 1 oil. 4/ (Equivalent oil is not available under DPSC contract.)

For API Service Classifications MS, DG and DM
Available in SAE Grades 10W, 20-20W, 30, 40, and 50

Superior Lubricants--Series 3. In 1947-48, Series 2 specifications for lubricants for use with high sulfur diesel fuels were issued. These oils were tested in a supercharged single-cylinder diesel engine known as the Caterpillar 1-D Supercharged Engine Test. With the development of higher output engines, this specification was superseded in 1956 by a Superior Lubricants Series 3 Specification, which required not only passing the Caterpillar 1-D but also the Caterpillar 1-G Supercharged

*"CRC" is an abbreviation of "Coordinating Research Council," a joint organization formed by the Society of Automotive Engineers and the American Petroleum Institute.

Engine Test.3/ Oils meeting these specifications are made from solvent refined paraffinic oils and selected additives. Military Specification MIL-L-45199A was issued in 1959, and is essentially the same as the Series 3 Specification except the military requires that the lubricant pass the previously described CRC L-4 gasoline engine test. Lubricants meeting these specifications are recommended primarily for high output supercharged diesel engines, and diesel engines under very severe conditions3/ using low-grade fuel with high sulfur content, and where engine manufacturers recommend the use of Series 3 lubricants. Although the Series 3 lubricants give greater protection against fuel deposits, oxidation, corrosion, and wear than is available in lubricants designed solely for gasoline engines, their use in gasoline engines is not recommended. Such use may cause abnormal combustion problems, valve burning, and piston failures in gasoline engines due to the high ash. Some gasoline engines are particularly prone to these types of ash-promoted failures in high load, hot running service.2/

For API Service Classification DS only
Available in SAE Grades 10W, 20-20W, 30 and 40

Break-in Oils. Break-in oils are used in new engines by the manufacturer and by users in rebuilt engines. These oils are drained after about 500 miles or 10 hours use. Generally, the same type break-in oil is used for both gasoline and diesel engines.

Specifications for the most recent factory-fill oils specify a definite or a minimum amount of zinc dithiophosphate to provide antiscuff protection. These specifications are designed to establish the desired control of deposits, wear, and scuff protection during break-in. In addition, special engine rust additives are used to ensure adequate protection in storage prior to sale. The current trend of the automobile manufacturers is to recommend to the equipment owner that he use oils meeting factory specifications (not necessarily the same as factory-fill oils) which usually meet the API MS service classification.2/

Effect of Temperature. The effect of temperature on viscosity varies with different oils. An oil which shows relatively little change in its ability to flow as it is heated or cooled is said to have a high "viscosity index." The 9000 series oils have a low viscosity index. Recent investigations by major marketers of oil indicate that oils with a viscosity index such as the 9000 series tend to form softer deposits which is most desirable. The 9000 series oil is available in Grades 10, 20, 30, and 50. The military symbol used in marking the different grades of oil is 9110, 9170, 9250, and 9500, respectively. SAE "multi-grade" oils are basically light oils, having a high viscosity index and may have a viscosity index improver added. The viscosity improvers (polymeric material) have the handy faculty of being more effective as the temperature rises. Therefore, 10W-30 (SAE) oil has the viscosity of 10W lubricant at zero degrees Fahrenheit and the viscosity of a Grade 30 oil at 210 degrees Fahrenheit. Oils of the multi-grade types

apparently have undesirable characteristics such as formation of hard deposits.5/

Oil Change Periods

The reason oil is drained is to remove from the engine those contaminants which have entered the oil as a result of use. These contaminants may be water, dust, sand, unburned and partly burned fuel, fuel soot, and oil oxidation products. Modern detergent oils are designed to prevent fuel soot and oxidized contaminants from depositing by keeping them in suspension so that they will be removed at the time of oil drain. Some people think that an oil which looks clean after a considerable period of use is a good oil. Nothing could be farther from the truth. The contaminants mentioned above are in the engine; and if they are not being held by the oil, they are depositing somewhere, probably in the crankcase and valve chambers where they are forming sludge and other undesirable deposits. Most engines are equipped with oil filters. The use of these filters materially assists in removing solid contaminants from the oil, but they are not a substitute for periodic oil drains in removing contaminants from the engine.3/

If an engine is being operated at high speeds for sustained periods, if it is pulling excessively high loads, if dust conditions are abnormal, or if it is operating for short periods of time at low temperatures, oil change periods should be shortened accordingly.6/

Gear Lubricants and Greases

Definition of Terms

It is important to define certain terms used by the petroleum industry to better understand the necessity for and qualifications of a good lubricant:

Straight Mineral Oil. A straight mineral oil is a refined petroleum product used as a fluid lubricant. Corrosion and oxidation inhibitors, anti-foam agents, etc., are frequently added to such mineral oils to provide additional properties. These lubricants are classified by SAE as "regular-type gear lubricants."7/

Compounded Oils. There are many different types of compounded oils and lubricants such as cutting, soluble, and rust preventing oils used in common machine practice, internal combustion engine oils and gear lubricants. Compounded oils commonly used for automotive gear lubrication may be classified in two general groups: (1) Oils combined with noncorrosive lubricity additives, SAE "worm-type gear lubricant;" and (2) Oils combined with extreme pressure or multipurpose-type additives, SAE "multipurpose-type gear lubricants."

Noncorrosive fats, waxes, or soaps are frequently combined with high-quality straight mineral oils to make a lubricant that has increased load carrying ability due to greater oiliness and film strength. 7/

Extreme pressure or multipurpose lubricants are designed with certain load carrying characteristics. The EP qualities are to reduce the harmful effects of metal-to-metal contact. Such lubricants are usually formed by combining high-quality straight mineral oil with chemical additives such as sulfur, chlorine and lead or phosphorus in addition to the usual oiliness additives. These chemicals, under heat and pressure, react with the metal surfaces or with themselves to form a coating. This coating is microscopically thin, an excellent bearing surface that acts as a lubricant and is self-perpetuating. This liquid lubricant not only carries the additives, but serves as a coolant for the assembly. Compounded oils usually oxidize more rapidly than straight mineral oils. Thus, the increase in load carrying ability is obtained at a sacrifice of lubricant life. It is important not to operate vehicles beyond the established safe lubricant change interval. 7/

Recommended Lubrication Practices

Change Schedule. The axle lubricant in trucks should be drained at the end of the driveaway prior to putting the vehicle in regular service, or before the maximum of 3,000 miles, unless otherwise specified by the manufacturer. Completely drain the original axle lubricant while the assembly is warm. Flush well with clean flushing oil and refill the assembly with specified lubricant. Lubricant changes should be made as climatic temperatures demand, regardless of vehicle mileage or established change schedules. When the yearly mileage accumulation is less than 60,000 miles, the lubricant should be changed twice yearly (spring and fall) irrespective of mileage. 7/

Magnetic Drain Plugs. Any drive axle, while it is working, generates wear particles at a fairly steady rate. These wear particles are very fine but hard. If these hard wear particles are allowed to circulate in the lubricant, the anti-friction bearings will wear at a faster rate than they would if the hard wear particles were removed as they are generated. Magnetic drain plugs perform the vital function of trapping these small metallic particles that circulate through the gears and bearings, causing rapid wear and premature failure. The magnet must be strong enough to firmly hold the particles under service conditions. Plugs with elements having a minimum pickup capacity of two pounds of low carbon steel in plate or bar form are recommended. Magnets will rapidly lose effectiveness as collected material bridges the gap between the two poles. Change plugs before this occurs. It may be necessary to change plugs one or more times between complete lubrication changes. 8/

Types of Greases

A lubricating grease is a semi-solid material composed of a lubricating oil combined with a thickening agent to provide the characteristics required of the grease. A thickening agent changes a fluid lubricant to a semi-solid lubricating grease. Common soap thickeners used in the manufacture of grease are the metallic soaps such as sodium, calcium, aluminum, lead, and zinc. Nonsoap thickening agents are jelling agents or densifiers such as bentones, silicates, and silicones. The latter are compounded to withstand many special conditions such as high temperature, high acidity, and high resistance to moisture.7/ Additives may be used to impart special properties and are classified as follows:

Antioxidants or Oxidation Inhibitors
Metal Deactivators or Passivators
Corrosion and Rust Inhibitors
Water Repellents
Film Strength Agents
Color Stabilizers
Viscosity Index Improvers
Pour Depressants
Wear Prevention Agents
Stringless Additives

A single additive may perform one or more of the functions listed above.5/

Multipurpose Grease

Generally, a multipurpose grease will be used for simplified lubrication. This grease will have a high melting point, be oxidation stable, and have good mechanical stability; also, high load carrying ability and have good dispensability even at low temperatures, resist impact and squeeze out, prevent rust, resist throw-off, separation and bleeding. The multipurpose grease is not an all-purpose grease, and there are instances where special purpose greases are required. The wire rope-exposed gear greases fall in this category.5/

National Lubricating Grease Institute Consistency Classification

One of the most useful physical characteristics of grease is that of consistency or relative hardness. A widely used consistency classification is that developed and promulgated by the National Lubricating Grease Institute (NLGI) in 1941. The measurement of consistency or depth of penetration under specified conditions of standardized conical body into a worked sample of the test grease is determined by the American Society for Testing Materials (ASTM) Method D217-52TV. On this basis, the NLGI Consistency Classification has been established as follows:

NLGI Consistency Number	ASTM Worked Penetration at 77° F
0	355 to 285
1	310 to 340
2	265 to 295
3	220 to 250
4	175 to 205
5	130 to 160
6	85 to 115

Successively higher NLGI consistency numbers indicate greases of increasing hardness. This is inverse to the ASTM penetration value as obviously the depth of cone penetration into a grease sample becomes greater as the grease becomes softer. The actual ASTM penetration value is stated in tenths of a millimeter.5/

Types of Transmission and Axle Lubricants

Transmission and axle lubricants are made with well refined mineral oils properly compounded with lubricity additives and/or load carrying ingredients to prevent foaming, channeling, and to resist corrosion. The Lubricants Committee of the Division of Marketing of the American Petroleum Institute (API) have set up gear lubricant classifications which are used by the SAE. These are applicable only to conventional transmissions and axles, excluding automatic transmissions. The classifications are as follows:

Regular-type Gear Lubricants. This term designates gear lubricants generally suitable for use in automotive transmissions and in most spiral-bevel and worm gear differentials.

Worm-type Gear Lubricants. This term designates gear lubricants generally suitable for use in truck-type worm gear rear axles under very severe conditions of service.

Mild-type EP Gear Lubricants. This term designates gear lubricants having load carrying properties suitable for many automotive transmissions and spiral-bevel differentials under severe conditions of speed and load.

Multipurpose-type Gear Lubricants. This term designates gear lubricants having load carrying properties suitable for hypoid gear and other types of differentials and many transmissions. They are identified as meeting API Service GL-4.

The above definitions are somewhat broad and include all of the gear lubricants that are normally suitable for various services encountered. The above are service classifications and not specifications. The military have set up a specification for multipurpose gear lubricants (MIL-L-2105B) which is suitable for military service, and products qualified against this specification are gaining manufacturer acceptance and are widely available at service stations. 3/ These lubricants are available in SAE Grades 80, 90, and 140.

Service Applications for Transmission and Axle Lubricants

Service application for transmission and axle lubricants have been defined as follows:

Regular-type Gear Lubricants. In some gear sets, tooth pressures and rubbing velocities are low enough so that the gears can be satisfactorily lubricated with straight mineral oils. These oils are identified as "Regular-Type Gear Lubricants."

Worm-type Gear Lubricants. In some worm gear sets, tooth pressures or rubbing velocities are such that they cannot safely be lubricated by regular-type gear lubricants. For lubricants designed to meet these extreme conditions, a special designation has been developed. These lubricants are identified as "Worm-Type Gear Lubricants," or "Universal Gear Lubricants."

Mild-type EP Gear Lubricants. Some transmissions and particularly some spiral-bevel gear axles show a tendency to score and wear unduly when operated under extreme service conditions on regular-type gear lubricants. These gear sets may function satisfactorily on mild extreme-pressure lubricants which have load carrying capacities in excess of regular-type gear lubricants.

Multipurpose Gear Lubricants. (API Service GL-4) Gears are in general use which require a lubricant especially formulated to withstand the rigors of varying conditions of speed and torque. Typical of such gears are the hypoid type used in passenger cars and trucks. The multipurpose-type lubricants are designed to provide maximum protection at high speed in passenger car axle and maximum protection under the low-speed, high-torque conditions existing in heavy duty truck service. These lubricants are also suitable for spiral-bevel differentials of many transmissions. Lubricants of this type are designated as "Multipurpose-Type Gear Lubricants." The term "multipurpose" does not mean that a single viscosity grade may be used for all applications under all climatic conditions; the proper viscosity grade must be selected for each application. The multipurpose-type gear lubricant has practically replaced those lubricants referred to in previous editions of the SAE Handbook as passenger-car-type hypoid and truck-duty hypoid lubricants in regular service. The passenger-car-type hypoid lubricant is still used by several

manufacturers for the initial or factory fill of passenger-car hypoid rear axles.5/ Controlled slip differentials may have special lubrication requirements. The lubricant supplier should be consulted to see if his lubricant is suitable and meets the manufacturer's requirement.

SAE Numbers for Transmission and Axle Lubricants

SAE viscosity numbers have been selected without regard to the viscosity numbers for crankcase oils. The SAE viscosity numbers for transmission and axle lubricants are 75, 80, 90, 140, and 250. For example, an SAE 20 and 30 crankcase oil may have the same actual viscosity as SAE 90 gear lube.5/

Application of Gear Oils and Greases

Multipurpose Gear Lubricants

Gear oils are available in SAE Grades 80, 90, and 140 under API Service Classification GL-4. Multipurpose gear lubricant is made from high-quality solvent refined base stocks and improved additives. These oils meeting the requirements of MIL-L-2105B (12-8-58) are recommended for rear axle lubrication, including limited slip type when specified by manufacturer. Also, for use in manual-type transmissions of passenger cars and pickup trucks where a mild extreme pressure, multipurpose lubricant is required.4/

Worm Drive Gear Lubricants

Worm drive gear oils are available in SAE Grades 80, 90, and 140. These oils are for lubrication of truck and tractor transmissions and differentials, truck transfer cases and power dividers, tractor final drives, marine gear sets, and other gearing requiring gear lubricants of MIL-L-2105 (4-7-50), Universal Gear Lubricant, mild, extreme pressure or hypoid quality. It may also be used in transmission and gear cases where manufacturer recommends use of all-mineral gear lubricants. These oils are made from high-quality base stocks and versatile multipurpose extreme pressure additive to provide new gear lubricant giving improved high temperature stability, excellent rust, corrosion and antifoam protection, together with the desired extreme pressure characteristics. It meets requirements of Rockwell-Standard (Timken) Specifications 0-64 and 0-65 for use in spiral-bevel and hypoid gears, and Specifications 0-72 and 0-73 for use in heavy duty worm gear truck axles.4/

Multipurpose Greases for Automotive Use

Lithium base grease is available in NLGI Grades 0, 1, and 2. It is made with lithium soap and carefully selected oils for automotive use, and is both high temperature and water resistant, light colored, having

a smooth to short fibre, buttery texture. It can be used in all types of grease dispensing equipment. No. 2 grade is recommended for all types of wheel bearings in both summer and winter. It should not be mixed with sodium or calcium greases. Grade 0 is for special application at extreme low temperatures, but not for wheel bearings. 4/

Chassis Grease

Calcium Base Grease is available in NLGI Grades 00, 0, 1, and 2. It is a pressure gun grease for automotive and farm use. Calcium soap greases are made from selected fatty material and heavy refined lubricating oil. It is a light colored, transparent, tacky grease with excellent water resistant properties suitable for use in pressure guns and grease cup lubrication of automobile chassis, farm machinery, and industrial equipment where temperatures do not exceed 170° F. It is recommended for lubricating track rollers on crawler tractors except those manufactured by Allis-Chalmers which require a special calcium soap grease to resist deterioration of the seals.

Lithium Base Grease is available in NLGI Grades 1 and 2. This is a high-quality grease containing molybdenum disulfide with special additives to reduce friction and improve adherence to metal surfaces, intended for lubrication of automotive ball joint suspensions and chassis fittings.

Sodium Base Grease is available in NLGI Grades 0 and 1. This is a heavy duty pressure gun grease for automotive equipment. It is dark green and very tacky, noted for its ability to form a lubricating cushion in chassis points, and its adhesive characteristics aid in keeping dust and dirt from entering. It is suitable for use in 300° F temperature range, but not to be used where resistance to moisture or water-washing is required. 4/

Other Greases

There are a number of other greases available such as sodium base wheel bearing grease, water pump greases, graphited grease for leaf spring lubrication, and dark axle grease used for rust prevention and also for truck fifth wheel lubricant, to name a few.

Hydraulic Fluids and Industrial Oils

Types of Hydraulic Fluids

Petroleum Base. Petroleum base hydraulic fluids must be compounded with additives to control foaming and prevent corrosion, and must be extremely stable to minimize buildup of gum and varnish, as well as provide lubrication for pumps, bearings, and pistons.

Automatic Transmission Fluid, Type A. Automatic transmission fluid, Type A, Suffix A, specification was issued in November 1957. The test requirements of the new specification are more severe than for ATF Type A; and to qualify, fluids must possess improved high-temperature oxidation stability in addition to foam resistance, oiliness, low pour points, some extreme pressure properties, and a very high viscosity index. These qualities are necessary to maintain the proper viscosity through a wide temperature range.

Fluids qualifying are assigned a distinctive AQ AFT number which is suffixed by the letter A. This identification stamped on each container assures that the product meets the specification requirement. Passenger cars and light truck automatic transmissions require "Type A" transmission fluid. 3/

Hydraulic Transmission Fluid, Type C-1. In 1955, the Allison Division of the General Motors Corporation introduced a specification for a fluid for use in the heavy truck, bus, and earthmoving vehicle hydraulic transmission they manufacture. In these applications, both Type A and Type A Suffix A products were satisfactory; but the service did not demand all the characteristics so the use of less costly ingredients was recognized. The specification was modified in 1959 and designated "Type C-1." Many heavy duty motor oils in the SAE 10W viscosity classification, in addition to some special fluids, adequately meet the specification requirements. 3/ Operating oils of proper viscosity used for crankcase lubrication are suitable for hydraulic systems and transmissions. In some cases, equipment manufacturers refer to a Type "C" hydraulic fluid. The 9000 series oil under DPSC contracts of the proper viscosity meets the requirements for Type "C" hydraulic fluid. 5/

Nonpetroleum Base. Hydraulic fluid for braking systems having a nonpetroleum base are available in two types; namely:

Arctic. It has a temperature operating range of -90° to 125° F. This fluid should not be used unless temperatures lower than -40° F are encountered.

Heavy Duty Type. Procured under Specification VV-H-910. 5/ This fluid conforms to the requirement set forth in SAE 70R3 for use in highway vehicles where the brake fluid is exposed to severe operating conditions. Use of this fluid is mandatory in many states. Its use is prescribed for Bureau of Reclamation vehicles. This fluid is suitable for use in the atmospheric range of approximately -60° to 140° F. Heavy duty type fluid (SAE 70R1) is suitable in highway vehicles where the brake fluid is exposed to normal operating conditions.

Pneumatic Tools

There is a wide variety of equipment operated by compressed air. Reciprocating-type tools such as rock drills, paving breakers, tampers, chippers, riveters, and calking tools require lubrication.

Points to be lubricated are pistons, valves, and power feed mechanisms where employed. The lubricant may be applied by hand oiling, integral oilers, or air line oilers. All three methods involve the introduction of oil into the air stream. Air line oilers are most generally used. A light viscosity oil either straight or compounded, depending upon the moisture conditions, is recommended. If pistons are excessively worn, heavier grades may be required. Too light an oil for the piston clearance will be evidenced by dense oil fogging from the air exhaust. Drill lubricant is available in Grades 300 and 500, and is a mineral oil containing extreme pressure and rust-inhibiting agents. It contains no metallic soaps. Where rust prevention and atmospheric conditions permit, a nondetergent parafinic engine oil may be used.

Pneumatic tools of the rotating type are quite generally used in industry--tappers, grinders, polishers, screwdrivers, impact wrenches, and saws are examples. Air motors are used to drive small winches, pumps, and hoists. Rotating-type tools may be driven by pistons connected to a crankshaft or by vanes on the shaft. Such air motors may also have integral gearing. Piston-type tools and air motors are generally lubricated at regular intervals with a light grease or oil, depending upon design. For grease-lubricated rotating tools, a transparent calcium soap cup grease available in NLGI Grades 00, 0, 1, and 2 is recommended as it is light colored and tacky. This grease is water resistant and may be used for severe applications where the lubricant is subject to continuous operating temperatures below 160° to 170° F.4/

Simplified Lubrication3/

Scope

Older machines with slow speeds, light loads, and large clearances had few lubricating points and lubrication was not critical. Modern machines now being acquired for use by the irrigation projects have increased lubrication requirements severely because of their high speeds, heavy loads, and close tolerances. In the process of machine development and corresponding lubrication development, the lubricant supplier must supply adequate products. Manufacturers specify new lubricants with new equipment, resulting in several type of lubricants being required to service equipment purchased from the same manufacturer over a period of years. On a project with a variety of manufacturers supplying like equipment, a user might be saddled with 27 different or special lubricants for a small group of equipment such as is used on an irrigation project.

The manufacturer may not recommend by brand name, but may specify the characteristics required of the lubricants for his machine. Sometimes these specifications are restrictive. Other times, they will be very general and allow considerable leeway. Almost invariably, however, the warranty furnished by the equipment manufacturer will be honored only if the purchaser adheres to the lubricants specified and recommended by the manufacturer. At this point, the purchaser must decide to either use the manufacturer's recommended lubricant or use those available and on hand or under contract. The situation has been eased somewhat as the lubricant manufacturers have developed multipurpose lubricants and other all-purpose oils which eliminate carrying so many different types of products.

Definition

Satisfactory lubrication has been defined as comprising all of six rights: The right type and right quality of lubricant, in the right amount and right condition, in the right place, at the right time. Simplification is accomplished by reducing the number of lubricants required at an existing location as we can assume the right amount, condition, place, and time have already been provided by preventive maintenance and storage procedures. The remaining rights--right type and right quality--can be assured through careful application of the oils available under contract and selection of proper quality oils and greases in the open market.

Other factors that influence selection of lubricants are viscosity, viscosity index, pour point, extreme pressure properties, oxidation inhibitors, rust inhibitors, detergent-dispersant additives, etc. With a grease, consideration must also be given to soap base, consistency, dropping point, pumpability, etc.

Procedure

When simplifying the lubricants used at one location, the requirements of each unit should be set down on paper in terms of general type of lubricant (oil, grease, or gear compound). Under each type, the properties of each product should be grouped such as oil viscosity, detergent-dispersant requirements, EP requirements, rust and oxidation inhibitors, NLGI grade of grease, viscosity of oil component in the grease, pumpability, etc.

At this stage, viscosity grouping can be made. For instance, if three otherwise similar oils have viscosities of 110, 150 and 190 SUS (Saybolt Universal Seconds) at 100° F, the final oil selected should have a viscosity of about 150 SUS at 100° F. If one of the original oils was rust and oxidation inhibited, the final product should be also. A second group of oils with viscosities at 100° F of 280, 330, and 350 SUS could be reduced to one oil having a viscosity in the neighborhood of 315 SUS at 100° F.

In each group of oils selected, consideration should be given to the most severe requirement of any of the original oils and the consolidated oil required to have this same characteristic to at least the same degree. The same procedure is true for greases. There are hazards in selecting one oil or grease type for all equipment to minimize products in use.

One precaution to keep in mind is that there may be a few critical applications which require a very specialized lubricant, such as water pumps, pneumatic tools, fifth wheels, etc. These should be set aside and not consolidated in the simplified plan. A qualified lubrication engineer should be consulted to prevent misapplication with consequent breakdown of equipment. All major oil companies have qualified engineers available who will help with your problems. The integrity and reputation of the lubricant supplier are the best assurance that the product recommended will meet the requirement.

Lubricant Requirements

Bureau of Reclamation operating requirements can generally be met by, but are not limited to, using the products specified below:

	Temperature range +90° to 32° F	+40° to -10° F
(1) Crankcase Oil*		
Passenger car & truck gasoline engines and other gasoline engines	OE-30 MS 9250	OE-10 MS 9170
Construction equipment, such as tractors, draglines, cranes, etc., with turbocharged diesel engines or engines using high sulfur fuels (over 1%)	Series 3 SAE-30	Series 3 SAE-10
Nonturbo charged diesel engines--Fuel 0.4 to 1% sulfur content	Supl. 1 SAE-30 MS 9250	Supl. 1 SAE-10 MS 9210
Air compressors, industrial engines, etc.	(Use grade specified by manufacturer)	

*OE-10 and MS 9170 are suitable when SAE-20-20W is called for. When necessary, 20-20W grade may be ordered with an appropriate justification.

	Temperature range +90° to 32° F	+40° to -10° F
(2) Transmissions		
Standard **		
Passenger cars, trucks (1-1/2 tons or less)	SAE-90	SAE-80
Trucks over 1-1/2 tons	SAE-140	SAE-90
Tractors and other transmissions	Observe manufacturer's recommendations	
Automatic		
Passenger cars and light trucks	Type A, Suffix A	
Heavy trucks, when specified	Type C--(MS 9110)	
Torque Converters		
All	Torque fluid	
(3) Rear axles, steering gear, universal joint, chain drives, gear boxes	Extreme pressure lubricant GL-4 **	
	140	90
(4) Hydraulic mechanisms (except transmissions)	MS 2075H, 2110H, 2135H Hydraulic oil	
(5) Chassis grease fittings, wheel bearings, ball and roller bearings	Multipurpose grease NLGI-2--Lithium Base	
(6) Exposed gears, wire ropes and cables	Open gear lubricant adhesive type	
(7) Track rollers	As specified by manufacturer	

Storage and Handling3/

Lubricants are in the best possible condition when delivered to the customer. The manufacturer and dealer take every precaution to assure this. The user has an equal responsibility to see that when a lubricant is applied, it is in the same good condition as when it was received.

The adage, "There is many a slip 'twixt cup and lip, '" may be likened to storing and using of lubricants. Many things can happen to a lubricant between the time it is received by the storekeeper and the moment

**MIL-L-2105B multipurpose gear lubricant GL-4. When specified, Universal Gear Lubricant should be used for transmission and rear axles requiring extreme pressure oils meeting MIL-L-2105.

it is applied. Such things as careless handling, contamination, confusion of brands, exposure to extreme temperatures, and leakage can result in damaged equipment, excessive maintenance cost, and lost productive effort. The conditions under which an irrigation project must store and handle lubricants are particularly hazardous from the standpoint of contamination and exposure to temperature extremes. Consequently, unusual care must be taken to see that nothing detrimental happens to them.

Some "do's and don'ts" that apply to storage and handling of lubricants are detailed below:

(1) Choose storage area carefully. Select a central location so that hauling distances are as short as possible. Also, select an area where the atmosphere is free from dust and vapors.

(2) Store lubricants indoors if possible--chances of contamination will be less.

(3) If stored outdoors, drums should be placed on their side and on racks--do not lay them on the ground. When placed upright on end, rain water may accumulate and be sucked into the drum by the normal breathing action. If stored outdoors on end even temporarily, cover should be available to place over drum in the event of inclement weather.

(4) Cleanliness is essential regardless of whether storage is indoor or outdoor.

(5) Orderliness is another must. By keeping different brands and types of lubricants separated and in their proper places, there is less chance for confusion and error.

(6) Do not store more products than necessary. The lubricant dealer will be glad to make a survey of lubrication requirements with a view to keeping the number of different products to a minimum. This also will reduce chances of confusion.

(7) Exercise extreme care in heating products that have been exposed to low temperatures. If possible, transfer drums to a warm area and allow product to reach room temperature. If more rapid heating is required, use exhaust steam. Never apply direct heat, such as a flame, to exterior of the drum. This could cause leaking. It might also harm the product.

(8) Remember that exposure to temperature extremes can damage lubricants. If there is any reason to suspect that this condition has occurred, examine the lubricant before using. If the products appear abnormal, consult the lubricant supplier as to what to do. The lubricant may have to be discarded or it may be salvaged.

Application

Where equipment is serviced by a mobile unit, it is most advisable to apply the lubricant directly from the original container in which it came. The elimination of intermediate transfer receptacles precludes a very serious source of contamination. Be certain you have modern dispensing equipment as it is now available to fit all of the standard containers used to package lubricants and greases. Proper dispensers permit product to be removed from its original container with no danger of contamination, waste, or mess.

Preventive Maintenance

Equipment maintenance is of prime importance in any operation. A piece of machinery which must be pulled off the job for repairs represents lost time. Also, equipment not operating at top efficiency can have far-reaching costly effects. For example, a sluggish push tractor may upset the smooth operation of an entire fleet of scrapers; the breakdown of a dump truck may mean delays to a big loader; and the breakdown of a loader---even for a short time--may delay a long series of operations.

Although the lesson has been learned the hard way, experience has proven that in the long run, it pays to take care of equipment on the job and not neglect it. A good program of preventive maintenance, where properly executed, will pay for itself over and over again. For example, it is much cheaper to keep a bearing adjusted than it is to buy new bearings, shafts, and gears that become damaged when unadjusted bearings fail. Major breakdowns, lost time, and high operating costs can be minimized by keeping parts lubricated, tightened, and adjusted. Furthermore, an operator whose equipment is always in good condition is very apt to be a happy, satisfied employee.

Since no two jobs are exactly identical, the actual details and execution of preventive maintenance programs will necessarily vary from project to project. However, there are a few basic concepts which are common and essential to the success of such programs:

(1) Set up a definite schedule for lubrication and mechanical checkups and stick to it strictly. Any program may fail and become ineffective once exceptions are made and one starts to "cheat" on the original schedule. For example, if it is found that the interval between lubricant changes can be extended with no apparent adverse effect, the natural tendency then is to extend it further and further. Such practice is hazardous and may lead to disaster.

(2) When possible, have the preventive maintenance work performed on an off-shift as this will cause a minimum of interference with the productive effort.

(3) Assign men to this job who are familiar with lubricants and who are thoroughly acquainted with the equipment. The consequences are too great to entrust this work to uninformed personnel.

(4) Keep accurate records of the servicing done on each piece of equipment. This is not a complicated procedure. A study of such records by the mechanic will usually serve as a warning of possible trouble. For example, excessive oil consumption is evidence of poor lubefittings or oil leaks--items which can be checked at once by the mechanic. The repair dates recorded in the equipment records will indicate when the machine is nearing the overhaul stage.

(5) Develop a ready source of parts and expendable supplies--if they are available when needed, equipment requiring new parts will be out of service for a minimum amount of time.

(6) Clean equipment before servicing. There are two good reasons for following this practice. First, the lubrication fittings will be uncovered and the chances of any points being missed will be reduced. Fittings caked over with mud may be overlooked in accordance with the adage "out of sight, out of mind." Second, there is less chance of dirt from the machine contaminating the lubricant at the moment of application.

(7) On an operating irrigation project, it is quite important that equipment be ready for immediate use in case of emergency. For this reason, it is suggested that equipment be lubricated at the end of the shift so that it is ready to go to work when left.

Summary

Proper lubrication is vital to the successful and efficient operation of any piece of equipment. Operating costs can be reduced to a minimum and equipment life can be extended by (1) adopting a simplified lubrication plan which will keep the number of required lubricants to a minimum, (2) storing and handling lubricants in accordance with accepted established practices, (3) applying lubricants properly, and (4) establishing and following a good lubrication and preventive maintenance program.

- - - - -

Bibliography

1/ U.S. Naval Supply Office, Washington, D.C., C. W. Crossen, Technical Director (Letter 42-4410--October 3, 1963)

2/ "Military and Manufacturer Specification Oils--Their Evaluation and Significance," by F. A. Christiansen and P. I. Brown, California Research Corporation, SAE Preprint 573B, September 1962

3/ Courtesy of Texaco's magazine LUBRICATION (July 1957, June 1961, May 1960)

4/ "Handbook of Lubricants and Their Application," Phillips Petroleum Company, December 1960

5/ "Navy Oil Contracts and Symbols," by James Doran, U.S. Department of Navy, Paper presented at IMEAC meeting, October 31, 1962, Bismarck, North Dakota

6/ "Lubrication Guide," U.S. Army Engineer District, Omaha, Corps of Engineers, April 1963

7/ "Field Maintenance Manual No. 1 - Lubrication," Rockwell-Standard Corporation, Detroit, Michigan, Revised 1959

8/ "The Case for the Magnetic Drain Plug," by W. A. Johnson, SAE Preprint S-198, April 1959

9/ "Oil Contract Bulletin," U.S. Department of Defense, Defense Petroleum Supply Center, 1963

* * * * * *

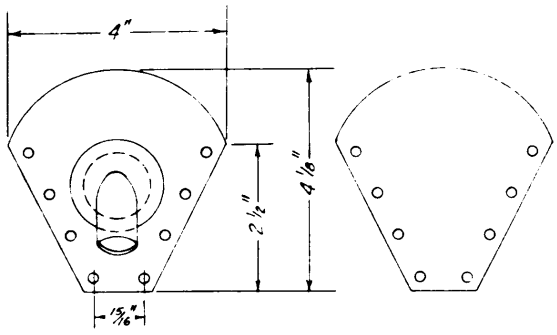
YUMA COUNTY WEED BURNER HEAD

The weed burner head shown in the drawing on the next page was developed by the Yuma County Water Users Association, Yuma, Arizona, to use fuel oil, heavy diesel gravity above 24° A.P.I., and compressed air, so as to secure complete combustion of the fuel. By obtaining complete combustion a great saving is made in the quantity of fuel used. It also makes a fan shaped flame which covers more area for burning weeds along canal banks, etc. Only two heads are necessary on the end of the burner boom to cover the same area as the old burner bar.

The burner head consists of six parts plus standard pipe fittings, cap screws, nuts, and washers, as follows:

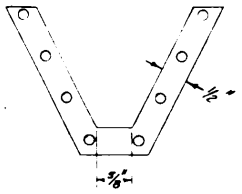
Part 1, the top plate, has the outside dimensions shown in the drawing with a cup pressed into it. A hole is drilled in the cup to accept a standard 1/4-inch pipe coupling. The opposite face is machined and ground flat.

Part 2, the bottom plate, is identical to Part 1, except a 1/2-inch standard pipe coupling has been fitted.



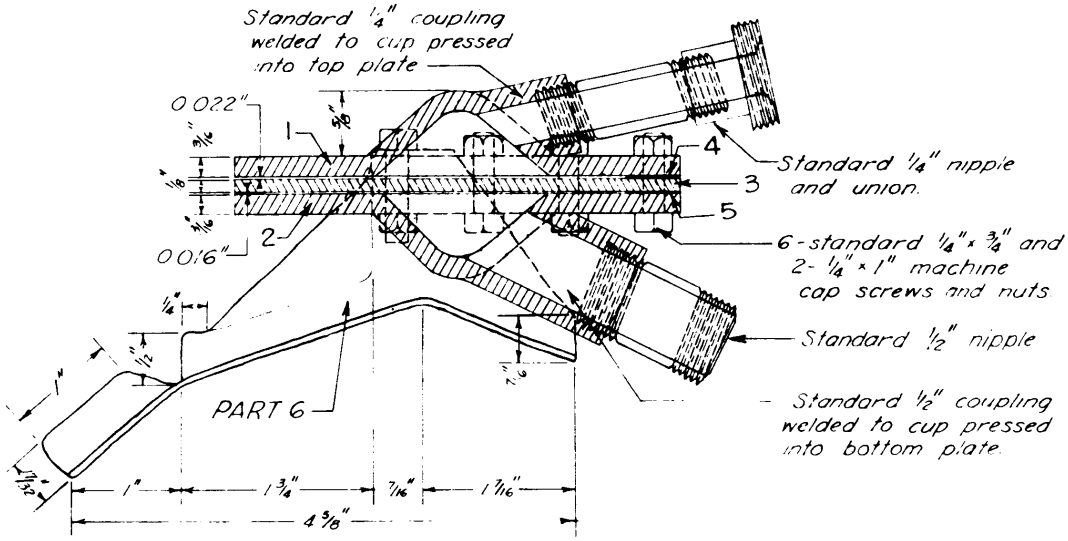
PART 1 - Top
PART 2 - Bottom

PART 3



PART 4 - 0.022"
PART 5 - 0.016"

Scale: Half Size



Scale: Full Size

YUMA COUNTY
WATER USERS ASSOCIATION
YUMA, ARIZONA

WEED BURNER HEAD

DESIGNED _____ SUBMITTED _____
DRAWN _____ APPROVED _____
TRACED A.J.M.
YUMA, ARIZ. MAR 22, 1954

Part 3, the middle plate, is solid but ground on both sides.

Part 4, is a metal shim or gasket as shown in the drawings, and is put between Parts 1 and 3 so as to close the sides and back, yet leave a slot opening in the front.

Part 5, is identical to Part 4, but of a different thickness, as shown, and fits between Parts 2 and 3, making a second slot opening below the first. Parts 1 through 5 are drilled for bolting together so that the front edges are flush and are perpendicular to the inside ground faces.

Part 6, is a hood of sixteen gauge metal fashioned roughly like one-half of a venturi tube and fastened under the other parts when assembled.

Burner heads are mounted on the end of a burner boom. The top, 1/4-inch fitting is connected to an oil line, and the bottom, 1/2-inch fitting is connected to an airline. Oil in the oil line is maintained at an eight to ten pound pressure, and its rate of flow through the head is regulated by hand valves. Air pressure, directly from a 125 CFM air compressor, is regulated at sixty pounds pressure. All the above, plus fuel tank, are mounted on a truck.

When burning, the oil comes out the front of the burner head through the upper slot made by the shim or gasket, Part 4, between Parts 1 and 3. Air comes out of the lower slot made by the shim or gasket, Part 5, between Parts 2 and 3. As the oil drips into the stream of air, it is picked up and mixed for burning. The hood, Part 6, underneath the assembled parts permits free air to come in from the back

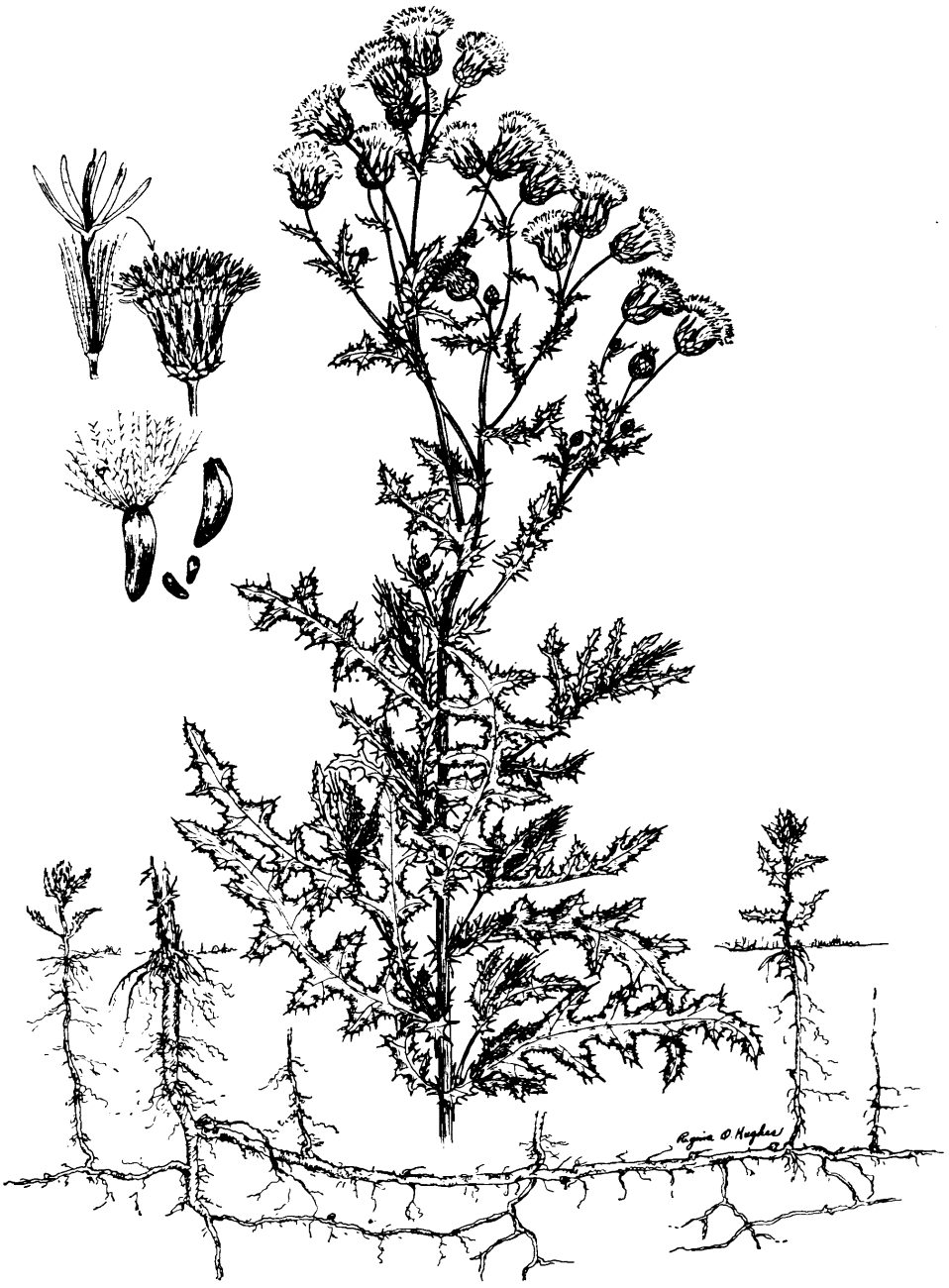
and under the air stream. This helps mix the oil and air. The front part of the hood also holds enough heat to keep a flame. With proper adjustment of the oil by the hand valves, a hot flame develops without smoke.

* * * * *

CANADA THISTLE CONTROL

The fact that Canada Thistle is a problem on many of our irrigation projects is emphasized by the study given to control of the plant by state colleges and other agencies in several of our Western States, in cooperation with the U.S. Department of Agriculture, and steps taken by state laws to control spread of the plant. Publications available on the subject include: Canada Thistle, Extension Bulletin 519, (Revised May 1959) by Tex Warren, Extension Farm Crops Specialist, Federal Cooperative Extension Service, Oregon State College, Corvallis, Oregon; Canada Thistle, Leaflet 50, June 1952, by Harold P. Alley, Wyoming Weed Specialist, Agricultural Extension Service, University of Wyoming, Laramie, Wyoming; and the more recent Leaflet No. 523 "Canada Thistle and Its Control," by Jesse M. Hodgson, Agronomist, Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture.

The latter publication cited above discusses control of the weed by cultivation and cropping practice as well as chemical control. Also precautions that should be used in application of chemicals are given.

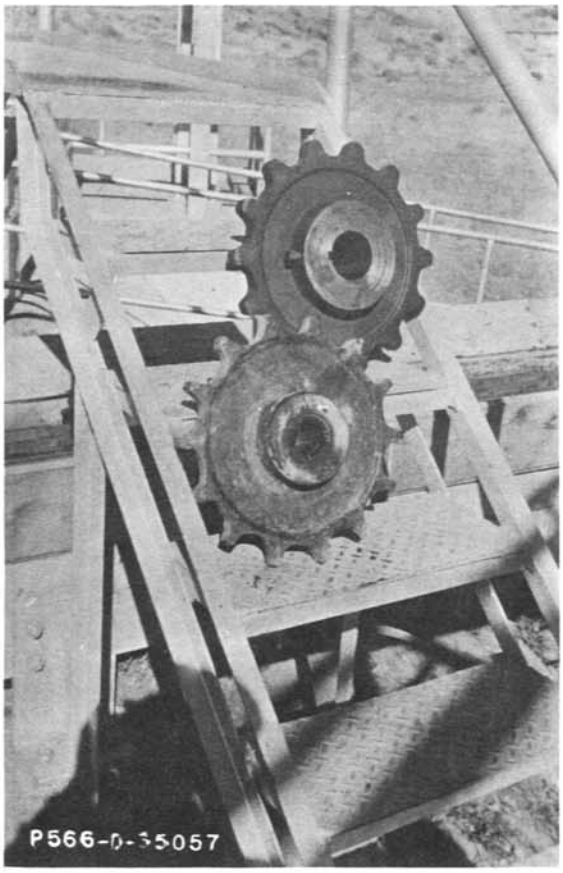


The above drawing shows the Canada Thistle plant, including part of the extensive root system. Insets show details of a flower and seeds.

Copies of these and other publications on the control of the troublesome weed are available from the cooperating agencies and the more recent Leaflet No. 523 can be obtained from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 at a cost of 5 cents per copy.

* * * * *

IDLER WHEELS FOR TRASH COLLECTOR
(Suggestion R1-64-12)



Because of wear due to the large amount of silt carried by the water flowing in the Chandler Power Canal on the Yakima Project, Washington, Mr. Floyd L. O'Banion, Power Field Division, has made some changes in the lower (idler) sprockets of the Chandler Power and Pumping Plant trash collector shown in the drawing on page 28.

The lower sprockets of the collector were catching and holding sufficient sand to cause severe abrasive action between the chain and the teeth of the sprocket. Wear on the chains in turn resulted in excessive wear on the upper sprockets as well, with the result that it was being frequently necessary to install new chains and the upper and lower sprockets. The extent of the sprocket wear is shown in the photograph at left with the worn sprocket in the lower position.

To overcome, the problem, as shown in the sketch on the following page and using the same hub and shaft, Figure 1, the sprocket teeth were removed and a rim casting, Figure 2, was bolted to the web of the original sprocket. After a 6-month test run with the new idler, it is estimated that the change made will lengthen the life of the chains and sprockets four times over that of the original equipment, and will result in a considerable saving in maintenance cost.

* * * * *

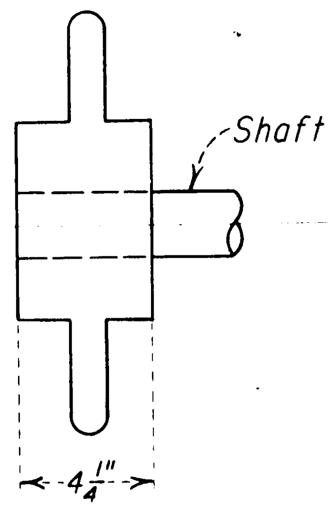


FIGURE 1

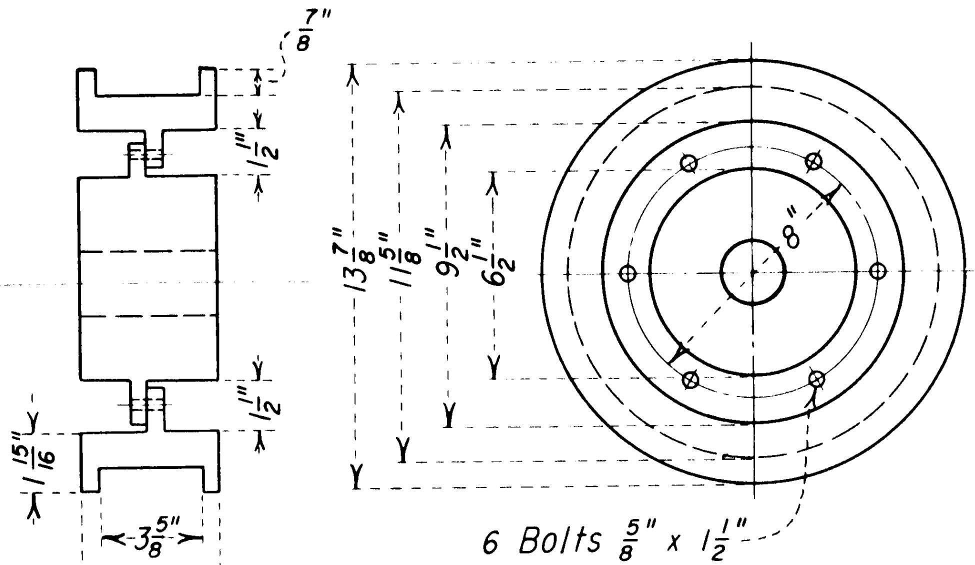
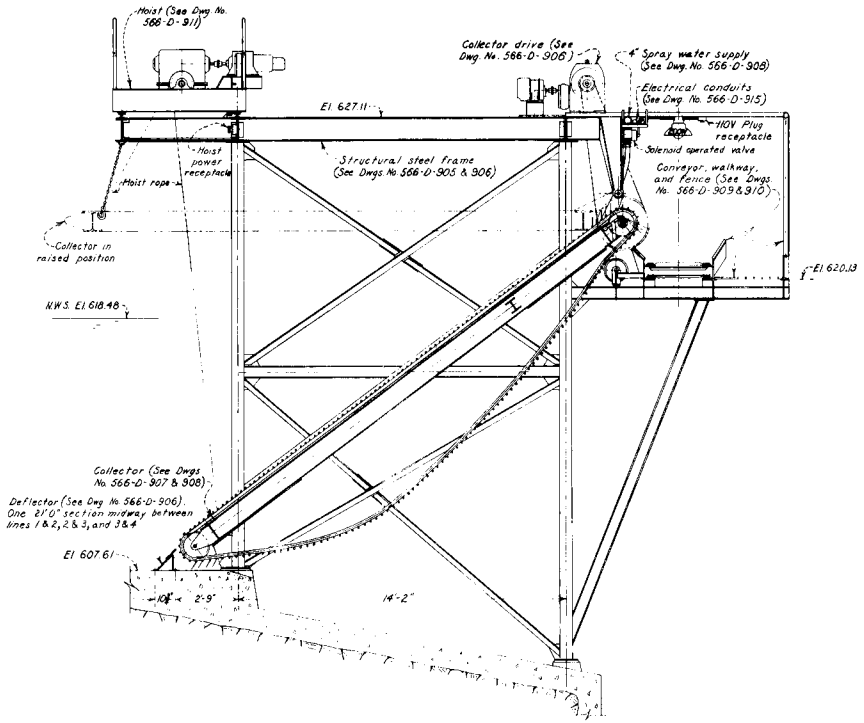
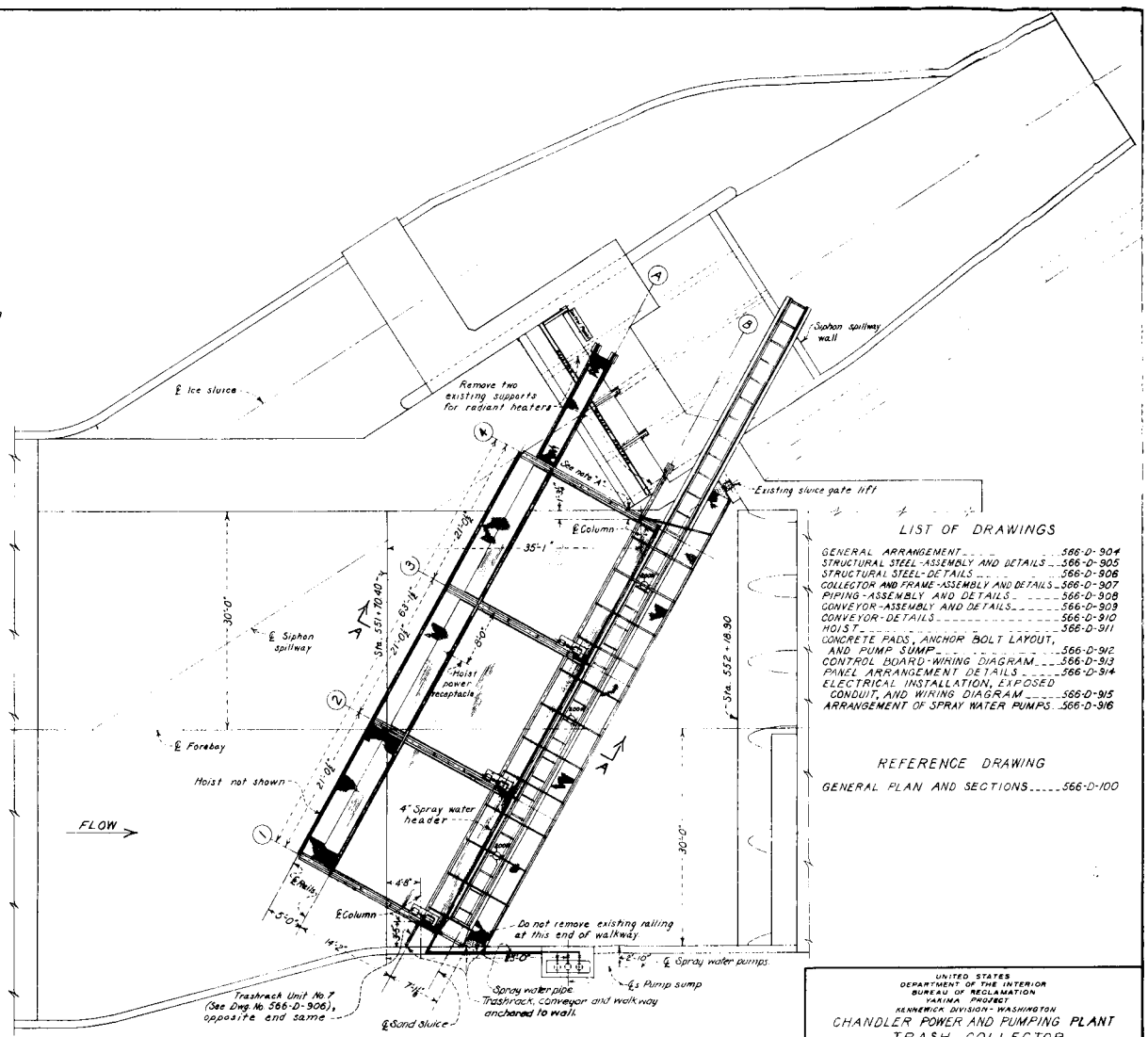


FIGURE 2

GPO 843-825



SECTION A-A
(TYPICAL)



PLAN

NOTES

A: Remove concrete from corner of siphon spillway to accomodate trashrack.
B: Remove handrail around siphon spillway deck as required to accomodate the conveyor and two walkways. Where existing railing is cut it is to be refinished to provide safety and neat appearance.

LIST OF DRAWINGS

REFERENCE DRAWING

GENERAL PLAN AND SECTIONS 566-D-100

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
YAKIMA PROJECT
KENNEWICK DIVISION - WASHINGTON

CHANDLER POWER AND PUMPING PLANT
TRASH COLLECTOR
GENERAL ARRANGEMENT

DRAWN: F.E. SUBMITTED: C.W. Bennett
TRACED: RECOMMENDED: H.E. Sheda
CHECKED: A.E.S. APPROVED: J.C. Cuenca
CHIEF DESIGNING ENGINEER

DENVER, COLORADO, FEB. 14, 1958 | 566-D-904