Universal
MARINE POWER

ATOMIC 4

OPERATION AND MAINTENANCE MANUAL

PART NUMBER
200156

WESTERBEKE

WESTERBEKE CORPORATION
MYLES STANDISH INDUSTRIAL PARK
150 JOHN HANCOCK ROAD, TAUNTON, MA 02780-7319

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INSTALLATION, OPERATION
and
MAINTENANCE INSTRUCTIONS
for
UNIVERSAL
MARINE ENGINES

BLUE JACKET TWIN, ATOMIC FOUR, UTILITY FOUR, SUPER-FOUR, UNIMITE FOUR, ARROW (SIX), BLUEFIN (SIX), MARLIN (SIX), TARPON (SIX), KNIGHT (SIX), LITTLE KING V-8 and BIG KING V-8 MODELS

MARINE ENGINE WARRANTY

PRODUCT WARRANTY

SELLER WARRANTS ALL PRODUCTS AND PARTS OF ITS OWN MANUFACTURE AGAINST DEFECTS IN MATERIAL OR WORKMANSHIP FOR A PERIOD OF ONE (1) YEAR FROM DATE OF SHIPMENT WHEN GIVEN NORMAL AND PROPER USAGE AS DETERMINED BY SELLER UPON EXAMINATION, AND WHEN OWNED BY THE ORIGINAL PURCHASER. COMPONENTS PURCHASED BY SELLER AS COMPLETE UNITS AND USED AS AN INTEGRAL PART OF SELLERS EQUIPMENT WILL BE COVERED BY THE STANDARD WARRANTY OF THE MANUFACTURE THEREOF. SELLER WILL REPAIR OR REPLACE F.O.B. ORIGINAL SHIPPING POINT (BUT NOT INSTALL) ANY PART OR PARTS OF ITS MANUFACTURE WHICH, IN ITS JUDGMENT, SHALL DISCLOSE DEFECTS IN EITHER MATERIAL OR WORKMANSHIP. IF REQUESTED BY SELLER, PARTS FOR WHICH A WARRANTY CLAIM IS MADE ARE TO BE RETURNED TRANSPORTATION PREPAID TO OUR FACTORY. THIS WARRANTY BECOMES VOID IF ARTICLE CLAIMED TO BE DEFECTIVE HAS BEEN REPAIRED OR ALTERED IN ANY WAY OR WHEN THE ARTICLE HAS BEEN SUBJECT TO MISUSE, NEGLIGENCE OR ACCIDENT OR WHEN INSTRUCTIONS FOR INSTALLING OR OPERATING HAS BEEN DISREGARDED. WE MAKE NO OTHER WARRANTY, EXPRESS OR IMPLIED, AND MAKE NO WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR ANY PARTICULAR PURPOSE, AND THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF. NO EMPLOYEE OR REPRESENTATIVE IS AUTHORIZED TO CHANGE THIS WARRANTY IN ANY WAY OR GRANT ANY OTHER WARRANTY. THE REMEDIES HEREINABOVE AFFORDED TO THE PURCHASER ARE EXCLUSIVE OF ALL OTHER REMEDIES PROVIDED BY LAW. SELLER SHALL NOT BE LIABLE FOR INDIRECT OR CONSEQUENTIAL DAMAGES WHERE THE LOSS SUSTAINED IS OF A COMMERCIAL NATURE.

PRODUCT IMPROVEMENTS

THE MANUFACTURER RESERVES THE RIGHT TO MAKE PRODUCT IMPROVEMENTS AT ANY TIME WITHOUT TAKING RESPONSIBILITY OR OBLIGATION TO MAKE SIMILAR CHANGES OR ADD SIMILAR IMPROVEMENTS ON ANY ENGINES DELIVERED PRIOR TO THOSE CHANGES.

WARRANTY REGISTRATION

ENCLOSED WITH EACH ENGINE IS A WARRANTY REGISTRATION CARD. THIS CARD MUST CONTAIN THE OWNER'S NAME, ADDRESS, SERIAL NUMBER OF THE ENGINE, V-DRIVE AND REVERSE GEARS AND RETURNED TO MEDALIST BEFORE THE WARRANTY BECOMES EFFECTIVE. THIS WARRANTY REGISTRATION MUST TAKE PLACE WITHIN 24 HOURS AFTER RECEIPT OF THE ENGINE.

WARRANTY EXCLUSIONS

THE FOLLOWING SERVICES AND EQUIPMENTS WILL NOT BE REIMBURSED UNDER THE WARRANTY:

1. REPAIRS DUE TO NEGLECT, MISUSE, IMPROPER APPLICATION, ACCIDENT, RACING AND INSTALLATIONS THAT DO NOT MEET MINIMUM STANDARDS AS SET FORTH IN THE INSTRUCTION MANUAL.

2. TUNEUP OR ADJUSTMENT EXPENSES NEEDED FOR CLEANING OF FUEL SYSTEM COMPONENTS DUE TO CONTAMINATION.

3. DAMAGE OR LOSS TO PERSONAL PROPERTY, LOSS OF REVENUE, TOWING CHARGES, STORAGE FEES, FUEL AND TELEPHONE CALLS.

4. DAMAGES OR LOSSES RELATED TO HANDLING AND SHIPPING.

5. EXPENSES RELATED TO REPLACEMENT OF LUBRICANTS, ANTI-FREEZE OR SPECIAL ADDITIVES.

6. FAILURE DUE TO NOT FOLLOWING RECOMMENDED MAINTENANCE SCHEDULES.

7. ALL TRANSPORTATION CHARGES WILL BE THE OBLIGATION OF THE OWNER, SUCH AS FREIGHT, TRAVEL TIME, AND TOLLS.

8. WARRANTY ITEMS RETURNED TO THE FACTORY COLLECT WILL BE BILLED TO THE SHIPPER.

WARRANTY AUTHORIZATION

PRIOR AUTHORIZATION IS REQUIRED FROM THE FACTORY WHERE COMPLETE REPLACEMENT OR OVERHAULING OF THE FOLLOWING IS NECESSARY:

1. COMPLETE ENGINE ASSEMBLY

2. CYLINDER HEADS OR ENGINE BLOCK.

3. MARINE REVERSE GEAR OR V-DRIVE.

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SECTION I
GENERAL INFORMATION

1. INTRODUCTION

This instruction book gives general instructions for the installation, operation and maintenance of all current production models of UNIVERSAL and former NORSEMAN models listed on title page. Instructions throughout the book generally pertain to all of the models listed. When specific differences occur, the model or models to which the instructions pertain will be referred to directly.

a. Marine engine requirements differ radically from those of the automobile. This fact was recognized as far back as 1898 when the founders of the Universal Motor Company conceived and built the first 100% marine engine. Through the years, as model after model was designed, exclusively for marine service, improvements and refinements have been continually added. Today Universal is the world's largest builder of 100% Marine Engines.

b. To provide for the more severe service that marine engines encounter in use, Universal has pioneered many advancements. These include larger water jackets, with water supplied to all cylinders in equal quantities and at even temperature; water jacket clean-out plate; corrosion-resistant metals; built-in, not attached, reverse and reduction gears; oil coolers; and gear-type water pumps of non-corroding construction.

c. Universal engines have many exclusive features not found in other marine engines -- features you will come to appreciate more and more as you become familiar and experienced with your Universal. Each one is designed to assure long, dependable and economical service afloat.

d. Every modern facility is employed in building these marine engines. Yet metals will wear, and as time goes on, certain adjustments will be necessary. It is, therefore, the purpose of this book to show you the "why" and "how" of operation and maintenance. A reasonable amount of care will assure your complete satisfaction.

2. FACTORY PREPARATION FOR SHIPMENT

a. Each Universal built engine is run on its own power from idle speed to full throttle. Each is checked for oil leaks, water leaks, oil pressure, and all other conditions which will assure the engine operating satisfactorily when installed. All adjustments are made during test and are undisturbed when the engine is shipped.

b. Run-in lubricating oil is drained from the oil pan, all openings sealed and the engine painted with special marine paint.

c. Special rust preventive oil, drawn into the engine through the spark plug openings, gives a rust resisting coating to valves, pistons and cylinder walls. This prevents corrosion within the engine during shipment and storage.

d. Heavy frame shipping skids and crates insure the customer receiving the engine in excellent condition and ready for installation and operation.

3. TREATMENT OF ENGINE ON ARRIVAL

Before installing a new engine make a complete inspection of the engine for damaged or loose parts. New gaskets tend to compress so it is wise to check all accessible nuts and bolts for tightness. The is wise to check all accessible nuts and bolts for tightness. The various tags and decals attached to the engine contain important information which should be carefully noted.

4. ENGINE ROTATION

Engines designated as standard rotation use a right hand propeller in all types and gear ratios with only two exceptions, and these are the reduction gear models of the Utility Four and Super-Four series. These two models utilize external type reduction gears which change the rotation and they therefore use left hand propellers. Opposite rotation engines are available in all of the six and eight cylinder series and in every case utilize a left hand propeller.

5. ENGINE IDENTIFICATION

Each engine bears a name plate indicating the engine model designation and the individual engine's serial number. The combination of the model designation and the serial number constitutes positive identification of the engine. It is, therefore, very essential that you use this identification every time you request information about your engine or order parts.

Table 1 -
GENERAL DATA

	Model	HP	No. of Cyl.	Bore	Stroke	Piston Disp. Cu. In.	Max. Engine RPM	Reduction Gear Ratio	Standard Propeller Rotation	Reversing Gear	Standard Ignition	Standard Coupling
Blue Jacket Twin	AFT	12	2	3"	3-1/2"	49.5	2200	---	R.H.	Manual	Magneto	7/8"
	AFTL	12	2	3"	3-1/2"	49.5	2200	---	R.H.	Manual	6 V. Elec.	7/8"
Atomic Four	UJ	30	4	2-9/16"	3-1/8"	64.46	3500	---	R.H.	Manual	6 V. Elec.	7/8"
	UJR	30	4	2-9/16"	3-1/8"	64.46	3500	2:1	R.H.	Manual	6 V. Elec.	1-1/8"
	UJ-VD	30	4	2-9/16"	3-1/8"	64.46	3500	1:1, 1.29:1, 1.67:1, 2:1	R.H.	Manual	6 V. Elec.	7/8" & 1"
Utility Four	BN	25	4	2-3/4"	4"	95	2200	---	R.H.	Manual	6 V. Elec.	7/8"
	BNM	25	4	2-3/4"	4"	95	2200	---	R.H.	Manual	Magneto	7/8"
	BNR	25	4	2-3/4"	4"	95	2200	2.28:1	L.H.	Manual	6 V. Elec.	1-1/8"
	BNMR	25	4	2-3/4"	4"	95	2200	2.28:1	L.H.	Manual	Magneto	1-1/8"
Unimite Four	HF	70	4	3-1/4"	4-1/4"	141	3500	---	R.H.	Manual	6 V. Elec.	1"
	HFR	70	4	3-1/4"	4-1/4"	141	3500	2:1	R.H.	Manual	6 V. Elec.	1-1/4"
	HF-VD	70	4	3-1/4"	4-1/4"	141	3500	1:1, 1.29:1 1.67:1, 2:1	R.H.	Manual	6 V. Elec.	7/8" & 1"
Super-Four	LSG	55	4	3-1/4"	4-1/2"	149.3	3000	---	R.H.	Manual	6 V. Elec.	1"
	LSGR	55	4	3-1/4"	4-1/2"	149.3	3000	2.28:1	L.H.	Manual	6 V. Elec.	1-3/8"
Arrow	230	100	6	3-7/16"	4-1/8"	230	3200	---	R.H.	Manual	12 V. Elec.	1"
	231	100	6	3-7/16"	4-1/8"	230	3200	1.88:1	R.H.	Manual	12 V. Elec.	1-1/8"
	232	100	6	3-7/16"	4-1/8"	230	3200	2.44:1	R.H.	Manual	12 V. Elec.	1-1/4"
	233	100	6	3-7/16"	4-1/8"	230	3200	3.32:1	R.H.	Manual	12 V. Elec.	1-3/8"
	234	100	6	3-7/16"	4-1/8"	230	3200	4.12:1	R.H.	Manual	12 V. Elec.	1-1/2"
Bluefin	SY230	113	6	3-7/16"	4-1/8"	230	3500	---	R.H.	Manual	12 V. Elec.	1"
	SY231	113	6	3-7/16"	4-1/8"	230	3500	1.5:1	R.H.	Manual	12 V. Elec.	1-1/8"
	SY232	113	6	3-7/16"	4-1/8"	230	3500	2:1	R.H.	Manual	12 V. Elec.	1-1/4"
	SY230P	113	6	3-7/16"	4-1/8"	230	3500	---	R.H.	Hydraulic	12 V. Elec.	1"
	SY231P	113	6	3-7/16"	4-1/8"	230	3500	1.5:1	R.H.	Hydraulic	12 V. Elec.	1-1/8"
	SY232P	113	6	3-7/16"	4-1/8"	230	3500	2:1	R.H.	Hydraulic	12 V. Elec.	1-1/4"
	VSY230P	113	6	3-7/16"	4-1/8"	230	3500	1:1, 1.5:1, 2:1	R.H.	Hydraulic	12 V. Elec.	1 to 1-1/4"
Marlin	320	110	6	4"	4-1/4"	320	2500	---	R.H.	Manual	12 V. Elec.	1-1/8"
	321	110	6	4"	4-1/4"	320	2500	1.88:1	R.H.	Manual	12 V. Elec.	1-1/4"
	322	110	6	4"	4-1/4"	320	2500	2.44:1	R.H.	Manual	12 V. Elec.	1-3/8"
	323	110	6	4"	4-1/4"	320	2500	3.32:1	R.H.	Manual	12 V. Elec.	1-3/4"
	324	110	6	4"	4-1/4"	320	2500	4.12:1	R.H.	Manual	12 V. Elec.	2"
Tarpon	Y330	140	6	4"	4-1/4"	320	3000	---	R.H.	Manual	12 V. Elec.	1-1/8"
	Y330P	140	6	4"	4-1/4"	320	3000	---	R.H.	Hydraulic	12 V. Elec.	1-1/8"
	Y331P	140	6	4"	4-1/4"	320	3000	1.5:1	R.H.	Hydraulic	12 V. Elec.	1-1/4"
	Y332P	140	6	4"	4-1/4"	320	3000	2:1	R.H.	Hydraulic	12 V. Elec.	1-3/8"
	Y333P	140	6	4"	4-1/4"	320	3000	2.5:1	R.H.	Hydraulic	12 V. Elec.	1-1/2"
	330	140	6	4"	4-1/4"	320	3000	---	R.H.	Manual	12 V. Elec.	1-1/4"
	331	140	6	4"	4-1/4"	320	3000	1.88:1	R.H.	Manual	12 V. Elec.	1-3/8"
	332	140	6	4"	4-1/4"	320	3000	2.44:1	R.H.	Manual	12 V. Elec.	1-1/2"
	333	140	6	4"	4-1/4"	320	3000	3.32:1	R.H.	Manual	12 V. Elec.	1-3/4"
	334	140	6	4"	4-1/4"	320	3000	4.12:1	R.H.	Manual	12 V. Elec.	2"
Knight	Y350	165	6	4"	4-1/2"	340	3300	---	R.H.	Manual	12 V. Elec.	1-1/8"
	Y350P	165	6	4"	4-1/2"	340	3300	---	R.H.	Hydraulic	12 V. Elec.	1-1/8"
	Y351P	165	6	4"	4-1/2"	340	3300	1.5:1	R.H.	Hydraulic	12 V. Elec.	1-1/2"
	Y352P	165	6	4"	4-1/2"	340	3300	2:1	R.H.	Hydraulic	12 V. Elec.	1-1/2"
	Y353P	165	6	4"	4-1/2"	340	3300	2.5:1	R.H.	Hydraulic	12 V. Elec.	1-3/4"
	350	165	6	4"	4-1/2"	340	3300	---	R.H.	Manual	12 V. Elec.	1-1/4"
	351	165	6	4"	4-1/2"	340	3300	1.88:1	R.H.	Manual	12 V. Elec.	1-1/2"
	352	165	6	4"	4-1/2"	340	3300	2.44:1	R.H.	Manual	12 V. Elec.	1-3/4"
	353	165	6	4"	4-1/2"	340	3300	3.32:1	R.H.	Manual	12 V. Elec.	2"
	354	165	6	4"	4-1/2"	340	3300	4.12:1	R.H.	Manual	12 V. Elec.	2-1/4"
Little King	LEV	188	V8	3-7/8"	3"	283	4000	---	R.H.	Manual	12 V. Elec.	1"
	LEV15	188	V8	3-7/8"	3"	283	4000	1.5:1	R.H.	Manual	12 V. Elec.	1-1/4"
	LEV20	188	V8	3-7/8"	3"	283	4000	2:1	R.H.	Manual	12 V. Elec.	1-1/4"
	LEV25	188	V8	3-7/8"	3"	283	4000	2.5:1	R.H.	Manual	12 V. Elec.	1-1/4"
	LEVH	188	V8	3-7/8"	3"	283	4000	---	R.H.	Hydraulic	12 V. Elec.	1"
	LEVH15	188	V8	3-7/8"	3"	283	4000	1.5:1	R.H.	Hydraulic	12 V. Elec.	1-1/4"
	LEVH20	188	V8	3-7/8"	3"	283	4000	2:1	R.H.	Hydraulic	12 V. Elec.	1-1/4"
	LEVH25	188	V8	3-7/8"	3"	283	4000	2.5:1	R.H.	Hydraulic	12 V. Elec.	1-1/4"
Big King	NKEV	277	V8	4.3"	3.7"	430	4000	---	R.H.	Hydraulic	12 V. Elec.	1-1/4"
	NKEV25	277	V8	4.3"	3.7"	430	4000	2.5:1	R.H.	Hydraulic	12 V. Elec.	1-1/2"

SECTION II
INSTALLATION

1. PREPARING FOR INSTALLATION

Remember that as much of the work of installing an engine takes place under and around the boat as inside. Provide plenty of room. Remember, too, that the boat and the engine amount to a considerable weight and all blocking must be strong enough to support this weight plus that of the people working in the boat.

As the first step, shore up the boat until the hull is approximately three feet off the floor. For most small boats, a three-point suspension will be sufficient. Blocking should be placed about six feet abaft the bow and at each corner of the transom. This type of blocking will give adequate support and at the same time leave the stern section free of obstruction. On larger boats, extra blocking should be used along the keel.

The next step in the procedure is determining the location and angle of the shaft hole. A number of things must be considered before this can be established. (See Fig.1)

The width of the rudder, size of the propeller, and the clearance between the propeller and the bottom of the boat (minimum 2").
Clearance between the rudder and the propeller should not be less than 4", and room to allow removal of the propeller without first removing the rudder is more satisfactory. It is, of course, also necessary to know the exact location of the engine and the manufacturer's recommended maximum and minimum angles of engine operation.

If full scale drawings of the boat are available, locating the shaft hole and establishing the angle is simple. It is only necessary to lay down a full-sized profile in some convenient spot and place over this drawing full-size cutouts of the engine, rudder and propeller in their proper places. The cutout for the propeller need only be an oblong of cardboard with the center carefully marked. The length should equal the diameter, and the width, the pitch divided by the number of blades. For example, a 12 x 12 propeller would be represented by a piece 12" long and 4" wide for a three-blade prop and 6" wide for a two-blade. The engine cutout should be a fairly accurate reproduction of the lower half of the engine with the shaft centerline clearly marked. This should be drawn with care on a large piece of paper using the dimensions given on the engine scale drawing.

With the rudder and propeller facsimiles in place and proper clearance accounted for, the cutout of the engine is then moved about until the centerline of the shaft lines up with the centerline of the propeller, and the spot and angle where this line passes through the keel carefully noted. The position of the engine is then carefully checked to be sure there is sufficient clearance between it and the bottom of the boat and that the angle of the engine does not exceed the recommended operating angle (5 to 14 degrees in most engines). The

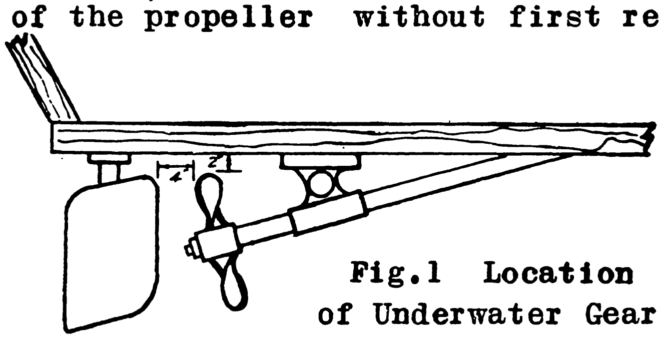


Fig.1 Location of Underwater Gear

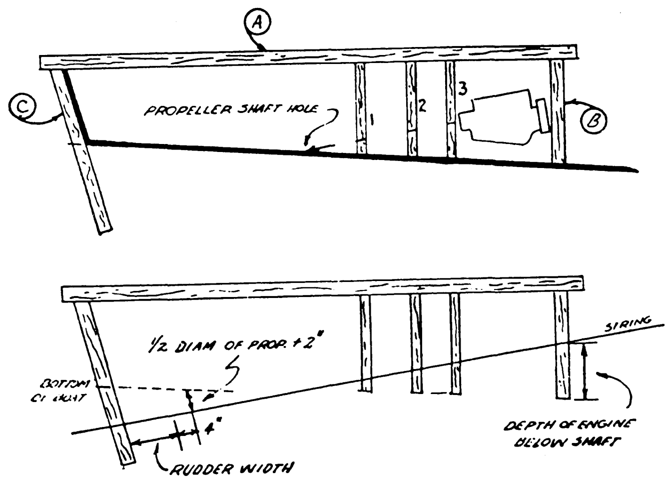


Fig.2 Method of Locating Shaft Hole

engine must be lined up either by raising or lowering it or changing the angle. Do not move the engine fore-or-aft from its previously determined location.

If full scale drawings of the boat are not available, another simple method of locating this spot is to lay a length of 1 x 4 lumber from the center of the transom forward to a spot well beyond the determined engine location.(See Fig.2). Temporarily prop this strip (A) in place so it is roughly parallel to the keel. To this,and at a right angle to it, nail another strip (B) at the point where the flywheel of the engine will be located. Fasten a second strip (C) so that it passes outside the stern, follows the angle of the stern and projects at least three feet below the bottom of the boat. Narrow strips are now fastened to the top strip, approximately every foot along its length and at right angles to it, so that the ends of the sticks just touch the bottom of the boat. This jig, which actually is a full sized pattern of the inside of the boat, can now be removed and laid flat on the floor.

A string is then stretched from the board which represents the transom to the one representing the location of the flywheel. The string is adjusted to obtain proper propeller clearances and crankcase and flywheel clearance for the engine. When the position of the string has been accurately determined, the place it passes each of the sticks is carefully marked and the jig placed back in the boat. It is then a simple matter to lay a straightedge along these marks (1,2,3 on Fig.2) to the bottom of the boat which will give the position and angle of the shaft hole.

2. INSTALLING THE PROPELLER SHAFT

A wedge is now constructed which will fit between the keel and the inboard shaft log. This wedge may be fashioned from any hardwood, but mahogany is recommended since it is

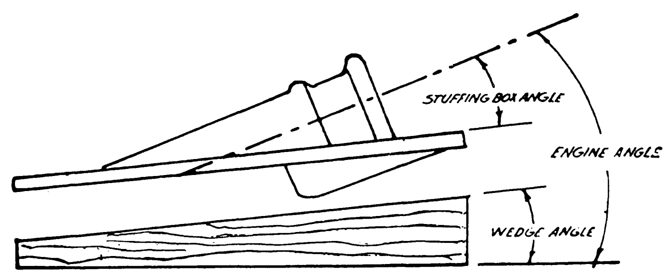


Fig. 3 Shaft Log

easy to work with and is an excellent marine material. This wedge should be as wide and as long as the shaft log to be used and cut at an angle corresponding with the angle of the shaft hole minus the angle of the shaft log. (See Fig.3) The thickness of the wedge will vary with the angle but the thin edge should be approximately 1/2 inch thick. In some cases, the width of wedge may exceed the width of the keel since it must be as wide as the shaft log.

In this event, the underside of the wedge should be shaped to fit the keel and the edges shaped to fit alongside the keel and fit the hull as snugly as possible. The wedge should also be notched out to fit any ribs which might interfere. The wedge is then screwed into position over the location of the shaft hole. Use a good grade bedding compound between the wedge and the keel and fasten securely to the keel with screws, being careful to place these screws where they will not interfere with the shaft log mounting screws.

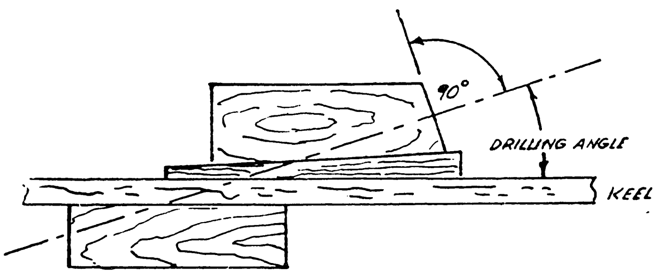


Fig.4 Method of Drilling Shaft Hole

After the wedge is in place, prepare for the drilling of the shaft hole. Preparation for this step consists of the construction of two hardwood blocks which will act as guides in getting the shaft hole started properly and keeping the angle of drilling fairly accurate. These blocks should be of straight-grained hardwood - maple or oak will do. They should be approximately 2" thick, 5" wide and 10" long.

One of these blocks (See Fig. 4 and 5) is fastened to the inside of the boat so that the center of the block lines up approximately with the position of the shaft hole and the other is fastened to the bottom of the boat at the approximate position the hole will emerge. The face of the block fastened to the inside of the boat is cut so as to be at right angles to the drilling angle. In order to keep the drilling angle accurate, a guide block can be fastened 3" to 6" from this starting block. A notch cut in this block to fit the shank of the drill will support the drill at the proper angle. (See Fig. 5)

A drill 1/8 inch larger than the shaft diameter should be used to provide proper clearance. Any type of drill may be used which will drill a clean hole and has a shank long enough to pass through the two blocks and the keel. A standard carpenter's auger is not recommended since the "worm" tends to follow the grain and using it may result in a wandering hole. If a drill cannot be found with a sufficiently long shank, it can be extended by welding on a steel rod. When the drill has passed completely through the keel and the bottom block, it can be removed and the two temporary drilling blocks unscrewed from the boat.

Now lay the shaft log on the wedge and over the shaft hole. In some cases, it will be necessary to chisel out the wedge to conform to the bottom of the shaft log. Make this notch slightly larger than necessary to allow for later alignment. Fashion a gasket from 1/16" rubber or 1/32" gasket material and place it between the shaft log and wedge.

Fig.5 Photo of Drilling Operation

Insert the propeller shaft in the shaft hole and with the shaft log over the hole, position the shaft log so that the propeller shaft is approximately in the center of the hold in the shaft log. Coat both sides of the shaft log gasket with a good marine sealer and fasten the shaft log in place with screws long enough to pass through the wedge and well into the keel.

Next slip the shaft strut over the

shaft and move it along the propeller shaft with the base pressed firmly against the keel until the shaft is approximately in the center of the bearing hole. Screw the strut to the keel at this point but do not tighten down. Using small wooden wedges, center the propeller shaft in the shaft hole. Make final adjustment of the strut and tighten its hold-down screws and angle adjusting nuts securely.

3. INSTALLING ENGINE STRINGERS AND BEDS

Engine stringers should now be installed (See Fig.6). These longitudinal members should run at least two-thirds the length of the hull, and to them the engine bed will be fastened. In most modern hulls, these members will be included in the hull plans and usually will be placed to take an engine with $22\frac{1}{2}$" mounting centers. If these stringers

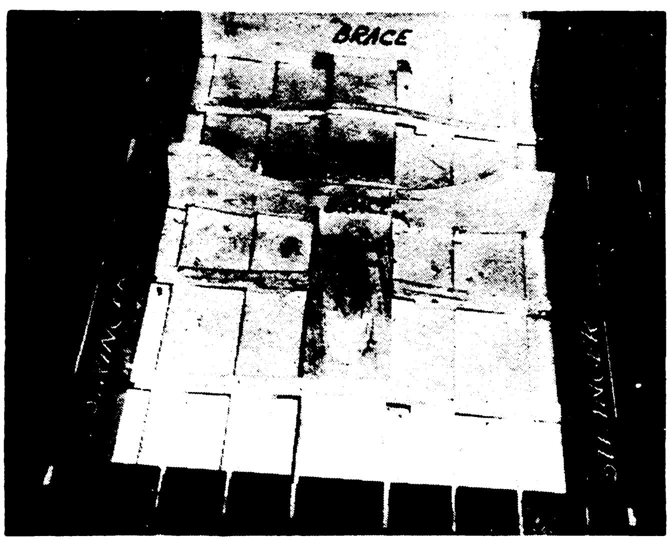


Fig.6 Photo of Engine Stringers

are not in place, they should be constructed of 8" by 2" oak or maple and should run from the transom to at least three feet forward of the engine location. The distance between them should be the distance between mounting centers of the engine plus one thickness of the material to be used for engine beds. They should rest firmly on the hull ribs and be cross-braced at intervals by notching into 2" by 8" members running at right angles to them. The braces and stringers

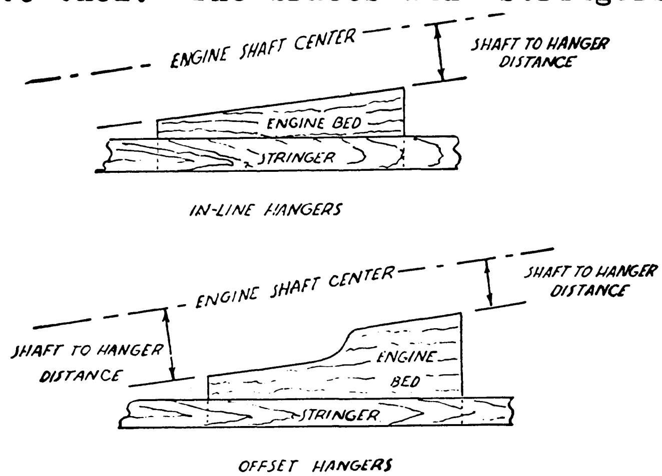


Fig.7 Engine Bed Construction

should be drift-bolted together. These cross-braces should conform to the shape of the hull and those that will be under the engine must be cut to fit the contour of the underside of the engine.

The next step is the construction of the engine bed. (See Fig. 7). These are pieces of 2" hardwood 8" to 10" longer than the length of the engine. The width of the material needed will depend on the angle at which the engine is to be mounted, the depth of the engine below the shaft line, and the type of engine hanger - that is, whether the hangers are parallel to the shaft line or offset in height. The height of these engine beds is easily determined by removing the propeller shaft and stretching a string through the strut, shaft hole and stuffing box and fastening it to a piece of stock tacked temporarily in place somewhat forward of the engine location.

A piece of engine bed material is then placed on edge alongside the string in the position where the engine is to be mounted. It is then a simple matter to measure down from the string, which represents the center of the shaft, to the position of the hangers using the figures given on the engine scale drawing. If the mounting lugs are parallel to the centerline of the shaft, the top of the engine beds are then simply cut at the same angle as the string and below it the distance of the mounting lugs. If the forward and rear mounting lugs are offset, the top of the engine bed is cut in steps at the angle of the string with the distance from the string to the top of each equaling the distance from the centerline of the engine to the mounting lugs.

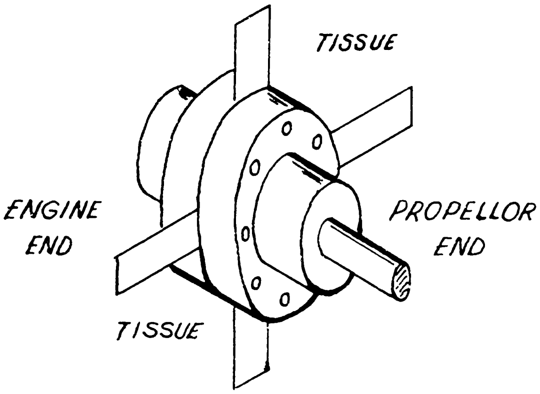
After the pattern of the engine bed is completed, replace the propeller shaft and fasten the propeller coupling in place on the shaft. The engine must now be lifted into the boat and temporarily blocked in place with the propeller coupling in as close alignment to the coupling half on the propeller shaft as possible. If the engine is a small one, this can be done by fastening a pole securely to the lifting eye on the engine and with two men on each end of the pole bodily lifting the engine in place. If the engine is large or help is not available, an "A" frame with a block and tackle can be used. Or the job can be done by a truck equipped with a winch. In any case, extreme care must be taken that all hitches used are secure and all tackle of sufficient strength to hold the load. A broken rope or slipped knot at this point could result in a very leaky boat and a very discouraged boatman.

With the engine securely blocked in place, slide the engine beds in place under the engine and on the inside of the stringers. When in place, fasten them temporarily with "C" clamps. Four 1/2" holes are then bored equally spaced along the length of the engine bed, through the stringers and bed. One-half inch carriage bolts are then inserted in the holes and securely tightened. Use washers under all nuts. The position of the engine hold-down bolts is now marked on the top surface of the engine beds. In some cases, it will be possible to drill these holes without disturbing the engine; in others, the engine must be removed. Drill these holes using a drill 1/8 inch smaller than the lag screws to be used for fastening the engine in place. Three-eighths-inch lag screws which will project three inches into the engine beds will be sufficient. Insert the engine hold-down bolts with washers under the heads and screw them to within three or four turns of being tight.

4. ALIGNING THE ENGINE

The blocking can now be removed from the engine and the engine lined up with the propeller shaft. The engine will be in alignment when the faces of the two halves of the propeller coupling are parallel within .003 of an inch or less. A feeler gauge is used, checking all around the two faces and shims added under the engine hangers until the two faces are in alignment. If no feeler gauge is available, four narrow strips of paper can be placed between the two faces at four points around the circle. Any variation of alignment can then be felt by the looseness of any one of the strips. Each time a shim is added or removed, tighten all hold-down bolts and recheck alignment. Extra care at this time will pay off in terms of future performance.

Do not attempt to bring the two faces of the coupling together by springing the propeller shaft. When the engine is in perfect alignment, bolt the two halves of the coupling together and remove the wedges from around the propeller shaft. With the engine in neutral, the propeller shaft should turn easily. If not, check for tightness in the stuffing box or slight misalignment in strut location or angle.



With engine installed and properly aligned, it must now be supplied with fuel, water, and electrical power, and provisions made for exhaust. How these elements are to be installed will depend to some extent on the model of engine being used, location of the gas tank, location of the instrument panel and personal preference as to side or stern exhaust. In any case these things should be installed in a workmanlike manner and certain good practices adhered to.

5. EXHAUST PIPING

Exhaust piping should be at least as large as the opening on the exhaust manifold. Either copper tubing or galvanized pipe may be used. If

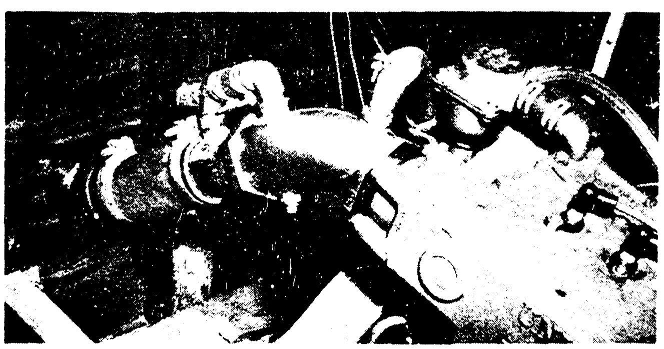


Fig. 8 Photo of Exhaust Piping

elbows are necessary in the line, they should never exceed 45 degrees. A short piece of steam hose (See Fig. 8) placed in the exhaust line close to the engine will help quiet the exhaust and prevent fracture of exhaust line due to vibration of the engine. It is common practice to direct cooling water from the engine into the exhaust line. In so doing, two purposes are served: the hot exhaust line is cooled below the danger point and the water quiets the exhaust. In this type of installation, two precautions must be observed. First, the water must enter the exhaust no less than 5" below the bottom of the manifold opening and some provision must be made to direct the flow of water away from the manifold. These provisions are necessary to prevent cooling water from backing up into

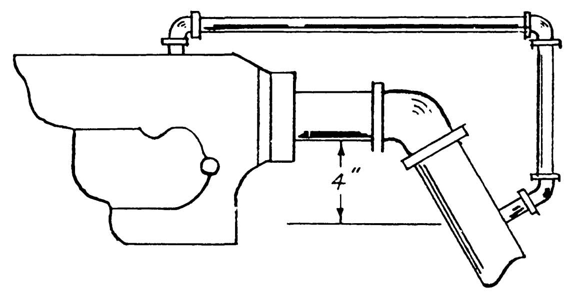


Fig. 9 Method of Cooling Water Discharge

the exhaust manifold and perhaps warping the hot exhaust valves.

There are several types of water cooled elbows on the market which will serve both of the above purposes and are worth their cost in labor of fabricating a substitute. However, a substitute can be made by welding a steel elbow into the exhaust line at least 4" below the exhaust manifold in such a way that the water will be directed away from the manifold. (See Fig. 9)

6. COOLING WATER SYSTEM

Water piping can best be done with standard copper tubing. Again, a short piece of flexible hose should be used between the intake piping and the engine. The water intake scoop should be located as close to the water intake on the engine as installation permits. Some engines are equipped with reversing and re-

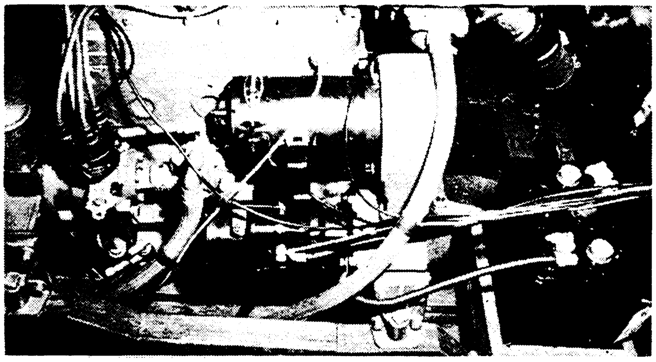


Fig.10 Suggested Battery Installation

duction gears that are also water cooled, in which case the manufacturer recommends that the cooling water enter at this point and be piped from there to the engine.

Installation of the water scoop is a simple process. A 3" square by 3/4" thick block is fastened to the inside of the bottom of the hull with four wood screws and set in bedding compound. A hole is then drilled through the block and hull the same diameter as the outside dimension of the water scoop pipe. The scoop pipe is then inserted in the hole from the bottom of the hull and fastened in place. A sealing compound is placed around the pipe on the inside and the locknut tightened.

7. <u>THERMOSTAT AND BY-PASS VALVE</u>

Most often engines are installed with water piping that simply draws water to the pump directly from the sea, circulates it through the engine and discharges it all overboard. In this type of system, engine temperature is determined by the temperature of the incoming water, pump capacity and the degree

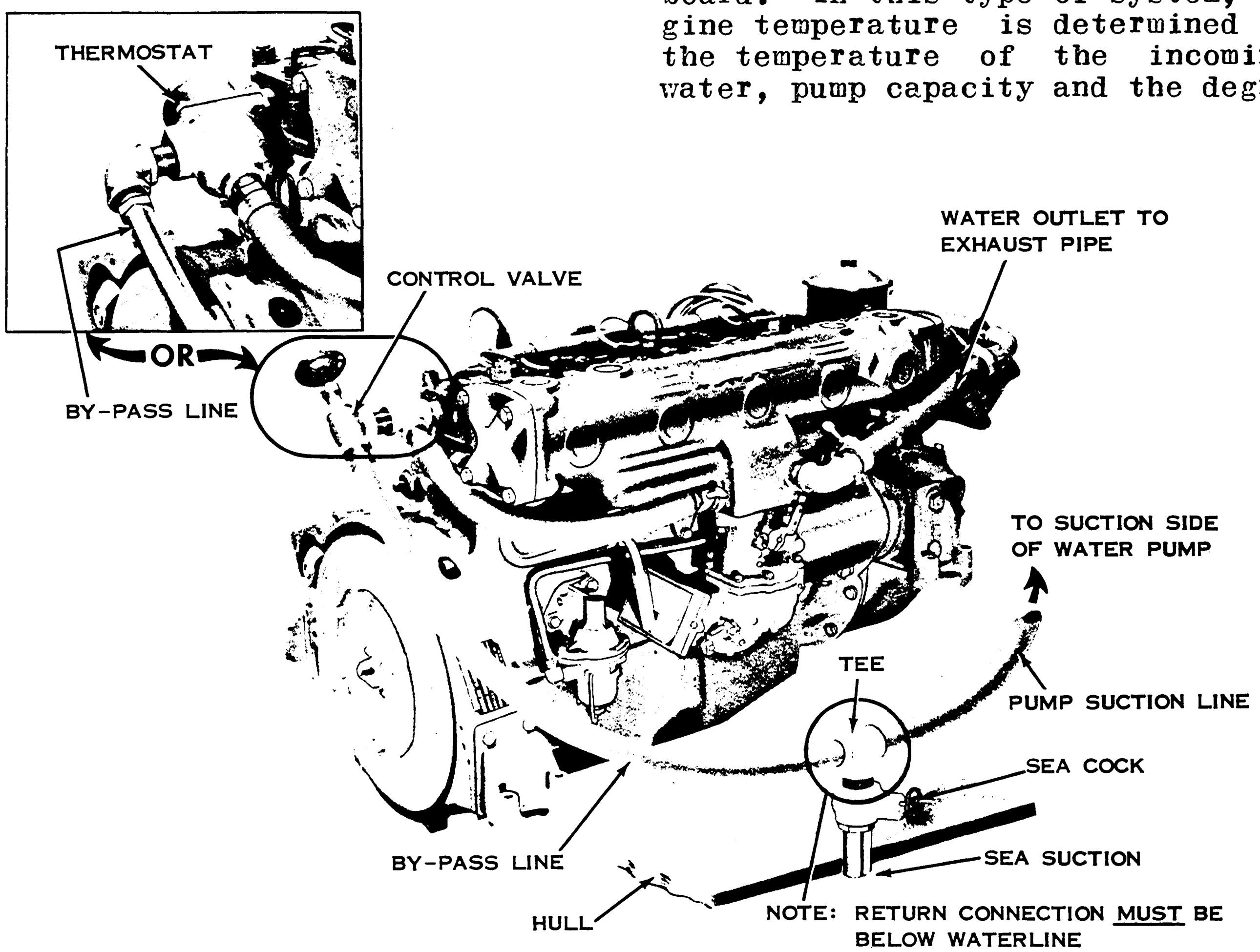


Fig. 11 Methods of Engine Temperature Control

of restriction to flow offered by the piping. It is quite common to find engine operating temperatures as low as 90° F. in these installations. We do not recommend this type system because the usually low operating temperature is conducive to valve sticking, sludge formation in the crankcase, dilution of crankcase oil with cylinder wall condensation and shortened valve spring life. We recommend a nominal operation temperature of 150°F. obtained through the use of a by-pass system as shown in the piping diagrams of Fig. 11. Do not attempt to control temperature by restricting the flow of water either into the pump or overboard.

In the by-pass system a quantity of warm water leaving the engine is diverted back into the pump suction line to be recirculated through the engine. By varying the amount of warm water fed back to the pump the engine temperature can be controlled. Control of water passing through the by-pass line is accomplished with either a hand control valve or a thermostat installed as shown in the piping diagrams. Opening the valve will divert a larger amount of warm water back into the engine and raise its operating temperature. If a thermostat is used it will automatically divert nearly all of the warm water leaving the engine back to the pump for recirculation when the engine is cold. When engine temperature nears 150° F. the thermostat will react to decrease the amount of recirculated water and will divert only enough to maintain engine temperature at about 150° F.

Generally, the thermostat will give faster warm up and closer temperature control over the engine speed range than will the hand control valve. The hand control valve should be adjusted to give adequate temperature at the usual running speed of the engine. It should not be necessary to continually re-adjust the valve.

On installations using the hand control valve, water should be noted issuing from the exhaust pipe soon after the engine is started. A lack of water indicates the pump has not primed and the engine should be stopped until the source of trouble is found.

On installations using a thermostat, only a trickle of water and sometimes only steam will issue from the exhaust until the engine reaches operating temperature at which time the thermostat will open to discharge more water overboard. The thermostat is designed to allow a small quantity of water to pass it and keep the exhaust pipe cool until the engine reaches operating temperature. When starting a cold engine always keep a close watch on the temperature gauge until it steadies to a constant value.

8. FUEL SYSTEM

A marine type gasoline tank should be used in all installations, constructed with internal baffle plates and a filler pipe which goes nearly to the bottom of the tank. Should a fire occur during the filling of such a tank only that vapor trapped in the filling tube will burn and this can be snuffed out by placing something over the neck of the tube. The gasoline outlet from the tank also enters at the top of the tank and passes down through the tank to just a short distance off the bottom. This pipe should be slightly larger in size than that required by the fuel pump on the engine.

The tank will also have a vent and overflow tube coming off the top of the tank of at least half-inch copper tube size. This tube should be run as directly as possible to a suitable through-hull fitting, located in most cases just below the sheer line of the hull. Overflow gasoline and tank vapors will thereby be discharged harmlessly over the side. Connection from the tank to the engine should be made with copper tubing of a size recommended by the engine manufacturer. A short section of flexible line should be placed in the line at the point of attachment to the fuel pump to prevent leaks occurring due to fatigue of the metal tubing.

9. ELECTRICAL SYSTEM

The importance of adequate and safe wiring aboard a boat cannot be overemphasized. All connections must be clean, tight, and free from oil. Where solder connections are necessary, the connection should be made mechanically secure before soldering Use only rosin flux when soldering to prevent corrosion. All wiring should be kept as short as possible to minimize voltage drop in the circuits.

A battery box should be built as close to the engine as possible, securely fastened to the boat and of a size to prevent shifting of the battery. Any cover on the box should be readily removable for periodic checking of water level in the battery (See Fig. 10).

All wiring should be run in such a fashion as to prevent mechanical injury. Wires for all circuits should be of a large enough size to minimize voltage drop in the circuit and of sufficient current carrying capacity to prevent overheating. (See Table 3)

10. FINISHING THE JOB

The instrument panel may be installed at any convenient location at the control station. Oil pressure and water temperature gauges should be connected in accordance with the instructions that come with the unit.

Gear shifting can be accomplished by using the shifting lever supplied with most engines or one of several types of controls available. These controls may be operated from a remote lever, either mechanically through a system of rods or hydraulically through piping.

With the engine installed, the propeller is then fastened to the shaft, care being taken to maintain proper clearances from the bottom of the boat and the rudder.

After the engine is installed and all connections completed, the engine should be enclosed in an engine box. In designing this box, keep in mind the possibility that it may be necessary to make adjustments or repairs in the future. A box with removable top and sides is desirable.

It must also be kept in mind that an internal combustion engine uses roughly 14 parts of air to one part of gasoline when operating. Therefore, sufficient ventilation must be provided to allow it to operate at full efficiency. This will vary with the size of the engine; the higher the horsepower the greater must be the ventilating area. Five square inches of ventilating area is sufficient for engines up to 25 H.P. and 15 square inches for engines up to 150 H.P.

After completion of the installation and with the boat in the water, the alignment of the engine to the propeller shaft should be checked once more. The engine may then be started and all connections checked for signs of leaks. Oil pressure and water temperature gauges should be closely watched for signs of improper operation. After making sure that everything is operating properl the boat should be taken on a short run at slow speed. Final checking and adjusting is done on this trip and the boat is now ready for operation.

11. V-DRIVE INSTALLATION

In recent years two factors have had a great influence on power for outboard type hulls. One of these is the demand for greater speed and the other a requirement for engines with sufficient power for towing water skiers. In many cases the demand for additional power and speed has been met by the use of a higher horsepower outboard or by installing twin motors. A second solution has been the installation of an inboard engine with V-drive.

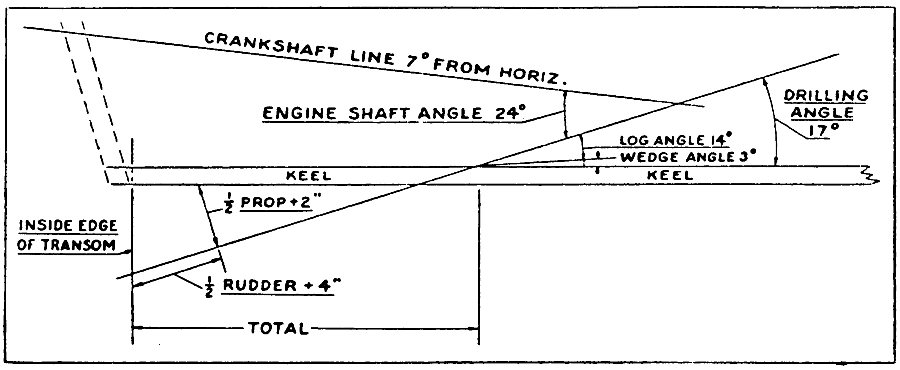


Fig. 12 Typical Shaft Location

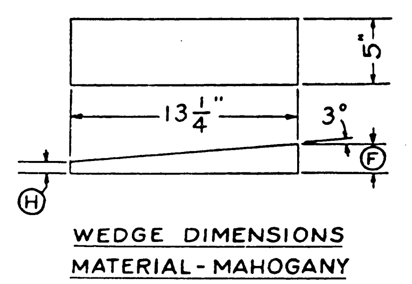
These V-drive engines are designed to be mounted in the extreme stern of the boat. They are suitable for most outboard hulls 17' and over and are being used successfully in houseboat hulls up to 32' in length.

The installation of a V-drive engine differs from the installation of a conventional drive engine in that the engine is mounted aft and in the reverse position, with the flywheel toward the stern of the boat. The installation of a typical V-drive engine will be described here. The general principles and practices will serve for most V-drive engines although the angles and dimensions may vary.

Preparation for mounting the V-drive engine is like that for mounting conventional engines and the same steps are followed in each case. As before, the first step is the blocking up of the boat.

In this case, the keel should be leveled from the transom to about six feet forward to aid in determining the shaft hole location and angle.

Location of the shaft hole and determining its angle are the next steps. Any of the methods described before will work. However, since the keel has been leveled and the distances involved are short, determination of the shaft angle by means of a simple, full-size sketch is the easiest (See Fig. 12). In



KEEL THICKNESS	F	H
1 1/2"	1 3/8"	11/16"
1 5/8"	1 1/4"	9/16"
1 3/4"	1 1/8"	7/16"
1 7/8"	1"	5/16"
2"	7/8"	3/16"

Fig. 13 Wedge Sizes

making this sketch, two parallel lines are drawn approximately six feet long, with the distance between them equalling the thickness of the keel. A line is then drawn on the sketch, indicating the crankshaft center, at an angle to the keel equal to the recommended engine mounting angle (7° in Fig. 12). The prop shaft line is now drawn slanting down and through the keel at an angle to the crankshaft line equal to the engine shaft angle. This angle is obtained from the manufacturer's scale drawings or from actual measurement of the engine (24° in Fig. 12). A third line is then drawn from the point the shaft line intersects the top of the keel, at

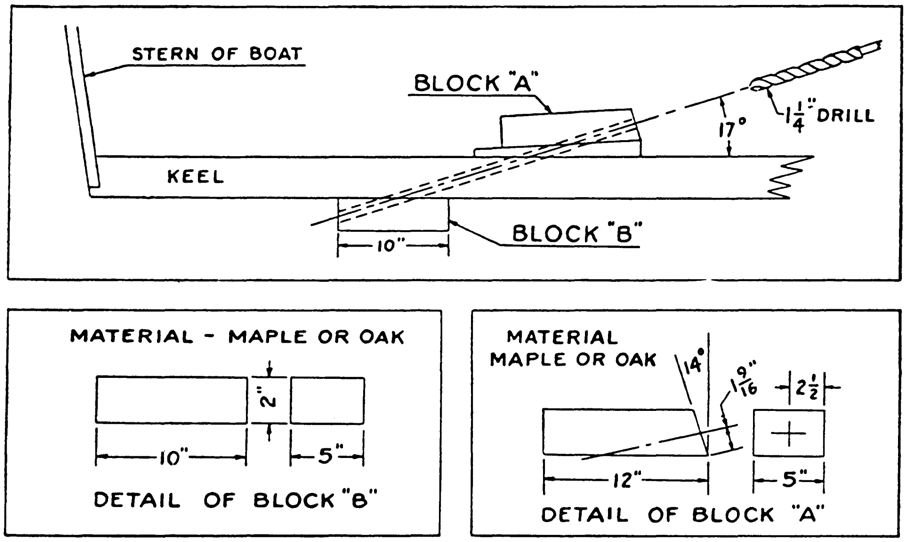


Fig. 14 Drill Block Details

an angle to the shaft line equal to the angle of the shaft log to be used (14° in Fig. 12). The angle this line makes with the keel then determines the angle of wedge needed (3° in Fig. 12).

The location of the shaft hole can now be determined. Its distance from the transom will be controlled by the dimensions of the rudder being used, clearance between the rudder and propeller, propeller diameter and propeller clearance to the bottom of the boat. Locate the after end of the propeller hub which will be at that point on the prop shaft where the right angle distance from the prop shaft center to the bottom of the keel is equal to half the prop diameter plus two inches. Mark a spot four inches plus half the width of the rudder toward the stern along the shaft line from the after end of the prop hub line. Draw a line from this point at right angles to the keel. This line now represents the inside of the transom. Measuring from this point to the spot where the shaft line passes through the keel will give the location of the shaft hole.

A wedge can now be cut to fit between the shaft log and keel as previously described. Fig. 13 gives

Fig. 15 Typical Bed, Stringer and Steering Set-up

dimensions of typical 3° wedges for varying keel thickness.

After installation of the wedge, preparations can be made for drilling the shaft hole. Fig.14 gives dimensions and angles for drilling blocks for installation requiring a shaft angle of 17°. Pre-drilled blocks are available in most cases, which will greatly simplify this step.

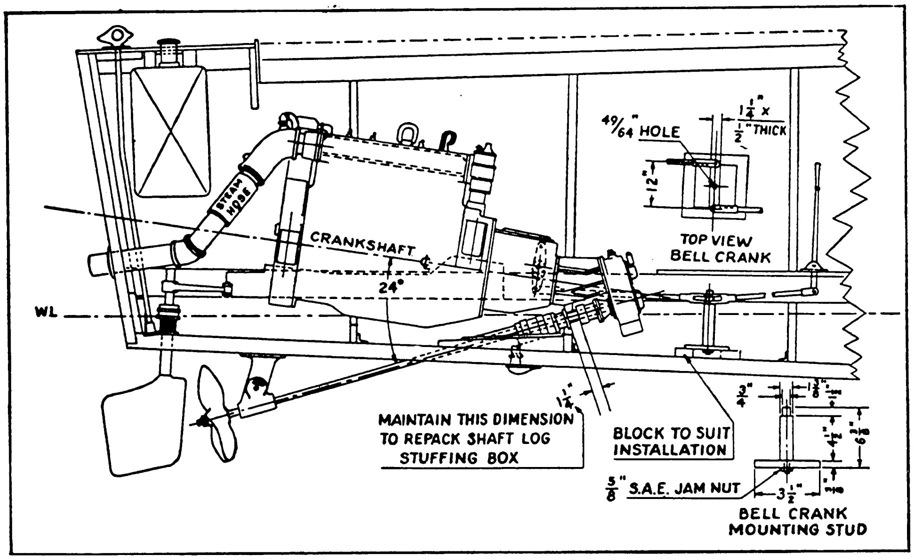


Fig.16 Typical V-Drive Layout

Following previous instructions, the shaft log, propeller shaft, strut and coupling may now be installed.

Engine stringers running at least two-thirds the length of the hull are now installed and fastened securely to the transom, and the rudder installed and braced to the stringers. A typical installation is shown in Fig. 15.

The gas tank comes next. In most V-drive installations, the tank is installed between the engine and transom as shown in Fig. 16. The same safety features described for conventional installation apply equally well in this case.

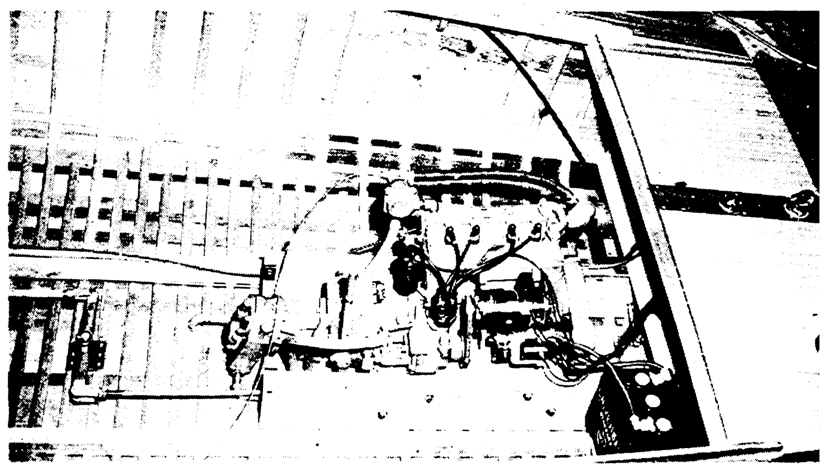


Fig. 17 Photo of Typical V-Drive Installation

From this point, installation is the same as for conventional drive engines. The engine beds are constructed, engine blocked in place temporarily, beds slid into place under the engine and clamped for marking of the mounting bolts. The engine is then removed, beds fastened in place and the engine installed and brought into proper alignment.

The installation of water intake scoop, fuel lines, oil lines, instrument panel, battery and exhaust can now be accomplished as described for conventional engines.

Shifting is controlled in a conventional manner by connecting the reverse gear lever on the engine with any commercially available remote shifting lever by means of a pipe or rod stock. Due to the fact that the V-drive engine is installed in the reverse position, the result of a direct connection will be that the remote lever will operate in reverse of the normal. That is, to go forward, it is necessary to pull back on the lever, and to reverse, the lever is pushed forward. This may confuse the experienced operator, but can be changed to the conventional method of forward on the lever to go ahead, and back to go astern by introducing a bell crank in the linkage. Figs. 16 and 17 show how this can be done, using a bell crank.

Because of installation at the extreme stern, the engine can be enclosed by building a seat over or in front of the engine with the seat back acting as the forward bulkhead of the engine box. However, care must be used in designing this seat to provide access for maintenance and adequate ventilation for operation and safety.

After installation is complete, the engine and shaft alignment should be rechecked and all controls operated to assure ease of operation, as in the case of conventional installations.

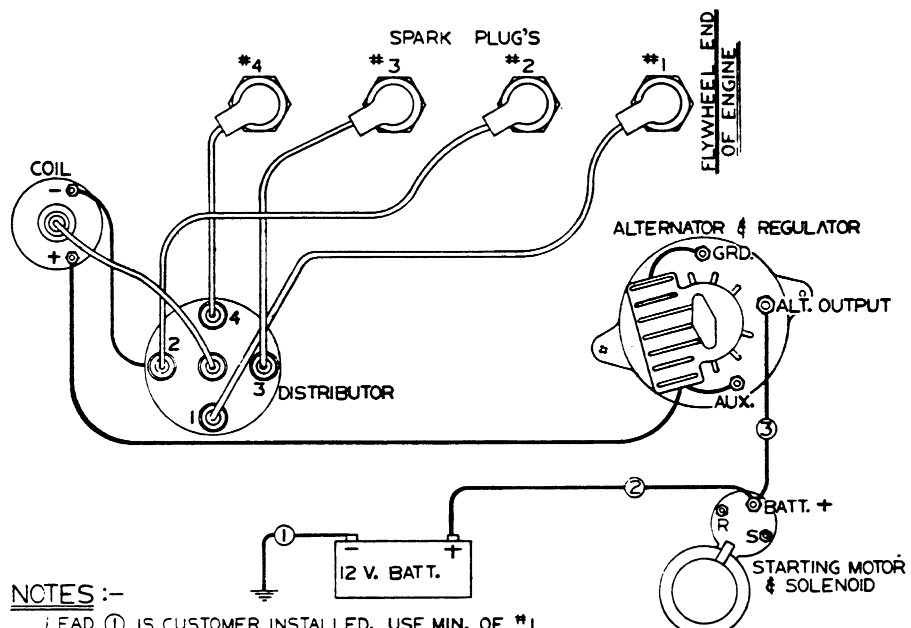
12. SPECIAL EQUIPMENT

Two types of instrument panels are available as special equipment. An instrument panel of the three-unit type is available and consists of an oil pressure gauge, ammeter, and ignition switch. This instrument panel is cadmium-plated and the instruments are constructed of brass. See Fig. 18. The five-unit panel consists of an ammeter, oil pressure gauge, heat indicator, tachometer head, and engine hour meter. See Fig. 19. Wiring diagrams for the three and five-unit panels are shown in Fig. 20 and Fig. 21.

Table 2
INSTALLATION DATA

Model Name	Max. Engine Angle	Compartment Ventilator Size, Min.	Exhaust Pipe Size	Cooling System Pipe Size In	Cooling System Pipe Size Out	Fuel Pump Intake Copper Tube Size
Blue Jacket Twin	12°	5 sq. in.	1-1/2"	1/2"	1/2"	5/16"
Atomic Four	14°	5 sq. in.	1-1/4"	3/8"	1/2"	5/16"
Utility Four	12°	5 sq. in.	1-1/4"	1/4"	1/2"	5/16"
Super-Four	12°	5 sq. in.	2"	3/8"	1/2"	5/16"
Unimite Four	14°	5 sq. in.	2"	3/8"	1/2"	5/16"
Arrow	12°	15 sq. in.	2-1/2"	3/4"	3/4"	3/8"
Bluefin	12°	15 sq. in.	2-1/2"	3/4"	3/4"	3/8"
Marlin	12°	20 sq. in.	2-1/2"	3/4"	3/4"	3/8"
Tarpon	12°	20 sq. in.	3"	3/4"	3/4"	3/8"
Knight	12°	20 sq. in.	3"	3/4"	3/4"	3/8"
Little King	16°	20 sq. in.	2-1/2"	2-3/4"	*	3/8"
Big King	16°	25 sq. in.	3"	2 - 1"	*	1/2"

*Cast in manifold



NOTES :-

LEAD ① IS CUSTOMER INSTALLED. USE MIN. OF #1 HEAVY DUTY BATTERY CABLE. THIS WIRE MUST BE GROUNDED BACK TO ENGINE.

LEAD ② IS CUSTOMER INSTALLED. USE MIN. OF #1 HEAVY DUTY BATTERY CABLE.

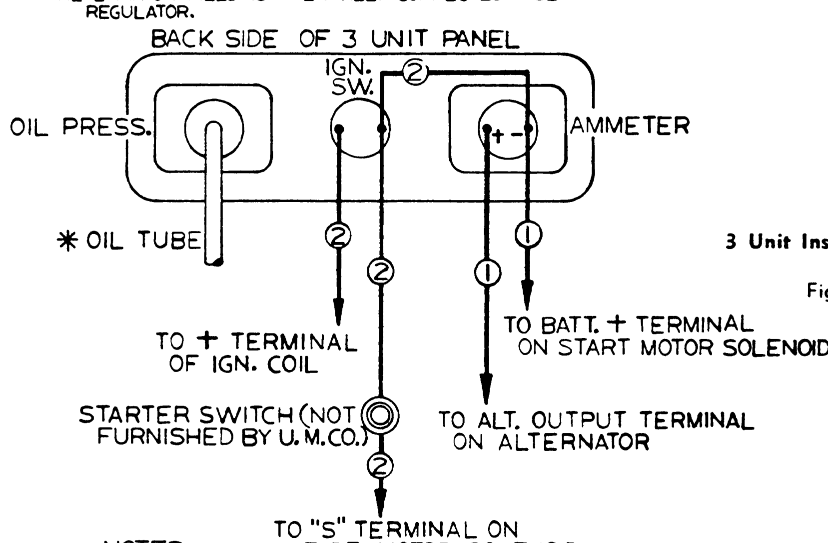
LEAD ③ IS CUSTOMER INSTALLED. USE MIN. OF #8 WIRE. DO NOT INSTALL THIS WIRE IF A PANEL MTD. AMMETER IS USED.

ALTERNATOR, REGULATOR, & START. MOTOR ARE GROUNDED TO ENGINE AT FACTORY.

ALTERNATOR FIELD IS INTERNALLY CONNECTED UNDER REGULATOR.

Wiring Diagram - Motorola Alternator - 12 volt - 35 ampere - Solid State Regulator

Figure 4



3 Unit Instrument Panel

Figure 5

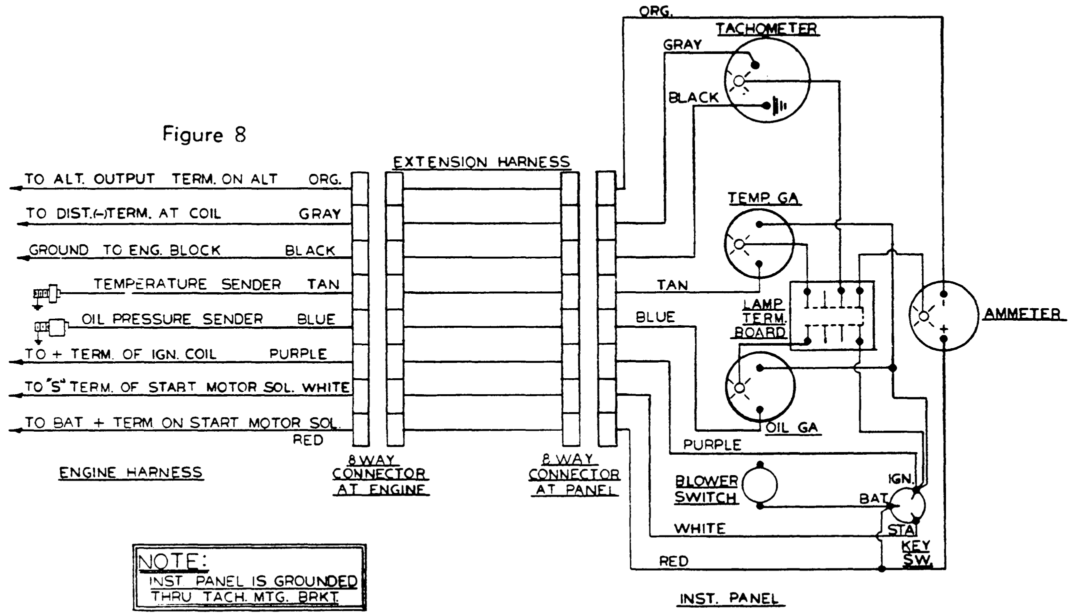
NOTES:-

LEADS ① ARE CUSTOMER INSTALLED. USE #8 GA. WIRE FOR CIRCUITS UNDER 15 FT., #6 GA. WIRE FOR CIRCUITS FROM 15 TO 25 FT.

LEADS ② ARE CUSTOMER INSTALLED. USE #16 GA. WIRE FOR CIRCUITS UNDER 15 FT., #14 GA. WIRE FOR CIRCUITS FROM 15 TO 25 FT.

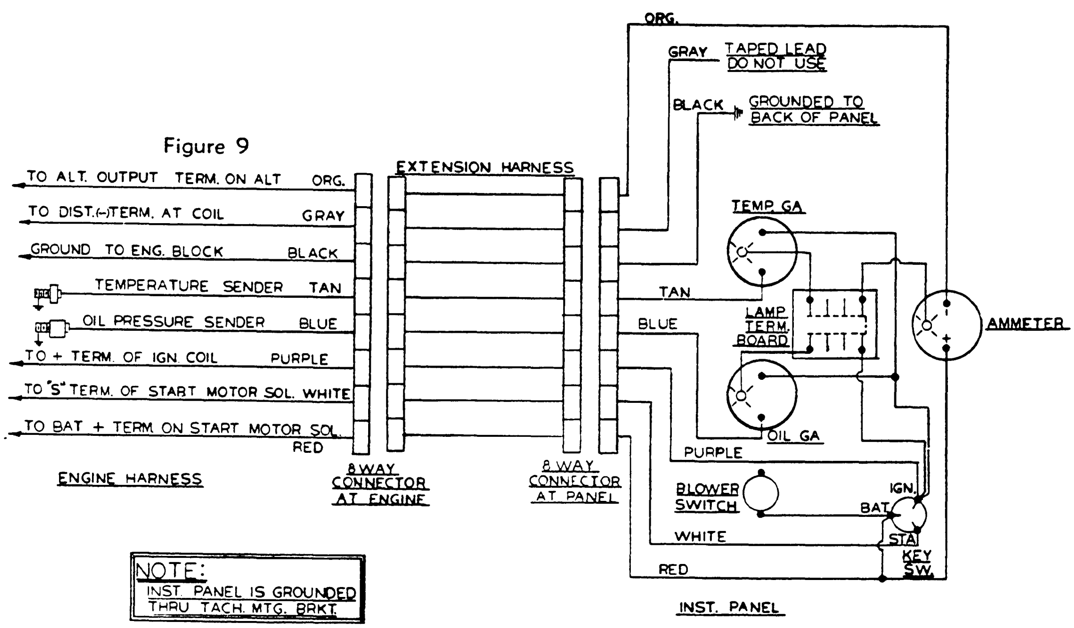
✻ WHEN NON-METALLIC FLEXIBLE OIL TUBE IS USED GROUND INSTRUMENT PANEL DIRECTLY TO ENGINE.

Figure 8

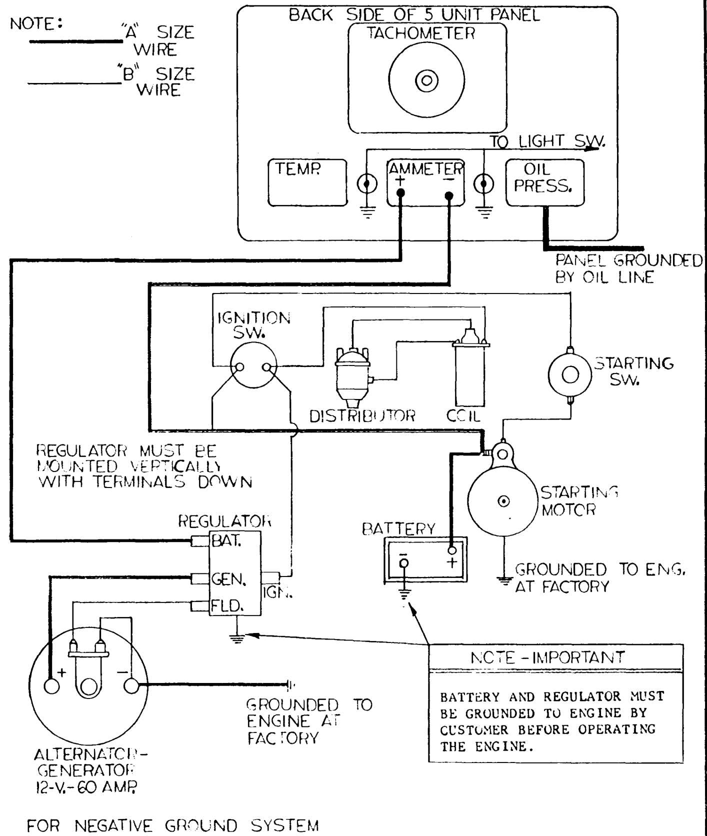


Electric Instrument Panel with Tachometer

Figure 9



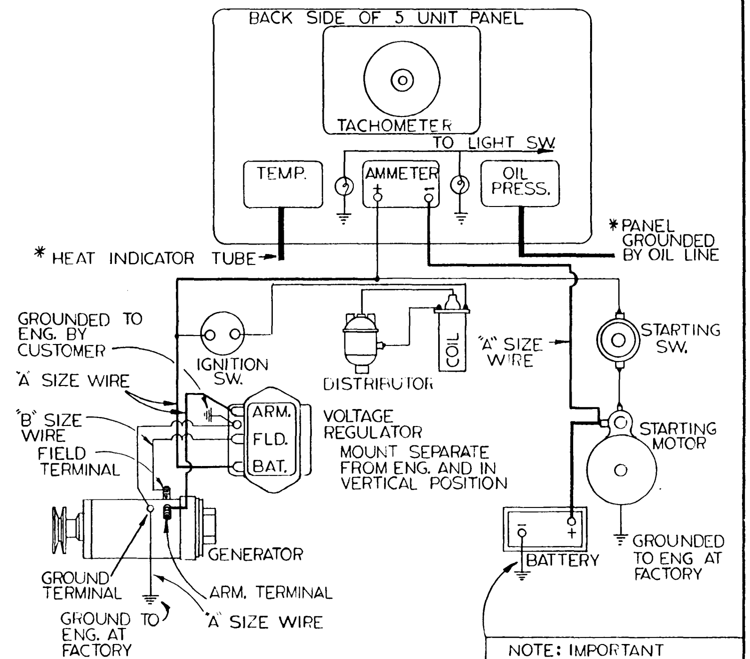
Electric Instrument Panel less Tachometer



RECOMMENDED MINIMUM WIRE SIZE FOR CONNECTING ALTERNATOR & REGULATOR

Total Length of Circuit In Feet	"A" Size Wire	"B" Size Wire
15' or less	#8	#16
15' to 25'	#6	#14

Fig. 21 **Wiring Diagram - Leece Neville Alternator - 12 Volt, 60 Amp**



NOTE: IMPORTANT

BATTERY AND REGULATOR MUST BE GROUNDED TO ENGINE BY CUSTOMER BEFORE OPERATING THE ENGINE.

*When non-metalic flexible oil tube or heat indicator connection is used, ground engine direct to instrument panel.

WIRE & CABLE SIZES FOR 12 V. CIRCUIT

	GA. NO.	LENGTH
GENERATOR	12 10 8 6 5	6' OR LESS 6' TO 10' 10' TO 15' 15' TO 25' 25' TO 50'
STARTING CIRCUIT	0 00 000	6' OR LESS 6' TO 7 1/2' 7 1/2' TO 10'
HORN	10	
LIGHTING	10 MAX. OF FOUR 21-C.P. LAMPS PER CIRCUIT	
IGNITION	12 WITH 1 COIL	

Recommended minimum wire size for connecting generator and regulator

Total length of circuit in feet	"A" size wire	"B" size wire
15' or less	#8	#16
15' to 25'	#6	#14

REPOLARIZING GENERATOR

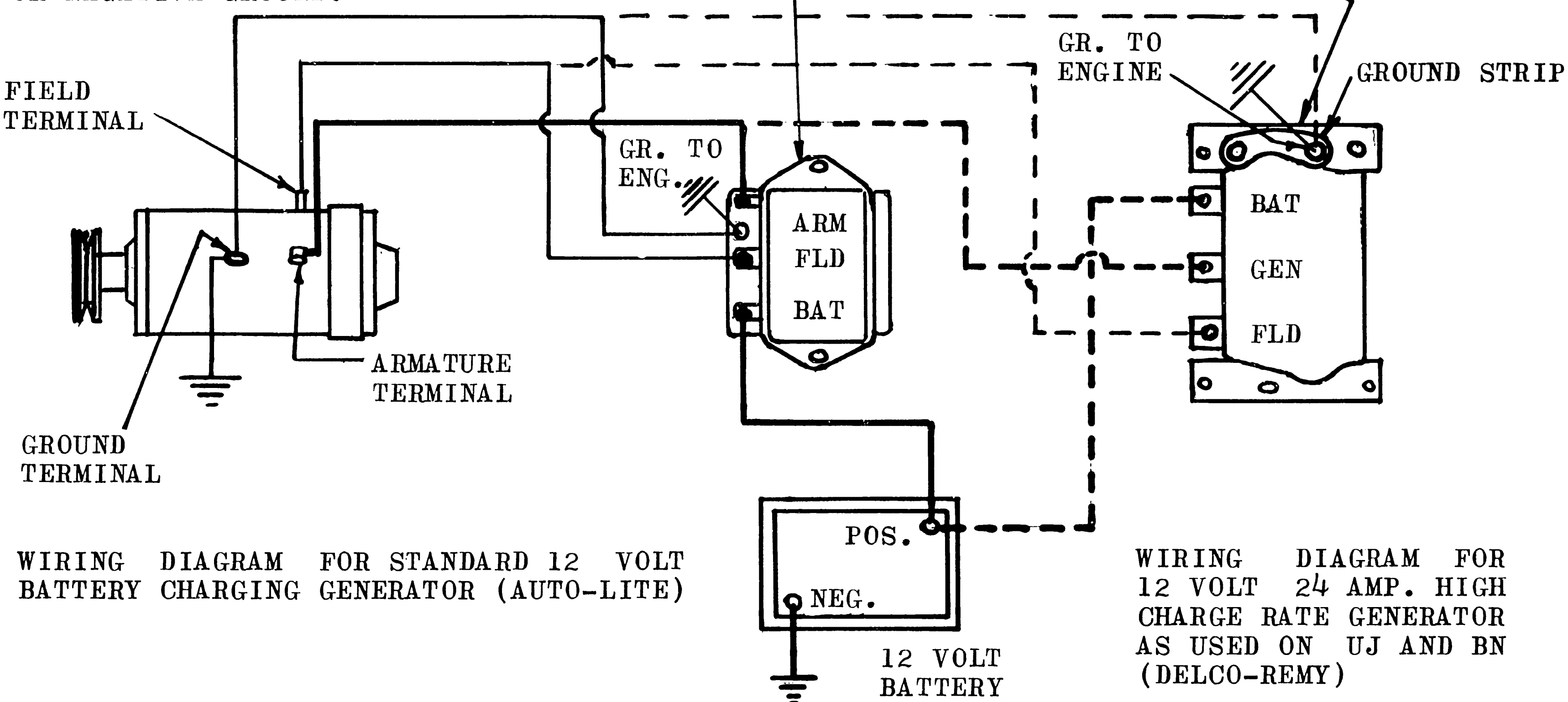
After reconnecting leads and before starting the engine, momentarily connect a jump lead between the "BAT" terminal of the regulator and the "A" terminal of the generator. This allows a momentary surge of current to flow through the generator, correctly polarizing it. Reversed polarity may result in vibrating arcing and burning of the cutout relay contact points.

12 VOLT IGNITION WIRING DIAGRAM WITH 5 UNIT PANEL FOR NEGATIVE GROUND SYSTEM

Fig. 21-A **Wiring Diagram - Auto-Lite Generator - 12 volt, 12 amp.**

THE ELECTRICAL SYSTEM OF ENGINE MUST HAVE NEGATIVE GROUNDED BATTERY WHEN 12 VOLT 24 AMP. GENERATOR IS USED. REGULATOR FURNISHED WITH STANDARD 12 VOLT GENERATOR CAN BE EITHER POSITIVE OR NEGATIVE GROUND.

REGULATOR IS TO BE MOUNTED SEPARATE FROM ENGINE AND PREFERABLY IN A VERTICAL POSITION



WIRING DIAGRAM FOR STANDARD 12 VOLT BATTERY CHARGING GENERATOR (AUTO-LITE)

WIRING DIAGRAM FOR 12 VOLT 24 AMP. HIGH CHARGE RATE GENERATOR AS USED ON UJ AND BN (DELCO-REMY)

Fig. 22 Wiring Diagram - Std. 12 Volt and 12 Volt 24 Amp.

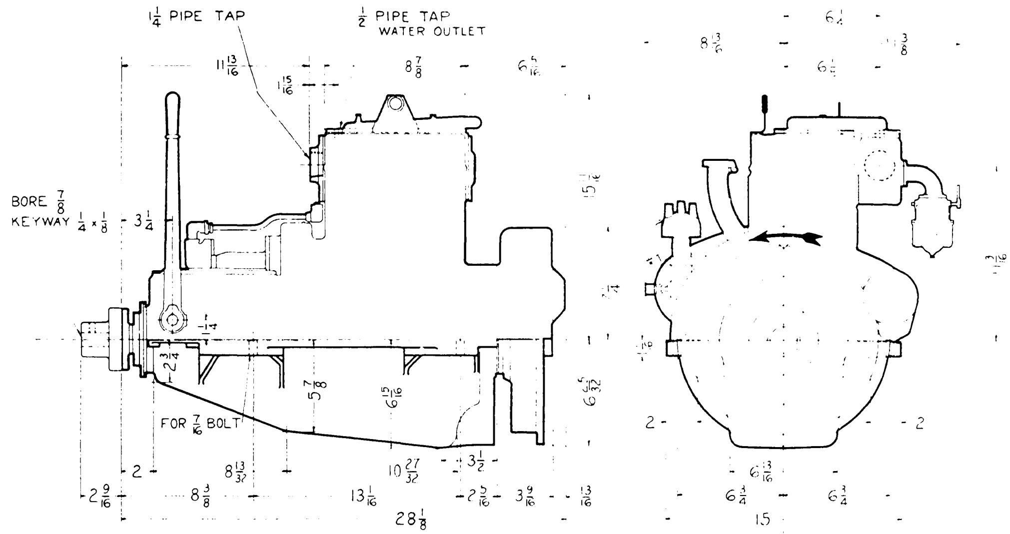
REPOLARIZING GENERATOR

After reconnecting leads and before starting the engine, momentarily connect a jumper lead between the "BAT" terminal of the regulator and the "A" terminal of the generator. This allows a momentary surge of current to flow through the generator, correctly polarizing it. Reversed polarity may result in vibrating, arcing and burning of the cutout relay contact points.

INSTALLATION DRAWINGS

BLUE JACKET TWIN SERIES

Fig. 23



ATOMIC FOUR SERIES

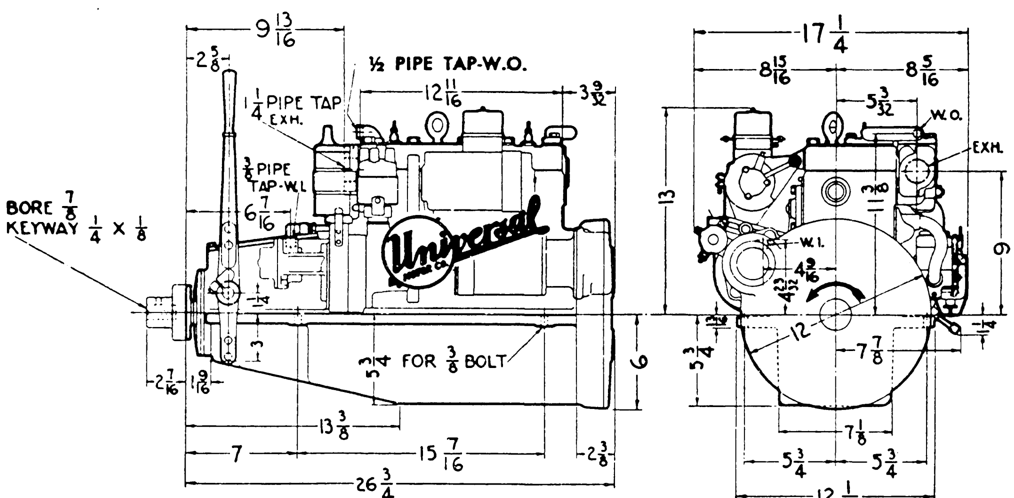
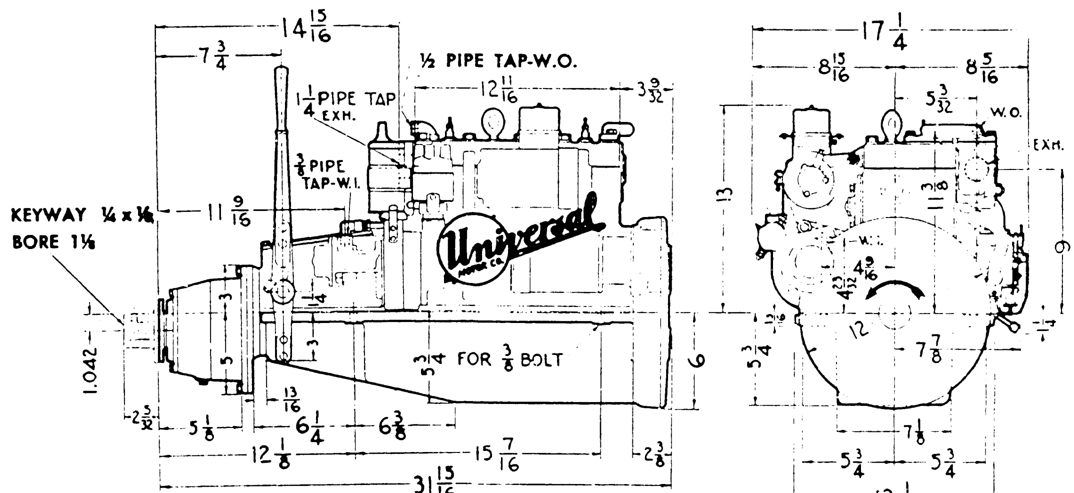


Fig. 24

DIRECT DRIVE

Fig. 25



REDUCTION DRIVE 2:1 RATIO

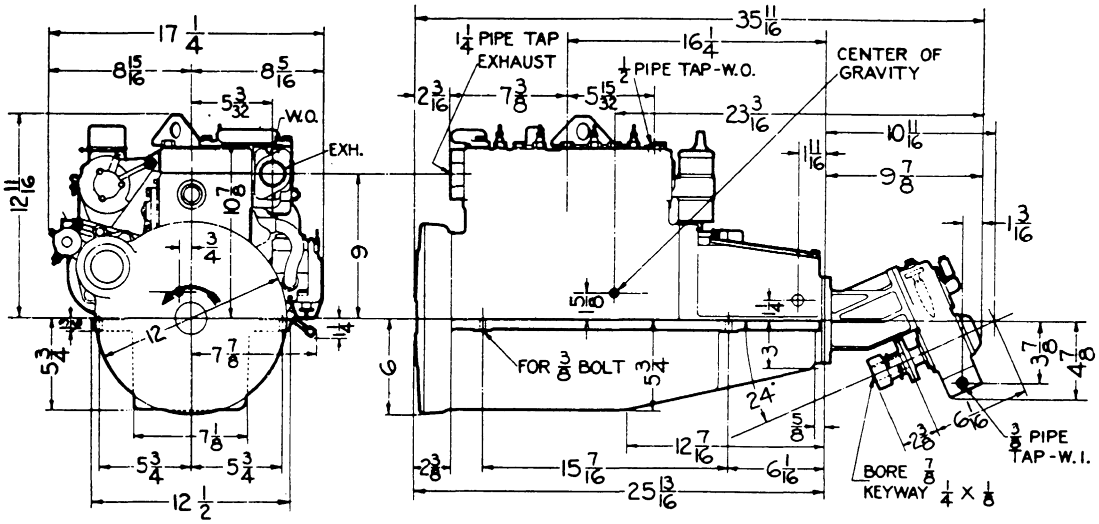
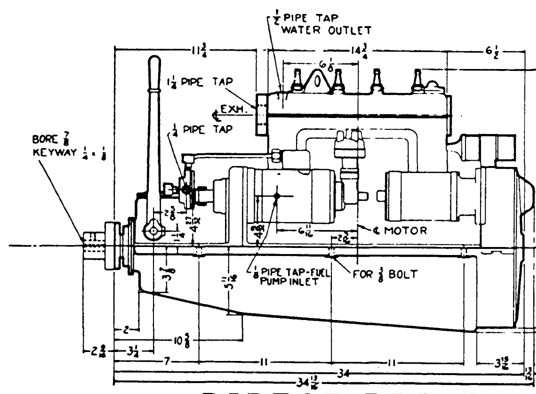


Fig. 26

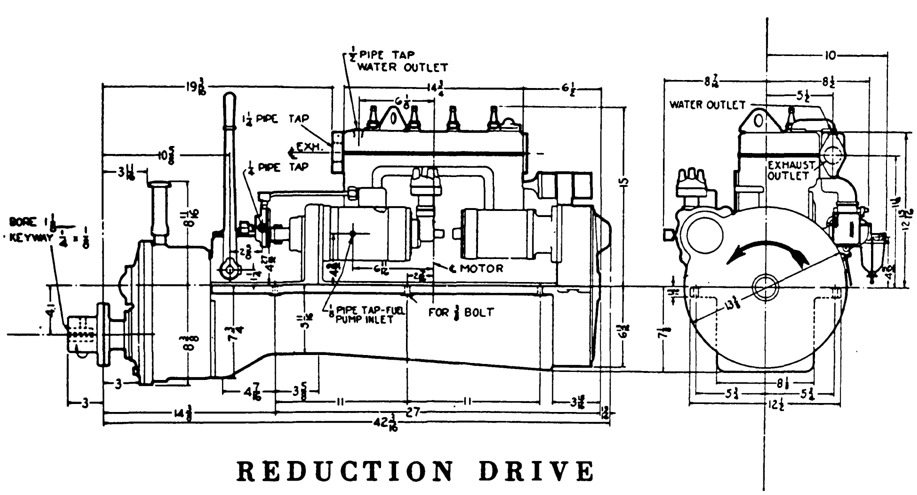
AQUA-PAK V-DRIVE 1:1, 1.29:1, 1.67:1 & 2:1 RATIO

UTILITY FOUR SERIES

Fig. 27

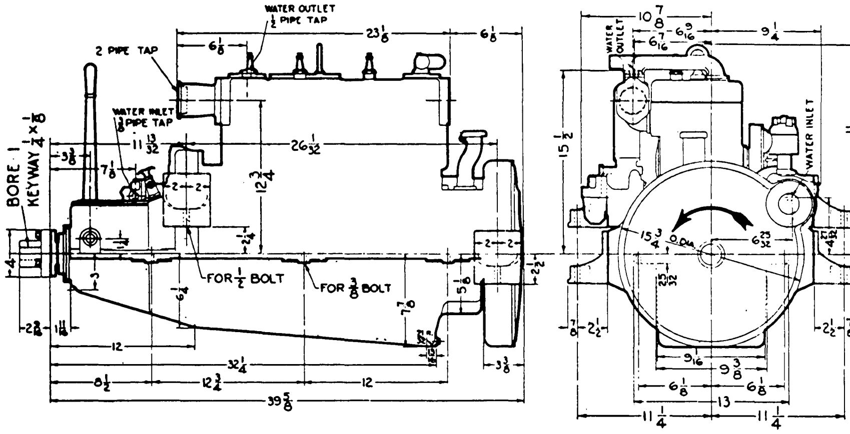


DIRECT DRIVE



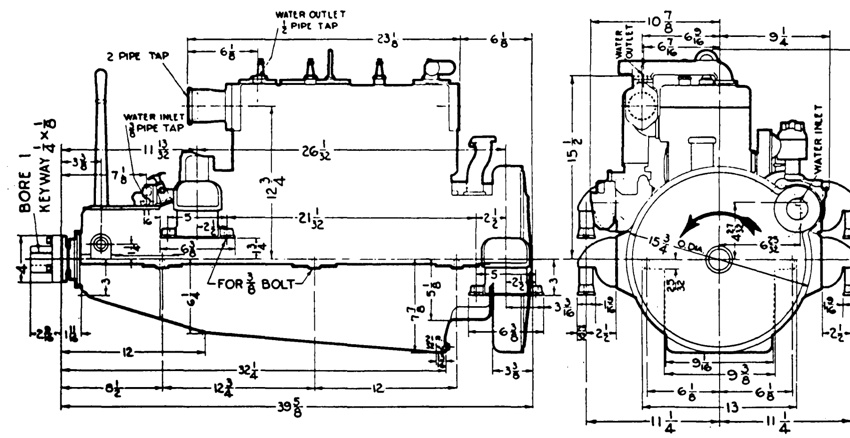
REDUCTION DRIVE

Fig. 28



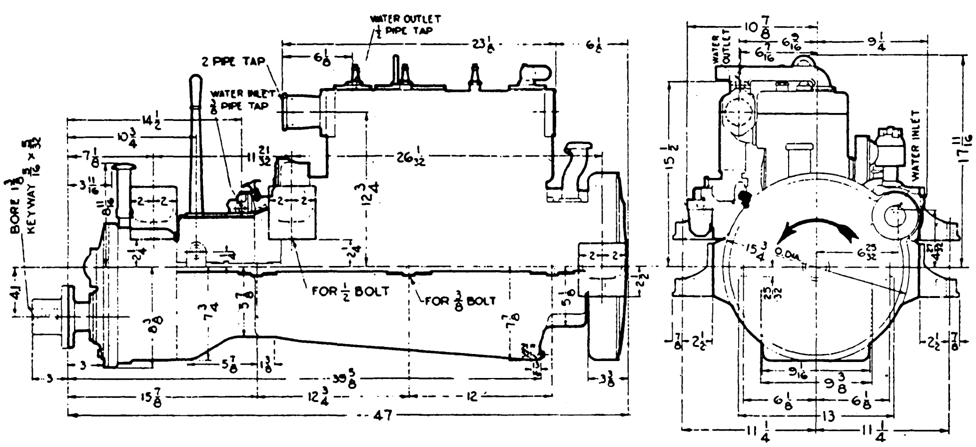
DIRECT DRIVE
RIGID MOUNTINGS

Fig. 29



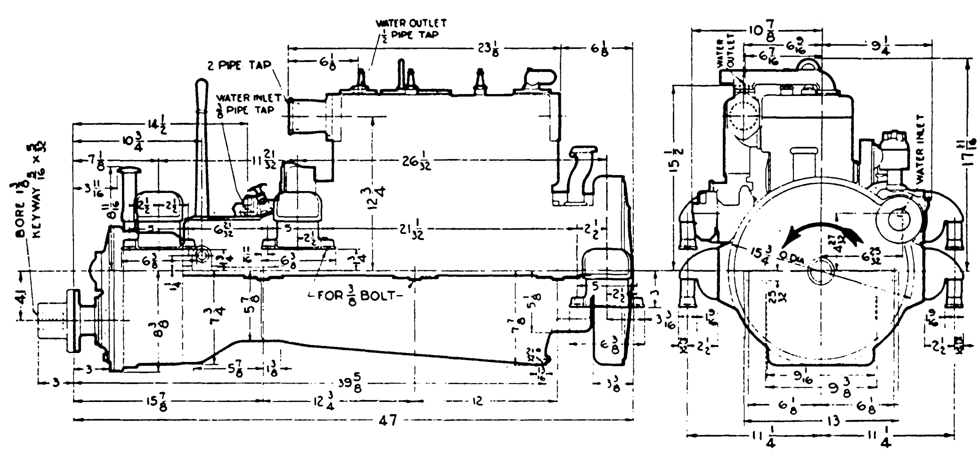
DIRECT DRIVE
RUBBER MOUNTINGS

Fig. 30



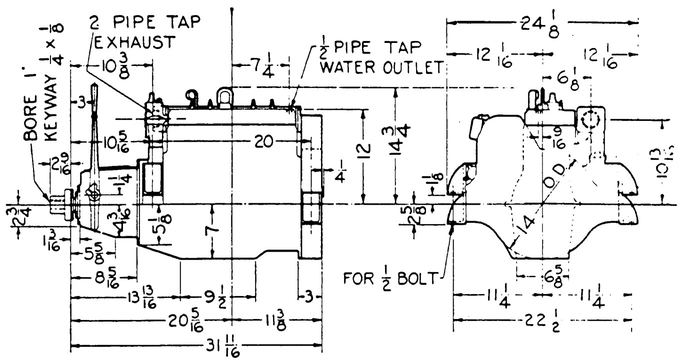
REDUCTION DRIVE
RIGID MOUNTINGS

Fig. 31



REDUCTION DRIVE
RUBBER MOUNTINGS

Fig. 32

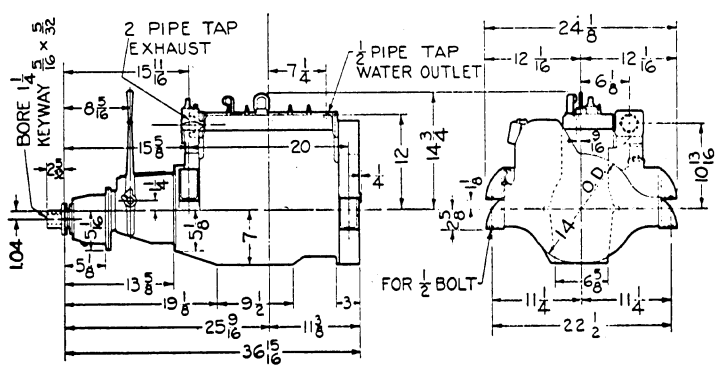


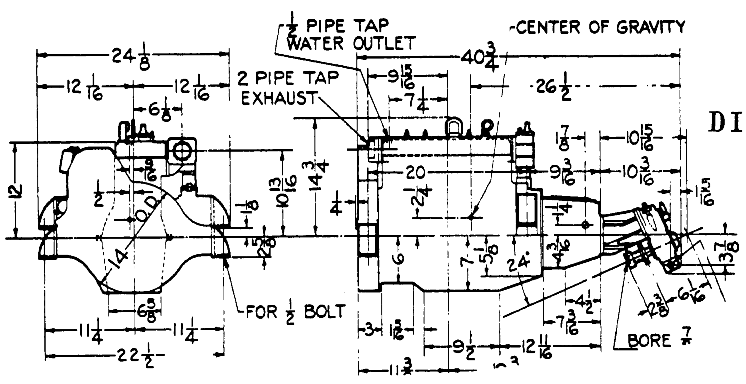
DIRECT DRIVE
RUBBER MOUNTINGS

Fig. 33

2:1 REDUCTION DRIVE
RUBBER MOUNTINGS

Fig. 34

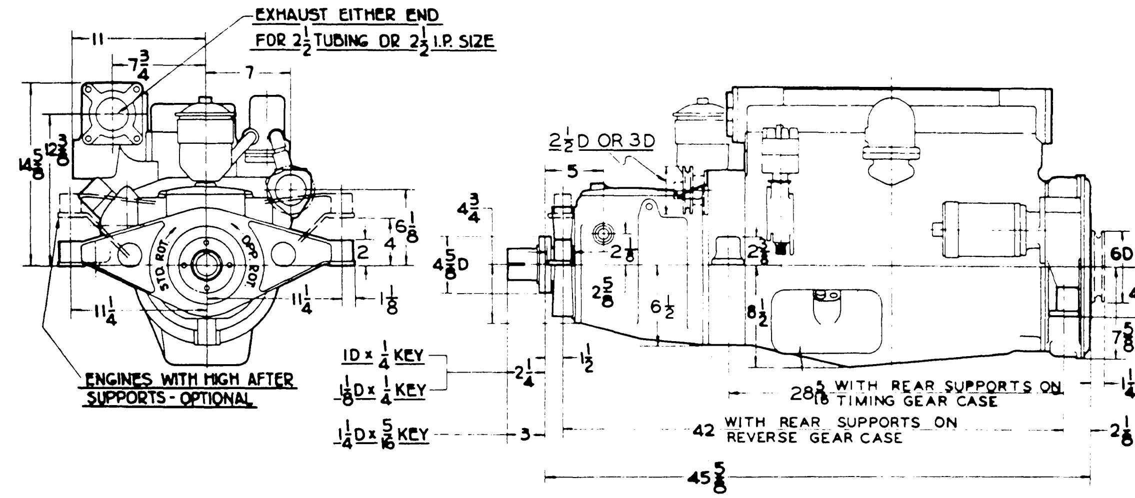




AQUA-PAK V-DRIVE
DIRECT DRIVE & ALL REDUCTION RATIOS
RUBBER MOUNTINGS

Fig. 35

Fig. 36



STA-NU-TRAL GEAR - DIRECT DRIVE

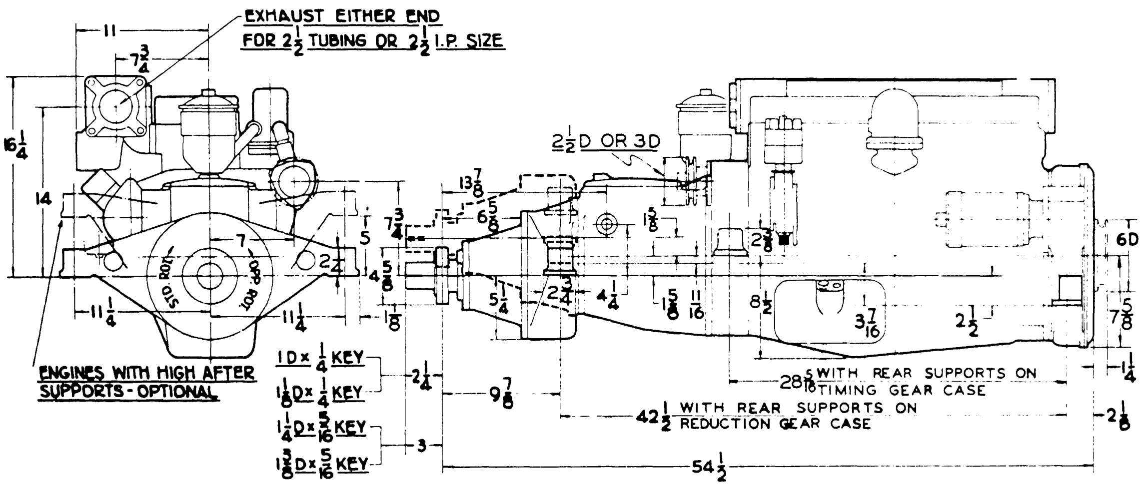
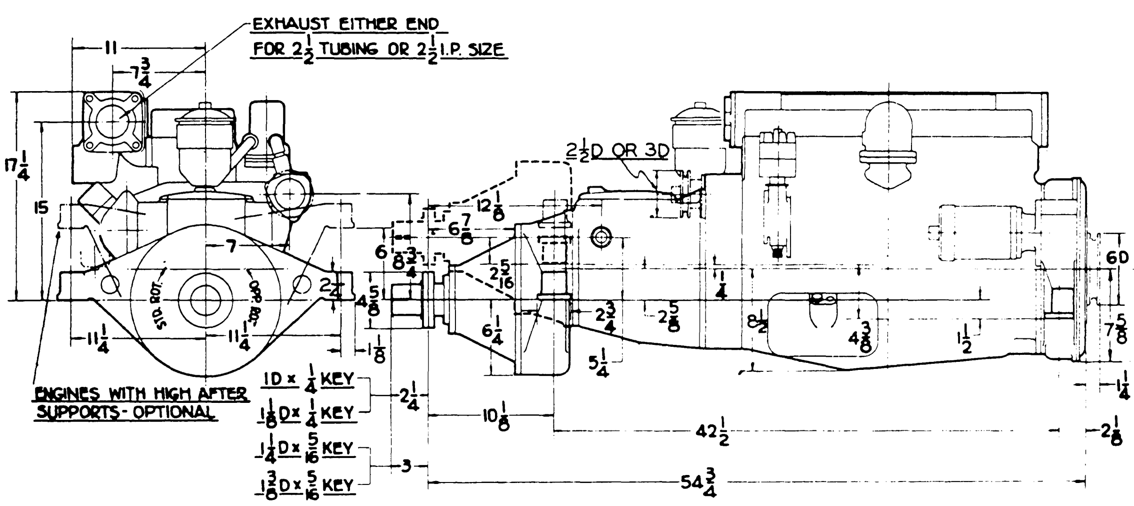


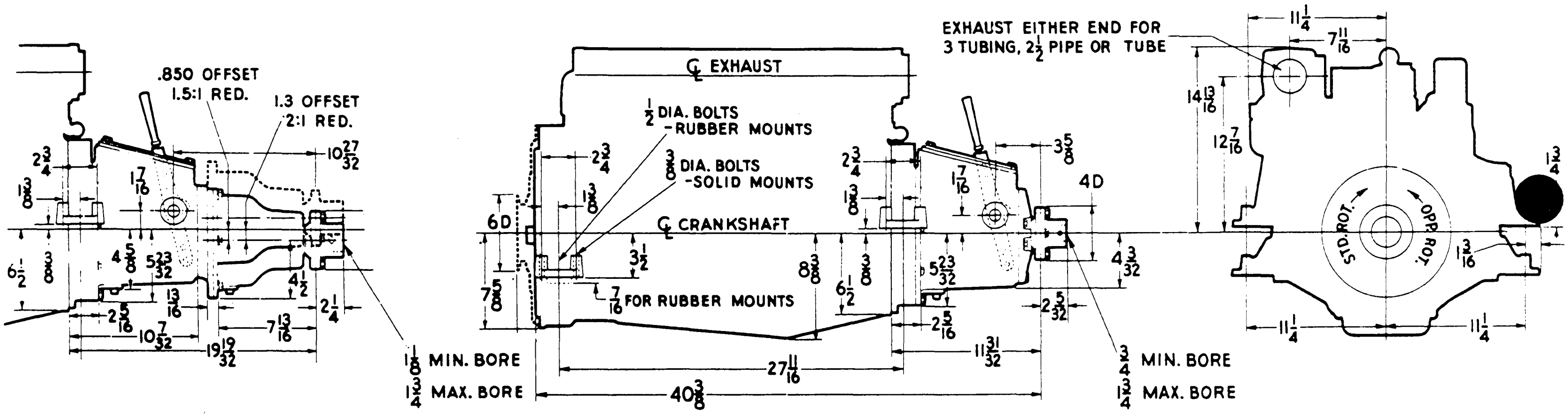
Fig. 37

STA-NU-TRAL GEAR - 1.88:1 REDUCTION RATIO

Fig. 38



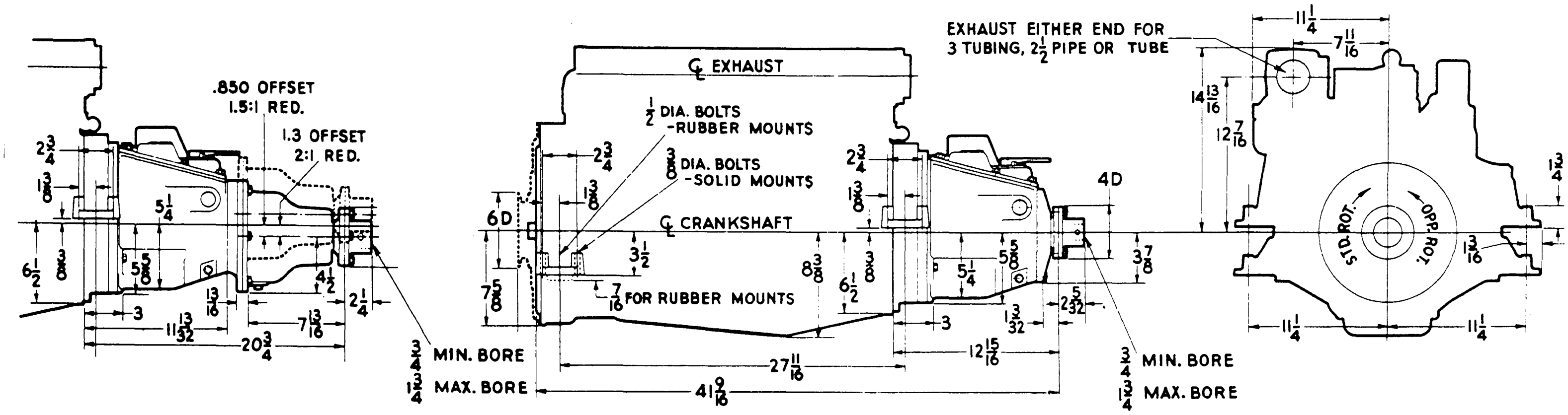
STA-NU-TRAL GEAR - 2.44:1 REDUCTION RATIO



1.5:1 & 2:1

DIRECT DRIVE
MANUAL REVERSING GEAR

Fig. 39

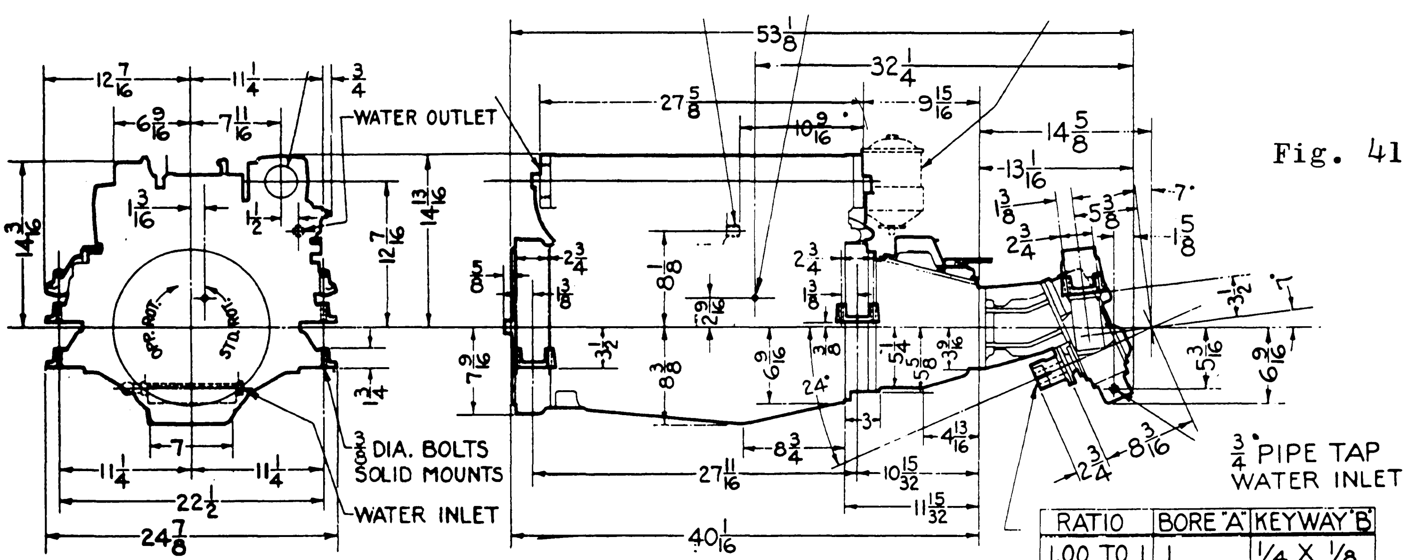


1.5:1 & 2:1

DIRECT DRIVE
HYDRAULIC REVERSING GEAR

Fig. 40

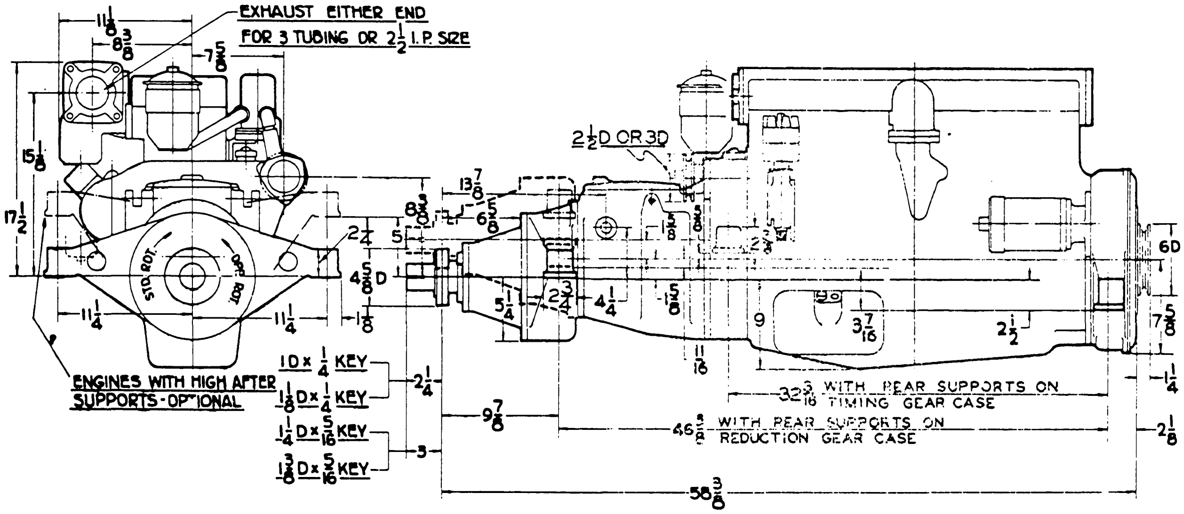
Fig. 41



RATIO	BORE "A"	KEYWAY "B"
1.00 TO 1	1	1/4 X 1/8
1.46 TO 1	1 1/4	5/16 X 5/32
2.05 TO 1	1 1/4	5/16 X 5/32
3.00 TO 1	1 1/2	3/8 X 3/16

V-DRIVE - HYDRAULIC GEAR - ALL RATIOS

Fig. 42



STA-NU-TRAL REVERSE GEAR, 1.88:1 REDUCTION GEAR

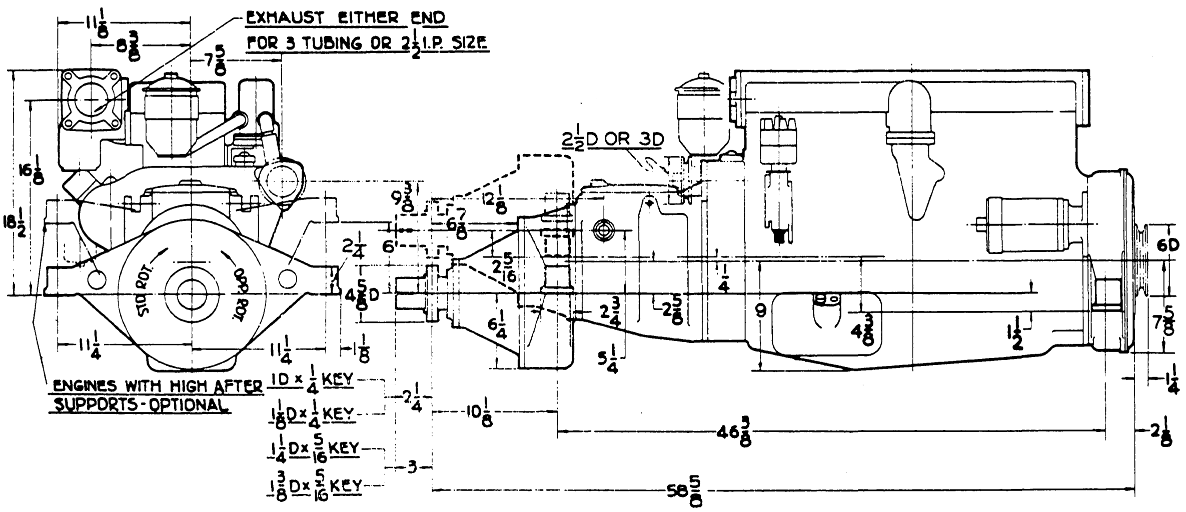
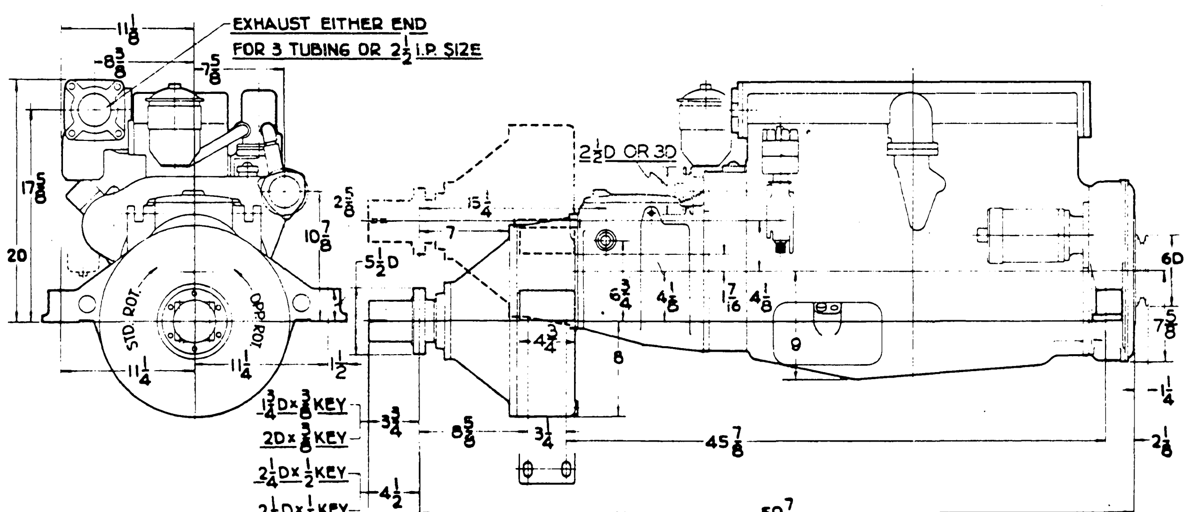


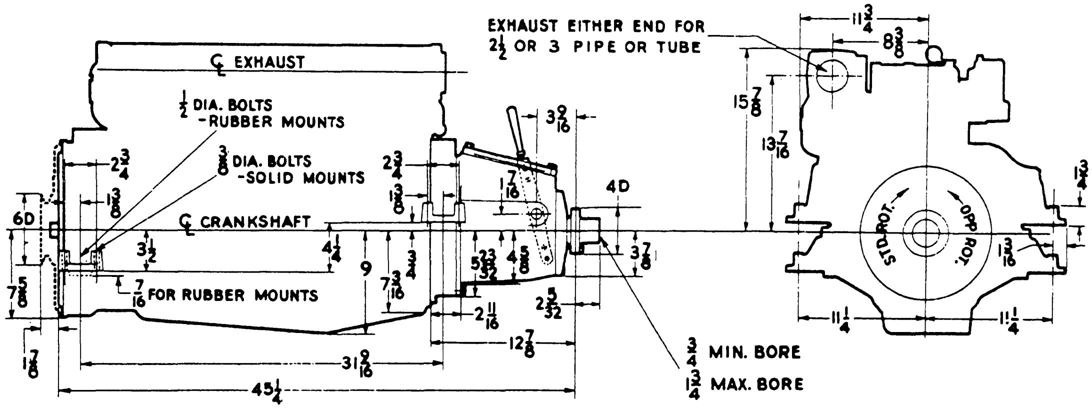
Fig. 43

STA-NU-TRAL REVERSE GEAR, 2.44:1 REDUCTION GEAR

Fig. 44

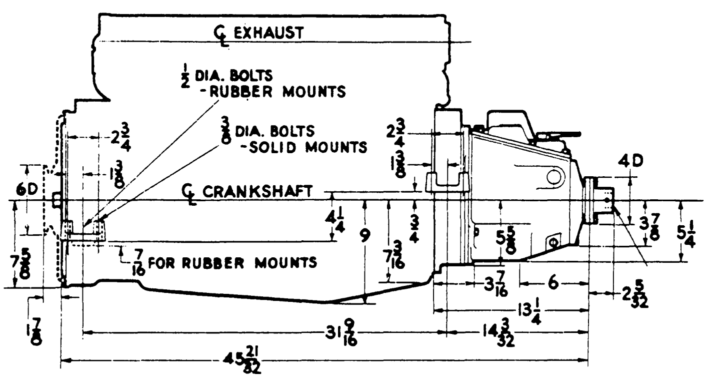


STA-NU-TRAL REVERSE GEAR, 3.32:1 REDUCTION GEAR

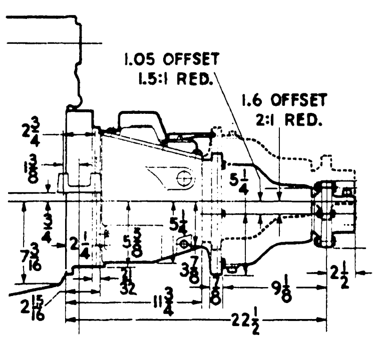


Direct Drive

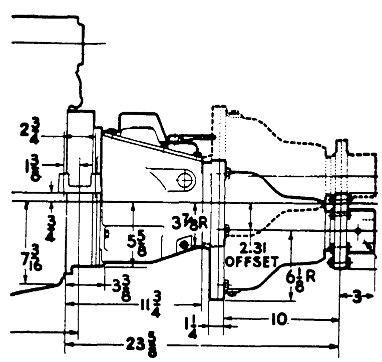
Fig. 45 MANUAL REVERSING GEAR



Direct Drive

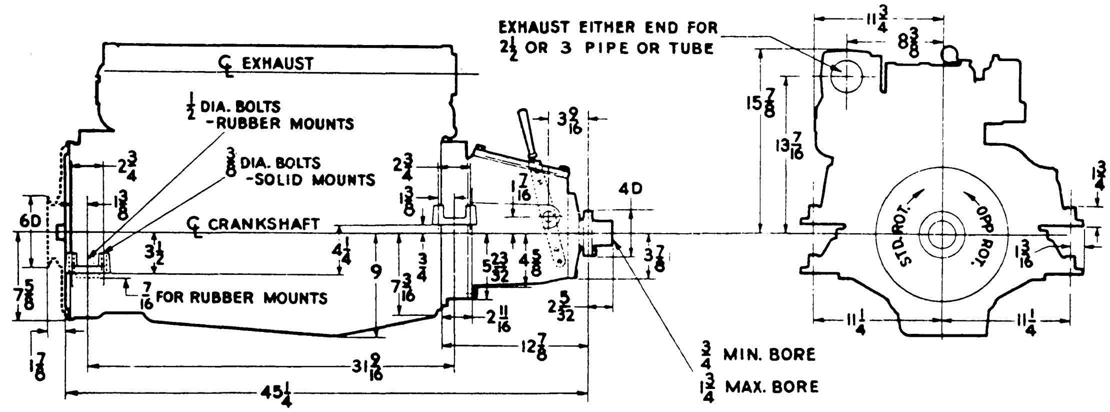


1.5:1 & 2:1



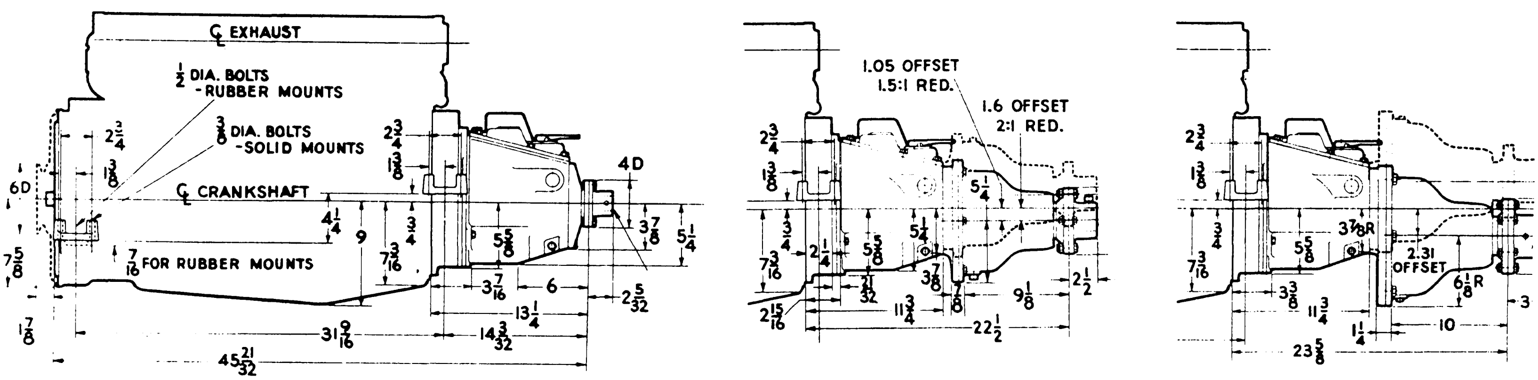
2.5:1

Fig. 46 HYDRAULIC REVERSING GEAR



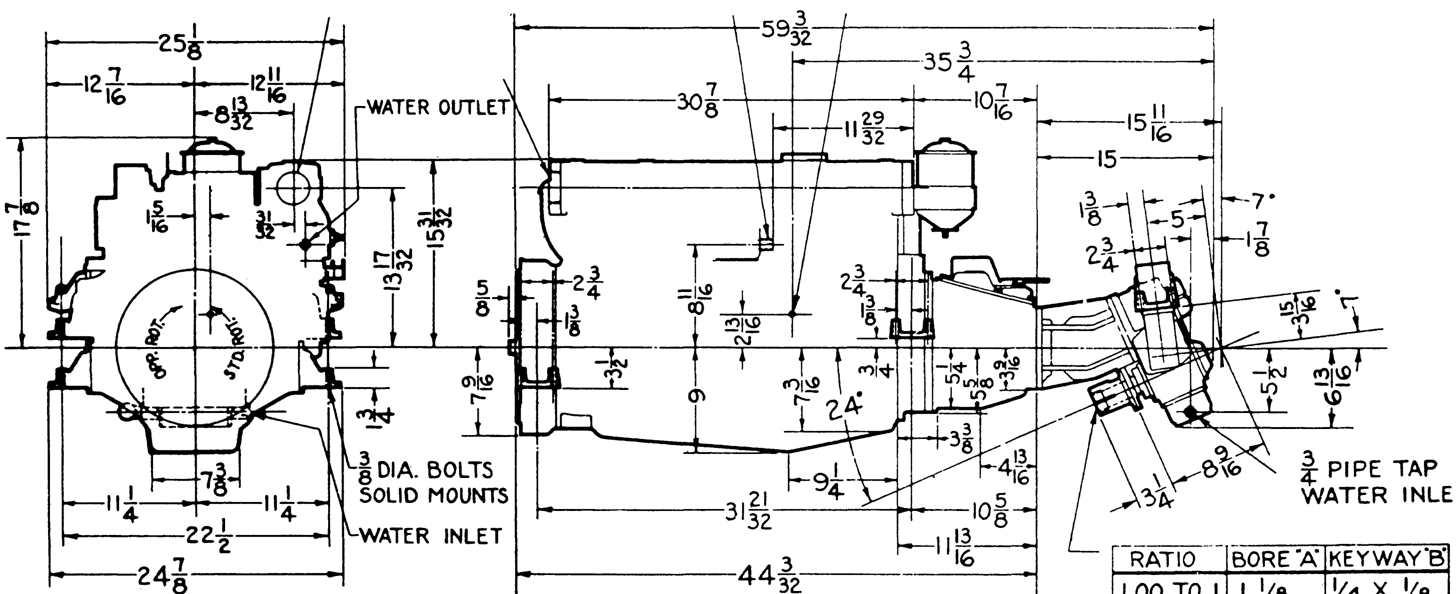
Direct Drive

Fig. 47 MANUAL REVERSING GEAR



Direct Drive 1.5:1 & 2:1 2.5:1

Fig. 48 HYDRAULIC REVERSING GEAR

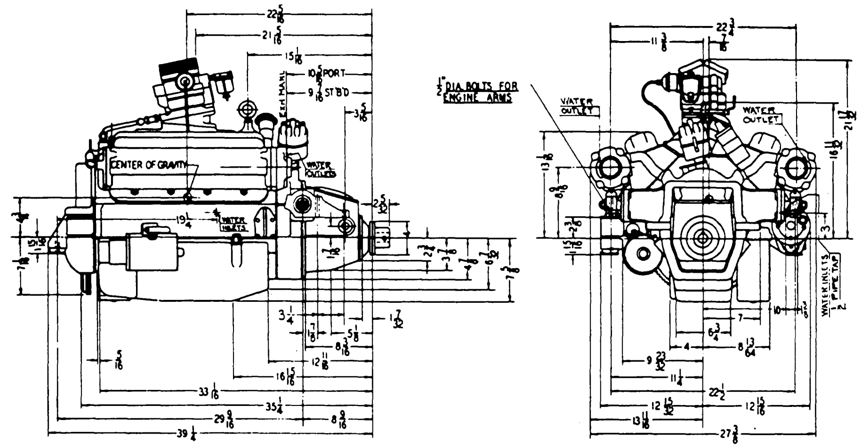


RATIO	BORE 'A'	KEYWAY 'B'
1.00 TO 1	1 1/8	1/4 X 1/8
1.52 TO 1	1 1/2	3/8 X 3/16
2.09 TO 1	1 1/2	3/8 X 3/16
3.00 TO 1	1 3/4	3/8 X 3/16

Fig. 49 V-DRIVE - HYDRAULIC GEAR - ALL RATIOS

Fig. 50

DIRECT DRIVE



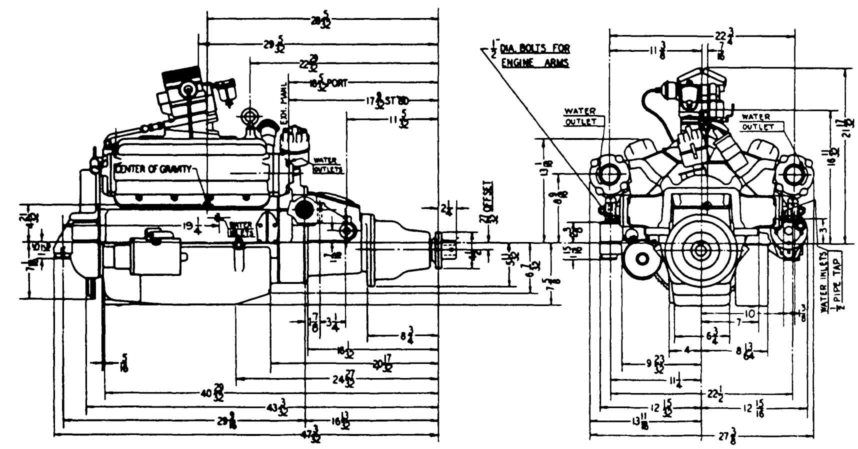
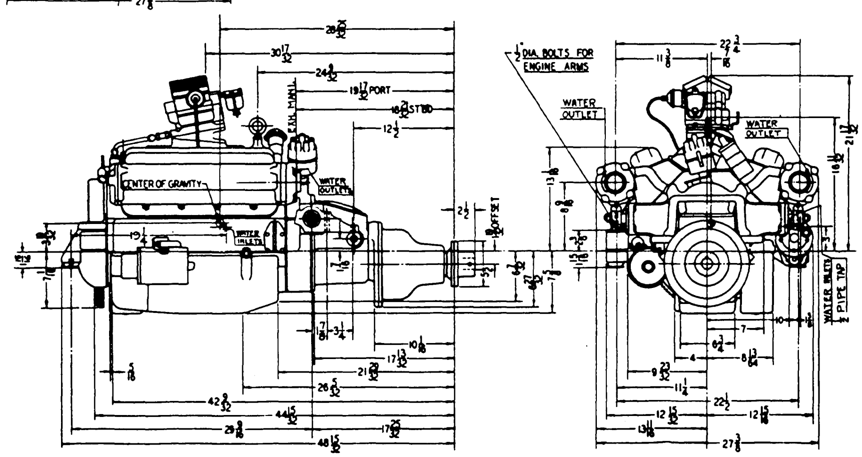


Fig. 51

REDUCTION DRIVE, 1.5:1 RATIO

Fig. 52

REDUCTION DRIVE, 2:1 RATIO



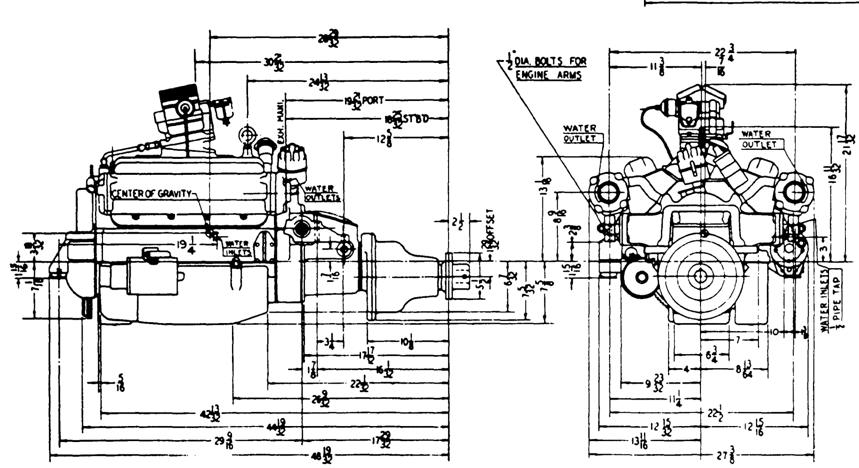
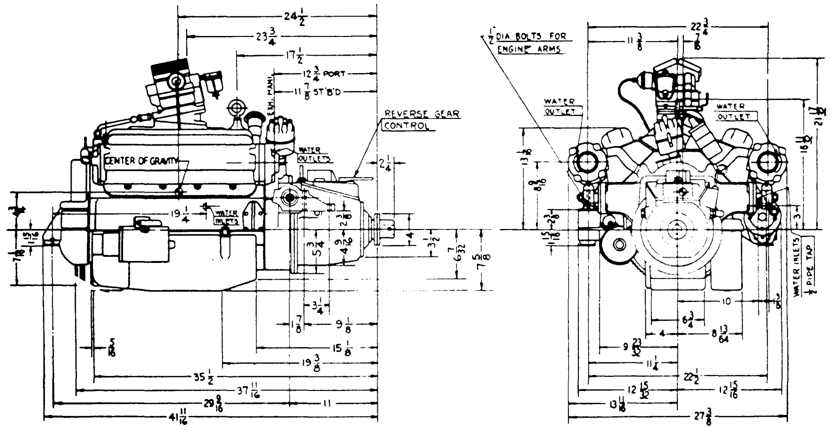


Fig. 53

REDUCTION DRIVE, 2.5:1 RATIO

Fig. 54

DIRECT DRIVE



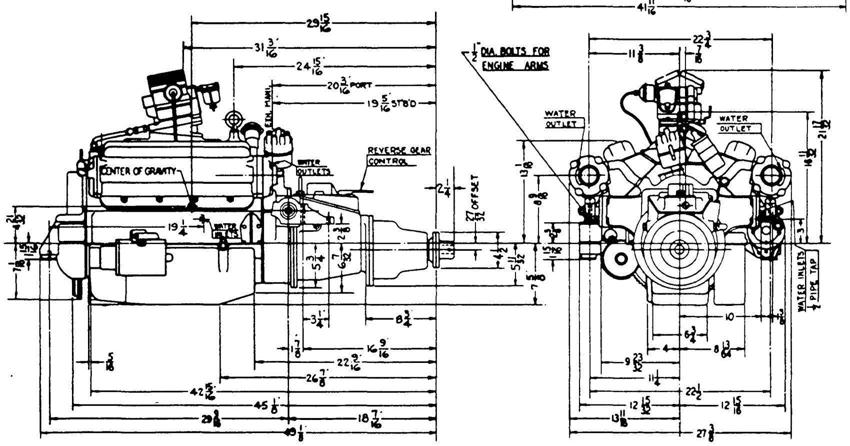
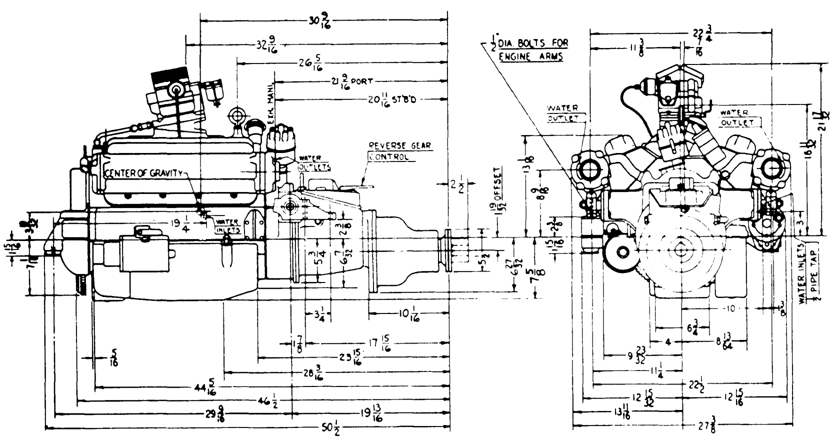


Fig. 55

REDUCTION DRIVE, 1.5:1 RATIO

Fig. 56

REDUCTION DRIVE, 2:1 RATIO



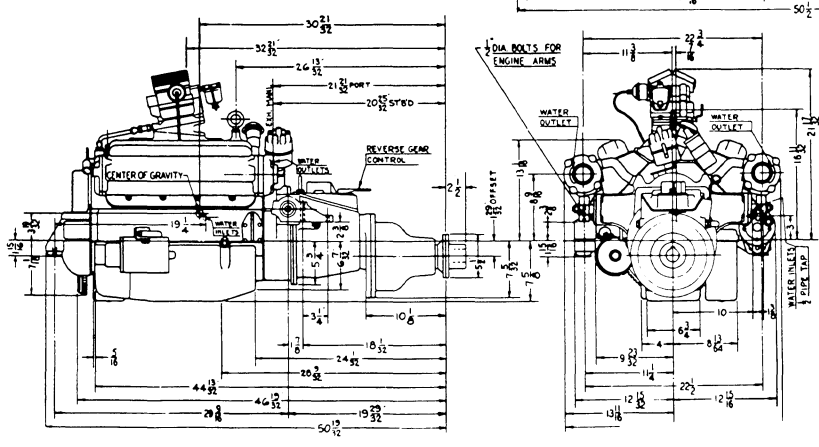


Fig. 57

REDUCTION DRIVE, 2.5:1 RATIO

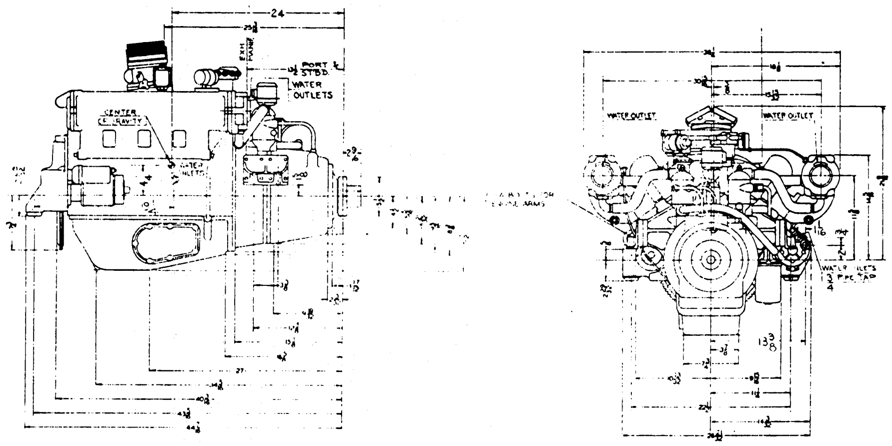


Fig. 58

DIRECT DRIVE
HYDRAULIC REVERSING GEAR

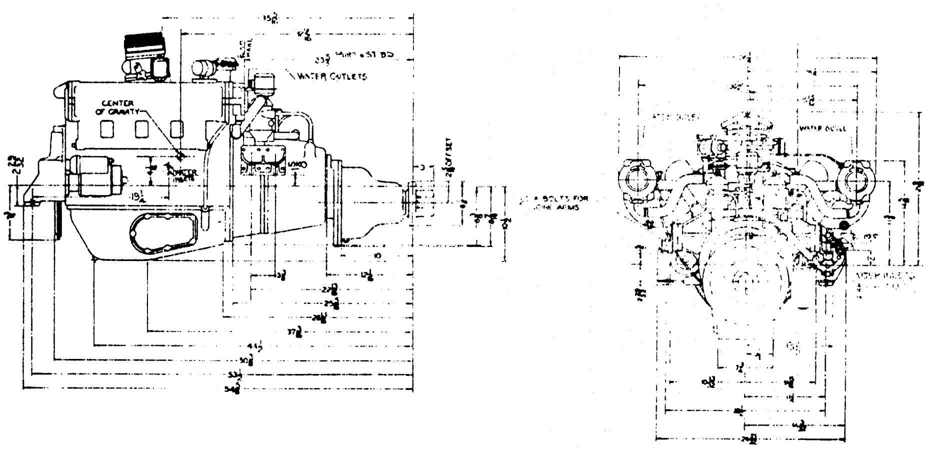


Fig. 59

REDUCTION DRIVE, 2.5:1 RATIO
HYDRAULIC REVERSING GEAR

SECTION III
OPERATION

1. PRELIMINARY CHECKS

a. Check to be sure the engine is filled with oil to the "full" mark on the bayonet stick. See Table 4 for proper grade.

b. On models equipped with hydraulic reversing gears, fill the reversing gear case with the grade oil shown in Table 4, Note 2.

c. On models requiring separate lubrication of reduction gears, fill reduction gear housing. Check Table 4 for proper type gear lubricant.

d. Fill fuel tank with 80-90 octane gasoline. Fuel oil-kerosene models are equipped with a one quart gasoline tank for starting purposes. See Table 5 for fuel specifications of fuel oil-kerosene models.

e. On electrical starting models be sure all connections are correct and secure. Check battery to be sure it is fully charged and that the water level is approximately 3/8" above the plates.

f. Open cooling system water inlet valve (if used). Be sure water lines are properly connected on both intake and overflow sides of water pump.

g. Check all controls for smooth and proper operation.

h. Air out bilge to remove any dangerous gasoline fumes.

i. With ignition off and engine in neutral, turn motor over several times to be sure everything is working freely.

j. Open shut-off valve below fuel tank. Operate hand primer, on models so equipped, to fill feed line and sediment bowl with fuel.

k. Remove shipping cover from flame arrestor.

l. Close all water drain cocks and drain plugs.

2. STARTING ELECTRICAL STARTING MODELS

a. Place clutch in neutral.

b. Open throttle approximately one-quarter.

c. Pull out choke.

d. Turn on ignition switch.

e. Push starter button. If engine fails to start within 30 seconds, see Table 6 to determine cause of trouble.

f. As soon as engine starts push in choke rod.

CAUTION

Do not run engine with choke out any longer than necessary. Over-choking will dilute crankcase oil and possibly cause motor failure due to raw gasoline being sucked into combustion chamber.

g. Check water pump for proper operation. If water fails to circulate, turn water pump grease cup in one or two turns (on gear type water pumps only). If water still fails to circulate, stop engine immediately. See Table 6 for correction of trouble.

h. Check oil pressure gauge for operation of oil pump. If gauge does not indicate oil pressure, stop engine. Table 4 gives proper oil pressure for each model engine.

CAUTION

Do not race engine with clutch disengaged at any time. Racing a cold engine will cause excessive wear and may seriously damage engine. New motors should be run at one-half throttle for a period of 15 hours.

NOTE

If the engine temperature is controlled with a manual by-pass valve as shown in Fig. 11, water will issue from the exhaust pipe as soon as the pump has primed and the engine filled with water. If the engine temperature is controlled by thermostat, only a trickle of water will issue from the exhaust pipe until the engine reaches its normal operating temperature and the thermostat opens to dump water overboard.

3. STOPPING THE ENGINE

The speed of your boat should be gradually reduced while you are still some distance from the mooring or landing. Before stopping the engine, close the throttle and disengage the clutch. Allow the engine to idle for a minute or so before turning off the ignition. Stopping in this manner will permit excessive heat to be absorbed by the cooling system.

4. BREAK-IN

Your UNIVERSAL engine was run and tested for six hours on one of our test stands with electric dynamometer. It was adjusted and checked for maximum power at rated speed. However, those adjustments were correct only for the prevailing atmospheric conditions and fuel used. You may find it necessary to slightly readjust the carburetor and ignition timing for peak performance in your locality and with the fuel available. If readjustment is attempted it should be done by a competent mechanic.

The engine will not be thoroughly broken in until approximately 35 hours of operation have been attained. DO NOT CONTINUOUSLY RUN YOUR ENGINE OVER 2000 RPM DURING THIS PERIOD AND AVOID LONG PERIODS OF SLOW IDLING. OCCASIONALLY DURING BREAK-IN YOU MAY RUN THE ENGINE AT FULL THROTTLE BUT NOT FREQUENTLY OR FOR PERIODS OVER ONE MINUTE IN DURATION. ALWAYS WARM UP THE ENGINE BEFORE ANY RUN.

5. STARTING MAGNETO MODELS

a. Retard spark lever half way.

b. Open throttle approximately one-quarter.

c. Pull choke out all the way.

d. Crank engine two or three turns.

e. Push choke in half way.

f. Crank engine by bringing it to compression and then giving a quick pull. DO NOT SPIN.

g. When engine starts push choke in all the way.

6. STARTING FUEL OIL-KEROSENE MODELS

a. Start engine on gasoline as described in Paragraph 2.

b. Allow engine to run for a period of 3 to 5 minutes to allow it to reach proper operating temperature of 130 to 180 degrees.

c. Switch over to fuel oil by turning the three-way cock, located in the fuel line, to the proper position.

NOTE

Before stopping engine, switch from fuel oil to gasoline and allow engine to run approximately 2 minutes in preparation for the next start.

Table 4
LUBRICATION REQUIREMENTS

MODEL NAME	S.A.E. VISCOSITY NUMBERS FOR ENGINE CRANKCASE OIL			Average Engine Oil Pressure (Hot Engine) Lbs.	Herringbone Reduction Gear Lubricant S.A.E. Viscosity Number Separately Lubricated
	Surrounding Air Temp. Over 90° F. and Maximum Service	Surrounding Air Temp. 32 to 90° F. Average Service	Surrounding Air Temp. Below 32°F. Average Service		
Blue Jacket Twin	S.A.E. 30	S.A.E. 30	S.A.E. 20	30	---
Atomic Four	S.A.E. 30	S.A.E. 30	S.A.E. 20	45	See Note #1
Utility Four	S.A.E. 40	S.A.E. 30	S.A.E. 20	45	S.A.E. 90 to 140
Super-Four	S.A.E. 40	S.A.E. 30	S.A.E. 20	45	S.A.E. 90 to 140
Unimite Four	S.A.E. 30	S.A.E. 30	S.A.E. 20	30	See Note #1
Arrow	S.A.E. 30	S.A.E. 30	S.A.E. 30	30	See Note #1
Bluefin	S.A.E. 30	S.A.E. 30	S.A.E. 30	30	See Notes #1 & #2
Marlin	S.A.E. 30	S.A.E. 30	S.A.E. 30	30	See Note #1
Tarpon	S.A.E. 30	S.A.E. 30	S.A.E. 30	30	See Notes #1 & #2
Knight	S.A.E. 30	S.A.E. 30	S.A.E. 30	30	See Notes #1 & #2
Little King	S.A.E. 30	S.A.E. 30	S.A.E. 30		See Notes #1 & #2
Big King	S.A.E. 30	S.A.E. 30	S.A.E. 30		See Note #2

Note 1

The reduction gears of these engines (on engines with manual type reversing gears), are lubricated from the main engine oil supply and, therefore, use the same S.A.E. number of oil as the engine, and do not have to be separately lubricated.

Note 2

The hydraulic reversing gear is entirely self-contained and independent of the engine oil pressure system (sealed off from engine oil pressure system). Use same S.A.E. number oil as in the engine of good quality non-foaming type. If extreme foaming is encountered due to unusual installation or operating conditions, it will further reduce foaming if type "A" automatic transmission oil is used.

When engines have both hydraulic reversing gear and reduction gear, the reduction gear is lubricated from the oiling system of the hydraulic reversing gear.

The oil level should be checked periodically by means of the bayonet dipstick located on the side at the forward end of the hydraulic reversing gear housing. Oil level should be maintained between the marks on the bayonet dipstick.

Note 3

We do not recommend the use of heavy-duty, high detergent oils during break-in. These oils have such extremely good lubricating qualities that correct and thorough break-in is difficult if not impossible. This is particularly true with respect to seating of piston rings. We recommend the use of a straight mineral oil of S.A.E. 30 weight during the break-in period.

Most oil companies have now adopted a standard system of rating the service for which an oil is intended. In this system an oil designated for ML service is a straight mineral oil without additives and intended for light service. The heavy-duty, high detergent oils are designated MS and DG for severe gasoline engine service and general diesel service. An oil designated for ML service should be used during break-in and an oil designated for MS and DG service used thereafter.

Avoid using any oil that does not specifically state the service rating on the can. Watch the oil level gauge in the oil pan and always keep the oil up to the mark.

CAUTION

Check the oil level stick before starting and several times while filling to prevent overfilling. Keep oil level to the full mark on the oil stick. Amounts of oil required vary with the engine model and the angle at which the engine is mounted.

Table 5

FIRING ORDER

NO. OF CYLINDERS	STANDARD ROT.	OPPOSITE ROT.
2	1-2	
4	1-2-4-3	
6	1-5-3-6-2-4	1-4-2-6-3-5
V-8 LEV	1-2-7-5-6-3-4-8	1-8-4-3-6-5-7-2
V-8 SEVH	1-2-7-5-6-3-4-8	1-8-4-3-6-5-7-2
V-8 NKEV	1-5-6-3-4-2-7-8	1-8-7-2-4-3-6-5

7. OPERATION OF STANDARD REVERSING GEAR

Several types of reversing gears are used on UNIVERSAL engines. The operation, however, is the same in all cases. See Paragraph 6, Section IV, for detailed operation.

a. Moving the lever to the forward position (toward engine) places the transmission in forward drive.

b. Moving the lever to the stern position (away from the engine) places the transmission in reverse drive.

c. Moving the lever to the center position puts the transmission in neutral and no power is delivered to the propeller shaft.

8. OPERATION OF HYDRAULIC REVERSING GEARS

a. The hydraulic reversing gear is basically a hydraulically operated multiple disc clutch in combination with a hydraulically operated planetary reversing gear train. The gear positions are stamped on the top cover. See Paragraph 6, Section IV for detailed operation.

(1) Moving the lever, on the top cover, to the "F" position places the transmission in forward drive.

(2) Moving the lever to the "R" position places the transmission in reverse drive.

(3) Moving the lever to the center, or "N" position places the transmission in neutral.

b. The design of the reversing gear is such that the operation of both the forward and reverse drives is almost instantaneous with the movement of the shifting control lever. This condition exists even at low speeds. For this reason it is not necessary to race the engine to obtain good shifting characteristics. In fact, it is advisable to shift at low speeds, below 1400 RPM, and preferably in the 800 to 1000 RPM range. Shifting at conservative engine speeds will avoid damage to the boat, engine reversing gear, shafting and propeller caused by the shock of rapid shifting at high engine speeds.

9. COLD WEATHER OPERATION

Special precautions must be taken when operating engines in cold weather to insure efficient operation and to prevent damage to the engine. Some items to be considered are listed below:

a. Keep battery fully charged to prevent freezing and to get maximum starting power.

b. Be sure fuel lines and tanks are free of water to prevent stoppage in the fuel system due to freezing.

c. Substitute lighter engine oil. See Table 4.

d. When engine is stopped after a run, drain all water from cylinder block, water pump, and water lines before the water has time to freeze.

Starting an engine with the water pump frozen will probably break the drive shaft or damage the gears. Be sure the water pump is thoroughly thawed out before attempting to start the engine.

e. Extra choking or external heat may be required to get sufficient vaporization in the manifold for cold starts.

f. Give the engine sufficient time to warm up both water and oil before subjecting it to heavy loads.

10. PREPARING ENGINE FOR STORAGE

Neglect in preparing an engine for winter storage may lead to annoying and costly damage. The engine should be carefully covered to give complete protection from rain and snow.

a. Cylinder Block
Open all drain cocks on cylinder block. Leave drain cocks open.

b. Manifold
Open drain cocks in exhaust manifold and drain water from the manifold.

c. Water Pump
Water pumps are particularly susceptible to damage from freezing. The pump should be carefully drained. A drain plug is provided on the bottom of the pump housing. Six cylinder engines are equipped with Jabsco pumps and to drain loosen end cover.

d. Lubrication System
The oil pan and lubrication system should be drained of old or contaminated oils so that moisture or acid present in the old oil will not cause corrosion. Two or three quarts of new, clean oil should be pumped through the system by turning the motor by hand or electric starter. Doing so will distribute a clean film of oil which will act as a rust preventative.

e. Cylinders
Remove the spark plugs and pour one or two ounces of new oil into the combustion chamber of each cylinder to give lubrication to piston rings, cylinder walls, and valves. Turn the engine over a few times to be sure of distribution before replacing spark plugs.

f. Valves and Tappets
Remove the valve tappet covers and oil valves and tappets with clean oil. Replace tappet covers and seal breather tube end with tape.

g. Distributor
See that the distributor is clean and well lubricated. Special care should be taken to prevent the entrance of moisture during storage.

h. Starting Motor
The starting motor must be protected against rain and snow. The starter pinion and screw shaft should be clean and covered with a film of light oil. The bearings should be well lubricated. The motor should be sealed to prevent corrosion of

commutator and brushes. Do not oil the commutator.

i. Generator
Oil bearings. Seal moisture tight to prevent corrosion.

j. Battery
Remove battery and store in a warm dry place. Battery should be fully charged when placed in storage and checked periodically. Occasional charging may be desirable to prolong battery life. Terminals should be clean and coated with vaseline to prevent corrosion.

SECTION IV
THEORY OF OPERATION

1. GENERAL THEORY OF OPERATION

a. UNIVERSAL engines are four cycle, water cooled, "L" head and valve-in-head engines. While various models of the engine may use different fuels and may vary in number of cylinders, the basic operation of the engine remains the same.

b. While operating, a four cycle engine goes through four separate steps to complete one working or power cycle. These steps are: intake, compression, power and exhaust.

(1) Intake Stroke
As the piston travels down in the cylinder, the intake valve opens. Vacuum formed on top of the cylinder caused by the downward movement of the piston draws the fuel mixture from the carburetor, through the intake manifold, and into the cylinder compression chamber.

(2) Compression Stroke
As the piston travels up, both intake and exhaust valves close and the fuel mixture is compressed between the top of the piston and the cylinder head.

(3) Power Stroke
When the piston has reached the top of its stroke and has just started down, a properly timed spark causes the fuel mixture to explode. This explosion drives the piston down and the power developed by the sudden thrust is transmitted by means of connecting rod and crankshaft to the propeller shaft.

(4) Exhaust Stroke
The fourth and last stroke occurs when the piston again starts its upward travel. During this period the exhaust valve opens and the burned gases are forced out of the combustion chamber, into the exhaust manifold and out the exhaust system.

c. The exhaust stroke marks the end of one complete operating cycle. After completion of the exhaust stroke, the cycle repeats, starting with the intake stroke and continues as long as the engine is in operation.

2. THEORY OF IGNITION SYSTEMS

The Blue Jacket Model AFT and the Utility Models BNM and BNMR are equipped with a magneto ignition system. All other models described in this book have either a 6 or 12 volt, battery operated electrical ignition system.

a. Battery Operated Electrical Ignition System

(1) The ignition system consists of the battery, distributor, ignition coil, ignition switch, and spark plugs.

(2) Two separate circuits, primary and secondary, make up the ignition system. The primary low tension circuit consists of the battery, low voltage distributor points, primary coil winding and condenser. The secondary high tension circuit consists of the secondary winding of the coil, distributor rotor and cap, high tension wiring, and spark plugs.

(3) In operation, current from the battery passes to the primary winding of the ignition coil, through the breaker points of the distributor. Periodic opening and closing of the breaker points causes the flow of current to start and stop, thus causing an alternate build-up and collapse of the magnetic field around the primary winding of the coil. This fluctuating magnetic field cuts the secondary winding of the ignition coil, causing a very high voltage to be induced in it. Current from the secondary of the ignition coil is then passed through the distributor rotor to contacts in the distributor cap and finally to the spark plug.

(4) Arcing across the low voltage points of the distributor caused by the collapsing magnetic field around the primary winding of the coil is reduced by use of a condenser connected across the points.

b. Magneto Ignition Systems

(1) Magnetos are a special application of the electric generator and are usually used where the output of energy required is small. They are used on some models of UNIVERSAL engines to furnish energy for ignition of the compressed gases in the cylinder chambers. The elements of construction comprise a permanent magnetic field, armatures, which rotate within that field, a circuit breaker and a distributing mechanism which serves to carry the generated current to the spark plug.

(2) The high tension type magneto used on UNIVERSAL engines has a secondary winding, comprising a great number of turns of fine wire, superimposed upon the primary winding. The primary winding is short circuited by means of an auxiliary device, during the building up of the field in the armature coil. When the energy in the primary circuit has reached a maximum, this circuit is opened, and at the same instant, due to the rotation of the armature, the magnetic field is removed. The energy of the primary winding is discharged through the secondary, and due to the ratio of primary to secondary turns, a considerable increase in voltage results. The resulting high-tension current is then distributed to the spark plugs.

(3) Because the spark intensity of a magneto varies directly with the engine speed, an increase of energy is available at high speeds. At low engine speeds, such as when the engine is hand cranked, the magneto would sometimes fail to produce a voltage sufficient to spark across the spark plug gap. In order to prevent this from occurring, the magnetos used are equipped with an impulse coupling which serves to couple the magneto to the engine, and at the same time, accelerate its speed of rotation during the starting period.

3. LUBRICATION SYSTEM

All UNIVERSAL engines are equipped with a full pressure lubrication system.

a. Full Pressure Lubrication System

(1) The full pressure lubrication system effectively lubricates all necessary moving parts of the engine with the exception of those accessories mounted on the outside of the engine. See Table 4 for those models which require separate lubrication of reduction gears.

(2) The gear driven oil pump, located in the oil base, draws oil through an intake screen. Oil is forced to all main, connecting rod and camshaft bearings; through jet holes in the connecting rods for cylinder wall, piston and wrist pin lubrication. Drilled holes in the cylinder block provide lubrication for the valve tappets. Oil is supplied to the reversing gear through a drilled hole in the end of the crankshaft. Hydraulic reversing gears are separately lubricated from their own oil supply.

(3) All models using the full pressure system are equipped with an oil pressure regulator which may be adjusted for proper oil pressure. See Table 4 for proper setting.

(4) Six and eight cylinder models and the Super-Four models are equipped with oil coolers. Oil from the oil pump is circulated to the cooler and cooled by water from the engine cooling system. A by-pass (except on Super-Four models) built into the cooler short circuits the oil directly from the pump to the oil line in the event the cooler becomes clogged.

4. FUEL SYSTEM

The fuel system consists of fuel tank, fuel line, strainer, pump (except on Blue Jacket Twin models), carburetor, flame arrestor, and intake manifold. Gasoline from the tank enters the fuel pump through the strainer and into the carburetor where it is vaporized and drawn through the intake manifold, through the valves, and into the combustion chamber of the cylinder.

a. Fuel Pump

(1) The purpose of the fuel pump is to supply an adequate amount of gasoline from the tank to the carburetor to meet engine requirements at all speeds. This pump is of the diaphragm type and is operated by a plunger working off an eccentric on the camshaft.

(2) As the high point of the cam is reached, the plunger is forced down, causing a vacuum above the diaphragm. The vacuum draws gasoline from the tank, through the inlet valve and into the fuel chamber of the pump. The return stroke releases the compressed diaphragm spring, expelling gasoline through the outlet valve into the carburetor bowl.

(3) After several diaphragm strokes, the carburetor bowl fills and its float mechanism rises, thus seating the needle valve and stopping further passage of fuel from the pump. With the carburetor bowl filled and needle valve closed, back pressure is created on the diaphragm. With this back pressure on the diaphragm, the rocker arm movement continues, but is taken up by the linkage, rather than being transmitted to the diaphragm. As pressure reduces in the fuel chamber because of carburetor demands, the diaphragm will take longer strokes. Fuel flow is thus maintained in accordance with engine operating conditions.

b. Carburetor

The function of the carburetor is to furnish the correct mixture of gasoline and air to the engine in the proper proportion for all operating conditions, idling to full throttle. To accomplish this, the gasoline is accurately metered at all speeds, atomized or broken up into small particles, and mixed with air. The fuel is vaporized and preheated in the intake manifold before being drawn into the cylinder through the intake valve.

c. Flame Arrestor

A flame arrestor attached to the air inlet of the carburetor eliminates the possibility of fire being caused by backfiring through the carburetor. A special element, consisting of curved plates, dissipates the heat and prevents fire from extending through the arrestor.

5. COOLING SYSTEM

a. All engines are equipped with a positive displacement type water pump. Six and eight cylinder engine pumps are rubber impeller type. Two and four cylinder engines have bronze gear pumps. The opposite type in each case can be obtained on special order.

b. In the Twin, Atomic, Utility and Super-Four, the water flow is from pump to block, to head, to manifold, then overboard.

In the case of the Unimite, the flow is from pump to manifold, to block, to head, then overboard.

All six cylinder engines have the same flow which is: pump to oil cooler, to manifold for one complete pass, then into block through four to six holes (depending on engine size), then to head, to heat riser on intake manifold, and then overboard.

c. See special diagram of rather complicated water flow in special manual furnished with each V-8 engine.

d. Where either manual or automatic temperature control is used, varying amounts of discharge water will be recirculated. See Fig. 11.

6. REVERSING GEARS

Four types of reversing gear systems are used on UNIVERSAL engines covered by these instructions. Three of these are mechanically operated, and the fourth is a hydraulic system.

a. Joes Model Reversing Gear

(1) The Joes model reversing gear is currently being used on the Super-Four series engines only.

(2) The forward drive on this unit is a double friction clutch. On the propeller end are a series of friction discs of steel and bronze which are mortised into the engine and propeller drives and casing. On the engine end, a split cone clamps the engine shaft and frictionally locks the gears to it.

(3) When the reversing gear lever is moved forward the toggles force home the plungers, clamping all friction surfaces together. All moving parts are then locked and the whole unit functions as a solid coupling between the motor and propeller shafts.

(4) Reverse drive is obtained by throwing the lever back. This releases the forward drive and throws on the brake band by means of a cam. This cam passes through a slot in the camshaft that operates between the cam roll and cam shoe. This clamps the brake band and prevents the outside case from revolving. When the casing is thus held from revolving, the gearing drives the propeller in the reverse direction at 80 - 88% of the motor speed.

(5) To place in neutral, the lever is placed midway between forward and reverse, which releases both the reverse and forward drives and permits the gearing to run idle.

b. Paragon Model Reversing Gears

(1) Paragon reversing gears are used on all current production engines except the Super-Four and those models which are equipped with hydraulically operated reversing gears or Sta-Nu-Tral manual gears.

(2) Power from the engine is transmitted through the engine sleeve gear and the reverse idler pinions to the forward clutch or to the reverse drive gear.

(3) The forward clutch consists of

a series of friction discs, alternate ones held in the reverse gear drum and on the tailshaft clutch carrier. This group of discs can be clamped together by a pressure plate operated by three toggle arms attached to clutch adjustment plate. These toggles are moved by the yoke and collar assembly on the tailshaft. In the forward position the entire drum and clutch assembly rotates with the crankshaft. When in neutral and in the reverse position the forward clutch plates are free to turn with respect to each other.

(4) The reverse clutch consists of a brake band around the drum with an operating mechanism for clamping the band to the drum. The band is supported and rotation prevented by the band feet which rest on the support flanges in the reverse gear housing. When the operating lever is moved to the rear, the band clamping toggle levers pull the open ends of the band together, clamping the band tightly around the drum. This prevents rotation of the drum and the planet pinions or idle pinions. This causes the tailshaft to be rotated in the opposite direction to the crankshaft. The arrangement of forward and reverse clutches prevents both being actuated at the same time.

(5) When the operating lever is placed in the center position the drum and forward clutch plates are free to turn and no power is transmitted from the engine to the propeller shaft.

c.Paragon Hydraulic Reversing Gears

(1) The Paragon hydraulic reversing gear is basically a hydraulically operated multiple disc clutch in combination with a hydraulically operated planetary reversing gear train. The unit is self-contained and independent of the engine oil system.

(2) Power for the operation of the reversing gears is provided by the transmission oil pump mounted inside the reversing gear case and driven continuously by the engine while the engine is running. From the oil pump the oil under pressure is delivered to the pressure relief valve and control valve.

(3) The operation of the system is controlled by a control valve mounted on the top cover. Moving the lever determines whether the actuating oil is delivered to the forward or reverse mechanism.

(4) The forward clutch is engaged by moving the shifting lever to the forward position. This operates the control valve so that it in turn directs the pressure oil from the pump to the forward piston in its cylinder. The forward piston squeezes the forward multiple disc clutch and so turns the propeller shaft in the proper direction to move the boat ahead.

(5) The reverse band is similarly engaged by moving the shifting lever to the reverse position. This operates the control valve so that it in turn directs the pressure oil from the pump to the reverse piston in its cylinder. The reverse position clamps the brake band on the planetary gear train and so turns the propeller shaft in the reverse direction, thus moving the boat astern.

(6) Neutral, or center position, of the control lever prevents any pressure oil from entering either the forward or reverse cylinders. In addition the control valve opens drains in both cylinders so that any oil in either cylinder is drained out and the pistons completely retract disengaging both forward and reverse drives.

7. <u>REDUCTION GEARS</u>

Some models of UNIVERSAL engines are equipped with reduction gears in ratios varying from 1.5:1 to 4.12:1. Reduction gears supplied with various model engines are shown in Table 1.

a. Helical Reduction Gears

(1) The reduction gear unit consists of a helical drive pinion mounted on the reverse gear tailshaft supported in the reduction gear front cover and an internal helical gear rigidly supported on large capacity ball bearings in the reduction gear housing. The reduction gear ratio is determined by the number of teeth in pinion and internal gears. The centerline offset is the difference in pitch radii of the pinion and the internal gears. The pinion gear is keyed to the reverse gear tailshaft and held in place by a nut. It is supported in a large ball bearing in the adaptor plate and reverse gear housing. Correct alignment of the pinion gear is maintained by this ball bearing and the one on the engine sleeve gear at the forward end of the tailshaft.

(2) The internal helical gear is bolted to a flanged reduction gear shaft rigidly mounted on two large ball bearings. The one next to the gear and carrying most of the radial load is a single row unit. The propeller thrust bearing is a double row unit capable of taking the heavy axial propeller thrust in addition to the radial load imposed by the helical gear.

(3) The propeller shaft coupling is keyed to the end of the reduction gear shaft and held in place by a lock nut. The propeller shaft coupling is supported by the large double row ball bearing.

(4) A ring type oil seal pressed into the propeller thrust bearing retainer rubs on the polished surface of the propeller thrust coupling. This prevents loss of reduction gear oil from the housing and the entrance of water or dirt into the reduction gear.

(5) On some models the reduction gear is oiled by crankcase pressure and on others separate lubrication is provided. See Table 4.

b. Universal Reduction Drive

The Universal reduction drive consists of two herringbone gears, a small gear press fit on the reverse gear tailshaft, and a larger gear which floats on the spline shaft below it. Both the drive shaft and the lower spline shaft are supported by heavy duty ball bearings. Running in a continuous bath of oil, this type of drive is positive, quiet, and smooth.

SECTION V
PERIODIC SERVICE

1. GENERAL

Periodic maintenance procedures will do much to keep your engine operating at top efficiency. Regular inspection of the engine following the procedures listed in Paragraph 2 through 8 will reduce maintenance costs and uphold the high standards of quietness, reliability, and performance built into every UNIVERSAL engine.

2. PRE-OPERATIONAL CHECK

a. Check engine oil level. If necessary, add oil to bring it up to the full mark on the bayonet stick. See Table 4 for proper weight oil.

b. On engines having separately oiled reduction gears, check oil level and if necessary refill. See Table 4 for engine requirements.

c. On engines equipped with hydraulic reversing gears, check to see that oil level is at full mark on bayonet stick. If necessary refill with same grade oil used in engine.

d. Turn grease cup on water pump one turn. If necessary refill with good grade waterproof grease. (Bronze gear water pumps only).

e. With engine operating check oil pressure.

f. With engine operating, check temperature. On engines equipped with temperature indicators, temperature should be between 130 and 160 degrees F. (Fresh water 160° - salt water 140°). If engine is not equipped with a temperature gauge, a rough determination can be made by placing a hand on the engine block. Engine should operate at a temperature which will allow holding a hand on the block for a period of 15 to 30 seconds.

3. FIFTY HOUR CHECK

a. Using sump pump, remove all oil from crankcase. Refill with a good grade oil as specified in Table 4.

b. Inspect oil cooler and remove any accumulation of grit or dirt.

c. Oil generator, using three to five drops of light engine oil.

d. Add three or four drops of medium engine oil to distributor oil cup.

e. Clean fuel pump strainer.

4. ONE HUNDRED HOUR CHECK

a. Remove glass bowl from fuel pump and clean out accumulated sediment.

b. Inspect flame arrestor to be sure air passages are clean and free from oil. If dirty remove and wash with kerosene. Be sure arrestor is thoroughly dry before replacing.

c. Check adjustment of clutch. See Paragraphs 8 and 9, Section VI.

5. ONE HUNDRED FIFTY HOUR CHECK

a. Check valve tappet adjustment. See Paragraph 7, Section VI.

b. Remove, clean, and reset spark plugs. See Paragraph 13, Section VI.

c. Tighten all nuts and capscrews.

6. TWICE A SEASON CHECK

a. Apply one drop of light engine oil to the breaker arm hinge pin in distributor.

b. Apply two or three drops of light engine oil to the felt in the top of the breaker cam and to the governor weight pivots of the distributor rotor.

c. Clean the engine thoroughly.

d. Tighten all lag bolts holding engine to bed.

e. Check engine alignment. See Paragraph 4, Section II.

f. Check carburetor adjustment. See Paragraph 6, Section VI.

g. Clean and adjust distributor, magneto breaker points. See Paragraphs 1 and 5, Section VI.

h. Oil or replace cam lubricating wicks on magneto. See Paragraph 5, Section VI.

7. ONCE A SEASON CHECK

a. Clean generator commutator. See

Paragraph 3, Section VI.

b. Check generator and starter brushes for wear. If worn replace. See Paragraphs 3 and 4, Section VI.

c. Adjust valve tappets if necessary. See Paragraph 7, Section VI.

d. Remove and clean muffler.

e. Lubricate and repack bearings on magneto. See Paragraph 5, Section VI.

8. THREE THOUSAND HOUR CHECK
At the end of three thousand hours of operation the engine should be completely overhauled. All bearings should be checked for wear, valves ground, piston rings replaced, and the engine thoroughly cleaned.

SECTION VI
MAINTENANCE

1. DISTRIBUTOR MAINTENANCE

a. Removal

(1) Unsnap the two springs holding the cap to the distributor body. Remove the cap.

(2) Loosen the clamping screw at the base of the distributor.

(3) Remove the timing adjusting screw which holds the clamp to the engine block.

(4) Note the position of the distributor in relation to the engine, to facilitate replacement in the same relative position.

(5) Remove distributor from engine.

b. Inspection

(1) Inspect the distributor for cracked, broken, or worn parts and for excessive burning. Replace all defective parts.

(2) Clean all parts with carbon tetrachloride.

c. Adjustment and Replacement of Points

(1) Points which show only a slight discoloration and are not badly pitted should be cleaned with a fine point file and reset for a gap of 0.018 to 0.022 inch. See Fig. 60 (1).

(2) Badly worn or pitted points should be replaced. When replacing points be sure they are properly aligned. Bend stationary arm (2) slightly to align points. Do not bend **breaker arm (3).**

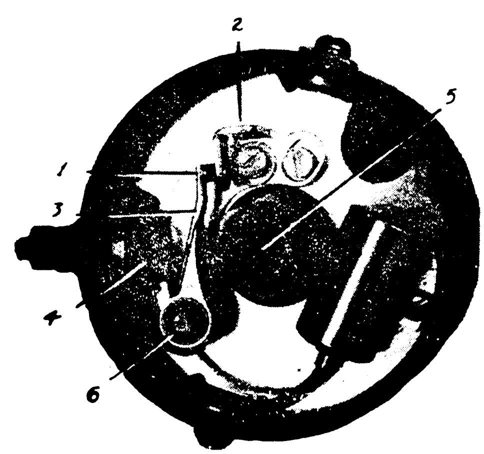


Fig.60 Distributor Body

d. Adjustment of Breaker Arm Spring Tension

(1) Hook a spring scale to the contact end of the breaker arm and hold at right angles to the contact surfaces.

(2) Read the scale just as the contacts separate. Scale reading should be between 17 and 20 ounces.

(3) If the scale reading is not within the above limits, loosen the terminal post, holding the end of the spring (Fig. 60 (4) and slide the end of the spring in or out as necessary.

(4) Tighten terminal post and re-check tension.

e. Governor Adjustment

Since setting of the governor requires special equipment, it should be done only by an experienced service man or by the Universal factory.

f. Replacement on Engine

(1) Replace the distributor in the same relative position as it was when removed.

(2) Replace the timing adjusting screw, but do not tighten.

g. Lubrication

(1) Place one drop of light engine oil on the breaker arm hinge pin. See Fig. 60 (6).

(2) Place three drops of light engine oil on the felt in the top of the breaker cam. See Fig. 60 (5).

(3) Place three drops of light engine oil on the governor weight pivots.

(4) Add three to five drops of light oil to the oiler on the outside of the distributor base.

2. TIMING PROCEDURE

a. The first step is to locate your UNIVERSAL engine model in the following list to determine the location of No. 1 cylinder upon which the whole procedure is based.

Engine Model	Location of No. 1 Cylinder
Blue Jacket Twin	Flywheel End
Atomic Four	" "
Utility Four	" "
Super-Four	" "
Unimite Four	Reverse Gear End
Arrow	" " "
Bluefin	" " "
Marlin	" " "
Tarpon	" " "
Knight	" " "
Little King	Flywheel End
Big King	" "

b. Remove spark plug from No. 1 cylinder.

c. Place thumb over No. 1 spark plug hole in cylinder head and crank engine over until compression pressure is evident.

d. Determining top dead center of No. 1 cylinder compression stroke varies from model to model thus:

Blue Jacket Twin - Turn flywheel in normal cranking direction until marking is lined up with parting line of cylinder block.
Atomic Four - Turn flywheel in normal cranking direction until cranking pin is straight up and down.
Utility Four - Same as above but until pin is horizontal.
Super-Four - Necessary to remove flywheel cover to see timing mark on flywheel. Mark should be located straight up by above procedure.
All Others - All have timing marks to match up on flywheel and flywheel housing.

e. Loosen distributor so it can be lifted up to disengage distributor drive gear. Set distributor so that rotor points to slot in distributor case when distributor drive gear is re-engaged. Rotate distributor body until breaker points are just beginning to open.

f. Tighten clamp holding distributor in position. Engine is now roughly timed.

g. Replace distributor cap on distributor body. No. 1 spark plug wire goes into the connection directly above the flat on the distributor body at which the rotor is aimed. The rest of the wires are inserted in the distributor cap in the proper rotation of firing order going from No. 1 in a clockwise direction.

h. Final setting for peak efficiency must be made with engine running.

i. With engine running at a fixed throttle setting, loosen distributor and rotate to maximum RPM, retighten at that point. Engines having matching timing marks are best adjusted with a timing light.

3. GENERATOR MAINTENANCE

Generators used on UNIVERSAL engines are nonventilated, three brush and shunt types. With the exception of periodic lubrication and occasional replacement of brushes and cleaning of the commutator, no maintenance should be required. If trouble of a major nature is encountered the generator should be sent to the Universal factory for repair.

a. Replacement of Brushes

If brushes should become oil soaked, or have worn to less than one-half their original length, they should be replaced.

(1) Disconnect generator wiring.

(2) On gear driven models, remove bolts holding generator to the timing gear train housing, and carefully pull generator away from housing.

(3) On models belt driven from flywheel, remove belt, remove nut holding generator pulley to shaft, remove bolts holding generator to flywheel housing, and carefully pull generator away from housing.

(4) On models belt driven from water pump, remove belt adjusting screw, belt, and hinge bolt.

(5) Loosen clamping screw and remove head band.

(6) Remove brushes from brush holder.

(7) Place new brushes in brush holders.

(8) Draw a piece of 00 sandpaper between the brushes and in the direction of the brush holder to properly seat the brush against the commutator. See Fig. 61.

(9) Blow out accumulated sand and dust and replace head band.

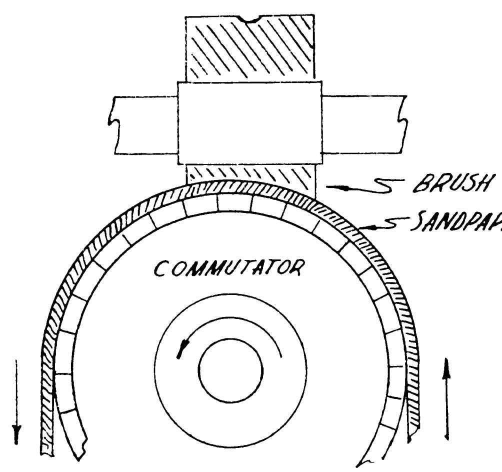


Fig.61 Sanding Distributor Brushes

(10)Replace generator on engine.

(11) On belt driven models adjust position of generator for proper belt tension.

b. Lubrication

The generator should be lubricated every 100 hours of operation. Place three to five drops of light engine oil in the oil cups at each end of the generator. Do not over oil.

c. Cleaning Commutator

(1) Remove generator from engine as described in subparagraph a (1) through (5) above.

(2) Loosen clamping screw and remove headband.

(3) Remove brushes from holders.

(4) Hold a piece of 00 sandpaper against commutator and rotate armature until commutator is clean.

(5) Blow out sand and dust, replace brushes in holders, replace headband, and install generator on engine.

4. STARTER MOTOR MAINTENANCE

With the exception of periodic lubrication and occasional replacement of brushes and cleaning of the commutator, the starting motors used on UNIVERSAL engines will require very little maintenance. Every starting motor is equipped with a Bendix drive which acts as an automatic clutch that engages the starting motor with the engine flywheel when the motor cranks the engine and disengages when the engine starts. This drive should be inspected once each season and worn parts replaced. If trouble of a major nature is encountered the starting motor should be sent to the UNIVERSAL factory for repair.

a. Replacement of Brushes

If brushes have become oil soaked or have worn to less than one-half of their original length, they should be replaced.

(1) Disconnect starting motor wiring.

(2) Remove bolts holding starting motor to flywheel housing.

(3) Remove motor from housing.

(4) Loosen the clamping screw and slide head band off motor.

(5) Remove brushes from holders. If brush lead is riveted to brush holder, remove the rivet. If brush lead is soldered to field coil line, unsolder and bend open the loop on the field coil lead.

(6) Install new brushes. Be sure bevel of brush fits the commutator.

(7) Draw a piece of 00 sandpaper between the brushes and in the direction of the brush holder to properly seat the brush against the commutator. See Fig. 61.

(8) Blow out sand and dust and replace motor on engine.

b. Cleaning of Commutator

(1) Remove starting motor from engine and remove brushes from brush holders as described in subparagraph a (1) through (4).

(2) Hold a piece of 00 sandpaper against the commutator and rotate armature until commutator is clean.

(3) Blow out sand and dust, replace brushes in holders, replace headband, and install starting motor on engine.

c. Bendix Drive Maintenance

(1) Remove starting motor from engine, remove head band and brushes as described above.

(2) Remove the pinion housing holding screws.

(3) Pull armature and pinion housing from the motor.

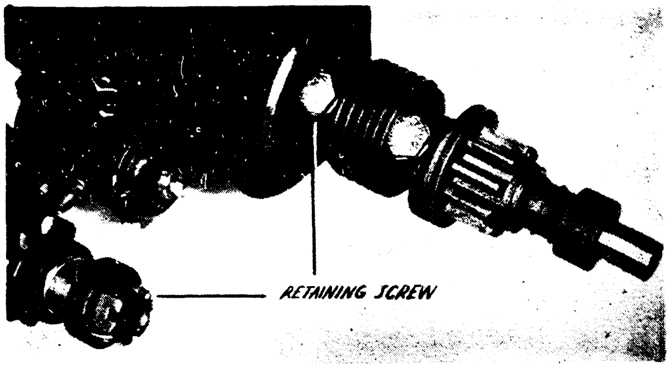


Fig.62 **Bendix Drive**

(4) Press the armature out of the pinion housing.

(5) Remove the Bendix head spring screw (screw nearest armature or on end of shaft), and slide the Bendix from the shaft. See Fig. 62.

(6) Inspect all parts for wear and distortion. Replace all defective parts.

(7) Reassemble and install on engine.

d. Lubrication

The service requirements of this unit are light and it requires very little lubrication. Once each season the motor should be disassembled and the bronze bearings soaked in oil. Some models are equipped with oil holes on the commutator end of the shaft. Three or four drops of light oil every 100 hours of operation placed in this oil hole is sufficient.

5. MAGNETO MAINTENANCE

a. Removal

(1) Pull the ignition wires free of the magneto distributor cap.

(2) Remove the two capscrews holding the magneto to the mounting bracket.

(3) Pull the magneto in a direction away from the drive shaft and lift it from the engine.

b. Inspection and Cleaning

(1) Loosen the screws and remove the end cap from the magneto. Be careful not to damage the gasket between the end cap and the magneto body.

(2) Remove the distributor cap from the end cap.

(3) Inspect magneto for worn or broken parts. Check end and distributor caps for cracks and burned areas.

(4) Replace all worn or broken parts.

(5) Clean all exposed portions of the magneto with carbon tetrachloride.

c. Adjustment of Points, American Bosch

(1) Inspect the points for evidence of pitting or burning. If points are only slightly burned, dress with fine point file. If points are badly burned, replace.

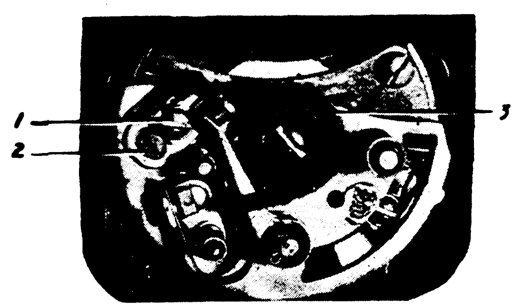


Fig.63 Magneto - American Bosch

(2) Turn the magneto shaft until the cam shoe rides on the highest point of the cam.

(3) Loosen the locking screw (1).

(4) Turn the eccentric adjusting screw (2) until the points are open 0.015". Tighten the locking screw.

d. Adjustment of Points, Fairbanks-Morse

(1) Inspect the points for evidence of pitting or burning.

(2) If points are badly pitted, replace. If pitting is minor, dress with fine point file.

(3) Loosen the two locking screws (1 and 2).

(4) Turn the magneto shaft until the cam shoe rests on the highest point of the cam.

(5) Insert a screw driver in the slot (3) underneath the breaker arm. Turn the screwdriver against the two projections until a separation at the points of 0.015" is obtained. Tighten the locking screws.

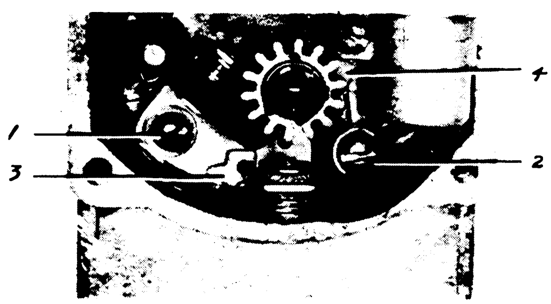


Fig.64 Magneto - Fairbanks-Morse

e. Lubrication, American Bosch (Fig. 63)

(1) Place two drops of light oil on the cam wick (3).

(2) Lubrication of the remainder of the magneto requires special tools for disassembly and should not be attempted by the operator.

f. Lubrication, Fairbanks-Morse (Fig. 64)

(1) If the cam wick (4) is dry and hard, replace with new wick.

(2) Further lubrication of the magneto by the operator is not recommended.

g. Timing, American Bosch

(1) Remove the distributor plate end cap.

(2) Turn the distributor shaft in the opposite direction from its normal rotation until the arrow on the end of the shaft points to the center of cable outlet No. 1.

(3) Crank the engine until piston No. 1 is at the top dead center position. This point is indicated by a mark on the flywheel.

(4) Mount the magneto on the engine.

(5) Loosen the impulse coupling adjustable drive and turn the magneto shaft until the points are just beginning to open.

(6) Tighten the impulse coupling and replace the end cap.

h. Timing, Fairbanks-Morse

(1) Remove the distributor cap.

(2) Turn the magneto shaft until the distributor rotor lines up with the projection on the inner wall of the end cap.

(3) Replace the distributor cap.

(4) Crank the engine until the No. 1 cylinder is at the top dead center position. This position is indicated by a mark on the flywheel.

(5) Mount the magneto on the engine. Be careful not to disturb the setting of the magneto. If necessary loosen the impulse coupling connector and turn it until it is properly aligned.

6. <u>CARBURETOR MAINTENANCE</u>
All UNIVERSAL Marine Engines

covered by these instructions are supplied with Zenith marine type safety non-drip carburetors, except the V-8 models (See special V-8 instruction books.) With the exception of the following adjustments, maintenance of the carburetor by the operator is not recommended. If difficulties arise which are not correctable by the following adjustments, it is recommended that the carburetor be sent to the UNIVERSAL factory for repair or replacement.

a. Adjustment of Throttle Stop Screw, Idle Needle Valve and Main Jet

(1) Before any of the above adjustments to the carburetor are made, the engine should be operated for a sufficient length of time to reach operating temperature.

(2) With throttle in idling position, adjust the throttle stop screw for desired idling speed. See Fig. 65 and 66.

(3) Turn the idle needle valve in and out until the speed of the engine is steady and as fast as this throttle position will permit.

(4) Readjust the throttle stop screw for desired engine idling speed.

(5) Open the throttle approximately one-third.

(6) Loosen the packing nut on the main jet adjustment.

(7) Turn the main jet adjustment screw in until the engine speed is noticeably reduced.

(8) Turn the main jet adjustment screw out until the engine runs smoothly and as fast as this throttle position will permit.

(9) Hold the adjusting screw in place and tighten the packing nut.

(10) Return the throttle to idle position and readjust idle needle valve slightly for best idling performance.

b. Carburetor

The carburetors used on six cylinder gasoline marine engines are the Zenith updraft type with both idling and high-speed adjustments. Each has a large air entrance whose bowl shaped bottom acts as a drip collector with automatic drain.

A properly adjusted carburetor should be left alone.

If the fuel is free from dirt or other impurities, the carburetor should not clog up or give trouble.

We recommend that a large size fuel strainer be inserted in the gasoline line between the fuel pump and carburetor to trap dirt and condensation.

Since a marine engine operates under more or less steady load conditions, it is comparatively easy to adjust the carburetor. To facilitate adjustment of the carburetor it is fitted with an idling jet "A", high speed jet "B", choke "C" and idling adjustment screw "D" as shown in Fig. 68.

When adjusting your carburetor, be sure that the flame arrestor is clean and free of obstructions, and that the choke "C" is wide open. Warm the engine up thoroughly before attempting the adjustment.

With the engine idling turn the idling jet "A" slowly to the right and left until the setting is found that will let the engine idle smoothly and as fast as that throttle setting will permit. Adjust the idling adjustment screw "D" to the

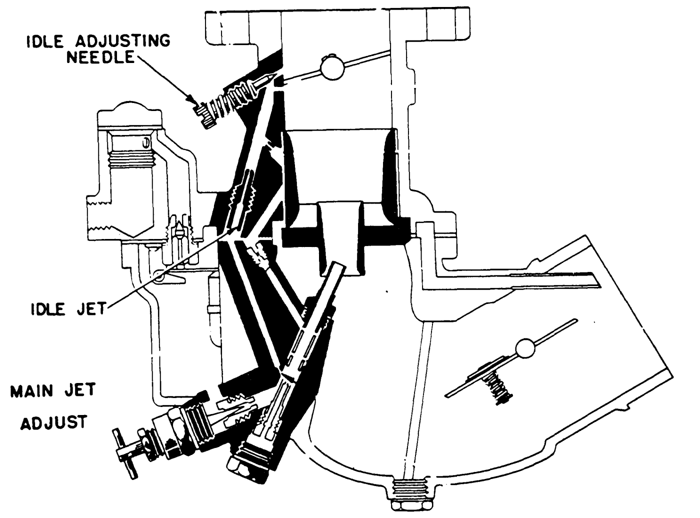


Fig.65 Carburetor - 63M and 263M Series

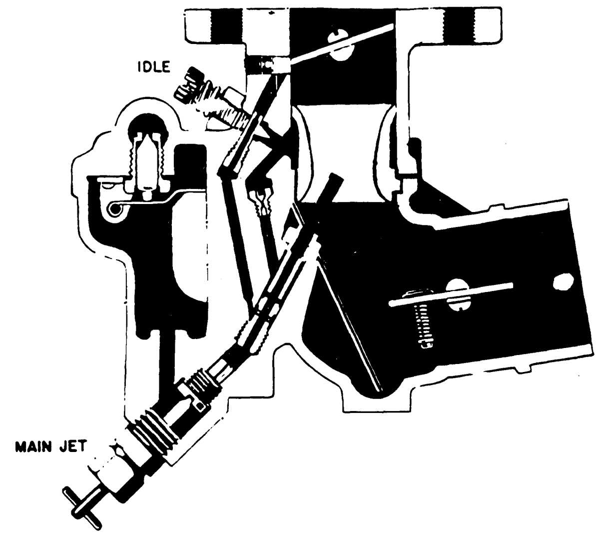


Fig.66 Carburetor - 61M Series

desired idling speed and repeat the adjustment of idling jet "A".

With the boat under way on smooth water, open the throttle approximately 75%. Turn the high speed jet "B" in until the engine loses power and RPM. Now open the jet slowly until the engine runs smoothly and at its highest RPM for this throttle setting.

The carburetor should now be correctly adjusted for smooth operation and maximum power at all speeds. A slightly rich fuel mixture is preferable to a lean mixture as a lean mixture has the apparent effect of reducing the octane rating of the fuel and can result in a tendency toward detonation (ping), burned valves and scored or worn cylinders. Therefore, do not lean out the fuel mixture in an attempt at fuel economy.

Knight engines with serial number 4979 to 6346 were equipped with a fixed main jet carburetor intended to discourage the general tendency to lean out the fuel mixture for economy but which is actually detrimental to the engine. Standard jet size is No. 42 (2.1 mm.) This jet size should be correct for all applications. However, if the operator desires very fine tuning he may try jets varying from size 41 to 44, but not smaller than 41.

At the bottom of the carburetor float bowl will be found a hexagon head brass plug where a variable main jet is usually found on marine carburetors. The main jet is reached by removing this plug. The jet itself is a small, brass threaded cylinder with a shoulder and a screwdriver slot at one end. Remove and install the jet with a screwdriver using care not to damage the jet or the threads in the carburetor bowl casting. The size number is stamped on the end of the jet.

This carburetor, part number 6005 120, has a two-hole idle system that is rather sensitive in adjustment. It will require more care in adjusting the idle jet than with the former Knight carburetor.

The part number of each carburetor model will be found stamped on the small, round brass disc riveted to the carburetor.

The Zenith carburetor supplied on the Model 250, 155 H.P. Knight may require adjustment of the throttle plate stop screw "A" at the full throttle position (See Fig. 69.) This carburetor is somewhat sensitive to the throttle plate positioning in that if it goes slightly past the vertical position, it will upset fuel distribution in the manifold and cause a marked decrease in engine power and speed at full throttle. The carburetor is correctly set on engines tested at the factory, but replacement carburetors will have to be adjusted in the field.

With the carburetor attached and the engine ready to run, loosen the stop screw "A" until it does not contact the stop pin "B" with the throttle lever "C" at the full throttle position as shown in Fig. 69. In this position the cast lug on the throttle lever should touch the stop pin. Now with the engine running at full throttle, close the throttle very slowly and carefully observe the reaction of the tachometer. If the tachometer shows a steady decrease as the throttle is retarded, the stop screw is not needed in adjusting the carburetor. However, if the tachometer first increases to a maximum and then falls off as the throttle is retarded, the stop screw must be used to correctly position the throttle plate as follows: Find the throttle position that will give maximum engine RPM and stop the engine without disturbing the throttle setting. Screw the stop screw in until it just touches the stop pin. Restart the engine and check to see that it will still attain its peak RPM as noted before the adjustment. It would be preferable if the adjustment or setting of the stop screw was made with the engine running, but this is not possible or advisable in many installations.

Always take every precaution against fire hazards when working around your fuel system. Be sure to disconnect batteries; do not turn on flashlights, operate electric switches or turn over the starter or generator.

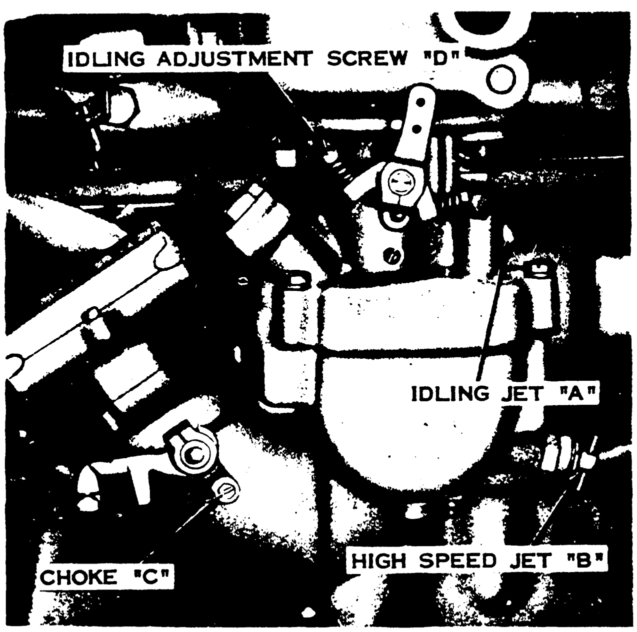


Fig.68 Carburetor - Adjustments

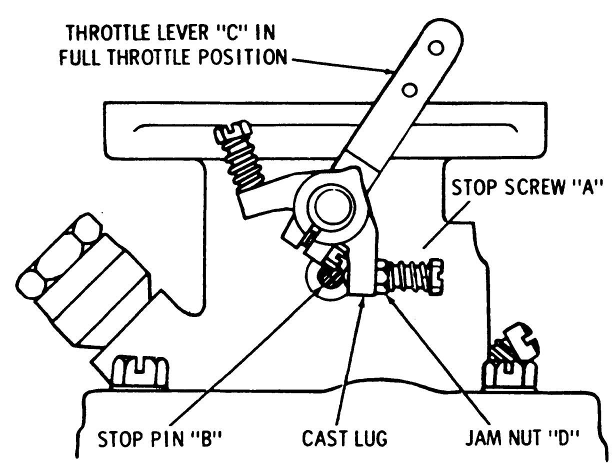


Fig.69 Carburetor - Adjustments

7. VALVE TAPPET ADJUSTMENT

a. Valve tappet adjustments are to be made with the piston on top dead center of the compression stroke with both valves closed.

b. Two types of tappet adjusting screws are used: one is of the self-locking type and the other has a locking nut for holding the adjusting screw in place. Before making the adjustment, this locking nut must be loosened and the adjusting nut held in place when it is re-tightened after the adjustment is completed. See Fig. 70.

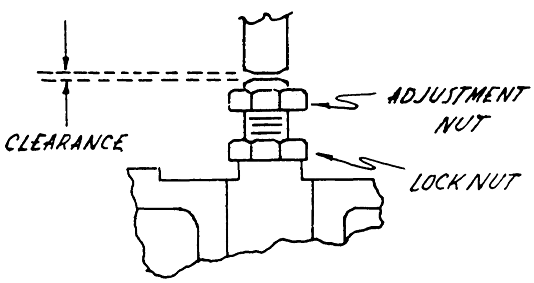


Fig.70 Valve Tappet - Adjustment

(1) Remove the valve cover plate on the carburetor side of the engine. Be careful not to damage the valve plate gasket.

(2) Crank the engine until the piston is in the top dead center position.

(3) Adjust the tappets to the clearance shown in Table 7.

(4) Replace the valve cover. If the gasket is damaged, replace with a new gasket using a good grade gasket cement.

8. REVERSING GEAR ADJUSTMENT, JOES MODEL

a. Forward drive Adjustment

(1) Remove the reversing gear cover plate.

(2) Loosen the screw (2) which holds the clip (3) in the notches cut in the gear case housing until the clip can be lifted out of the notch. See Fig. 71.

(3) Turn the gear case cover clockwise one notch.

CAUTION
Overtightening may cause reverse gear drum to break when shift lever is moved.

(4) Place the clip in the notch and tighten screw.

(5) Repeat the process until the clutch does not slip under full drive of the engine.

(6) Replace the reversing gear cover plate.

b. Reverse Drive Adjustment

(1) Remove the reversing gear cover plate.

(2) Remove cotter pin and slack off adjusting nut (1). See Fig. 71.

(3) Pull operating lever toward reverse position until cam roll rests on cam at point (A), Fig. 72.

(4) Tighten adjusting nut until drum will not revolve with the lever in reverse position and the engine at full power.

CAUTION
Do not adjust so tightly that the cam roll cannot ride out of the notch at point (C), Fig. 72.

9. REVERSING GEAR ADJUSTMENT, PARAGON MANUAL MODEL

a. Forward Drive Adjustment

(1) Remove the reversing gear cover plate.

(2) Back out lockscrew (1) until the end is free of the notch cut in the adjusting collar. See Fig. 74 (A and B).

(3) Turn the adjusting collar clockwise until the lockscrew is opposite the next notch in the collar.

(4) Tighten the lockscrew being sure that the end of the screw enters the notch in the collar.

(5) Repeat the above process until the clutch does not slip with the engine at full power.

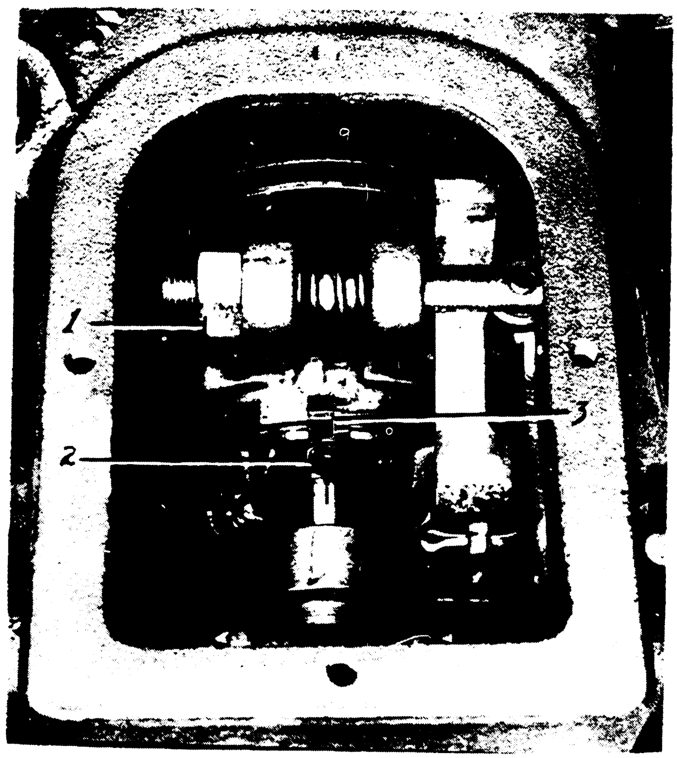


Fig.71 Reverse Gear - Adjustment - Joes Model

b. Reverse Drive Adjustment

(1) Remove the reversing gear cover plate.

(2) Remove the locking wire from the adjusting bolt.

(3) With the engine turning over slowly, move the operating lever to the reverse position. See Fig. 74 (A and B).

(4) Tighten the adjusting bolt (2) until the brake band prevents the gear case from revolving. Turn the adjusting bolt approximately one-half turn past this point to compensate for wear on the brake band.

(5) Replace the locking wire on the adjusting bolt.

10. REVERSING GEAR ADJUSTMENT, HYDRAULIC REVERSING GEAR

The hydraulic reversing gear is designed so that in normal service no adjustments are necessary. As the clutch plates wear, the forward piston compensates for this wear by moving further forward. As the brake band lining wears, the reverse piston moves further down to compensate for this wear.

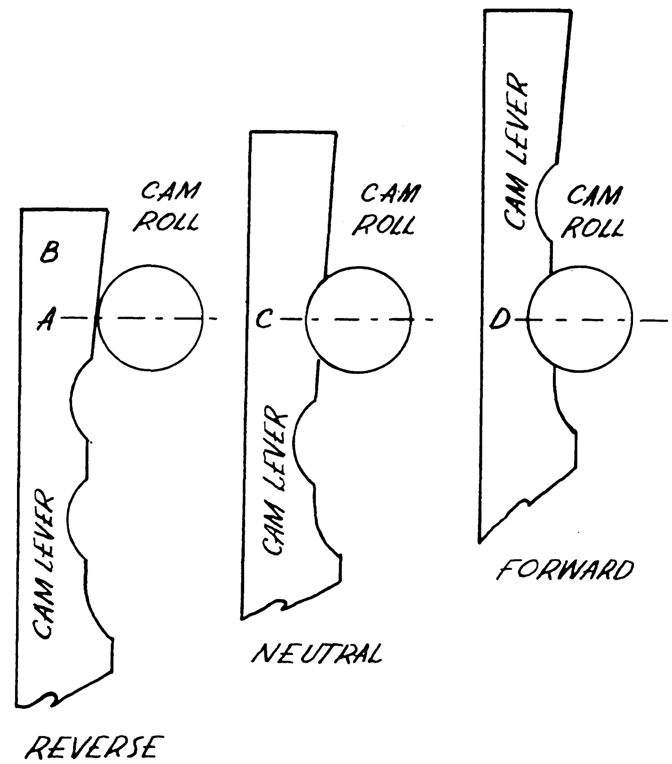


Fig.72 Reverse Gear - Cam Adjustment - Joes Model

11. STA-NU-TRAL MANUAL TRANSMISSION

The adjustments that follow for the Sta-Nu-Tral manual transmission should be made periodically. They are especially important where remote control type of equipment is used for shifting and the operator cannot feel the tension on the clutch.

The transmission is of the planetary type, with which is incorporated a multiple-disc clutch running in engine oil. Tension of the reverse lever "B", Fig. 73, determines whether or not adjustment of the clutch is required.

Adjustment of the clutch in forward motion is as follows: Remove top cover of reverse gear housing. Place shifting fork in the reverse position and pull out spring-loaded pin "A" in after plate of reverse gear and clutch assembly. This plate is threaded into the reverse gear drum. Rotate the end plate in a clockwise direction until pin "A" seats itself in the next adjoining hole in the clutch plate. Try the shifting lever to see if desired result has been obtained. Repeat performance until clutch adjustment is satisfactory.

When adjusting clutch for reverse, set reverse lever "B" in reverse position. Slack off locknut "F" and adjust stop screw "G" until reverse lever remains in reverse position. When this result has been obtained, lock stop screw with locknut. NOTE: This adjustment is made at the factory and is rarely required in the field.

Next, while still holding reverse lever in the reverse position, slack off locknut "C" and screw down on adjusting screw "D" until there is a 1/16" gap under washer "E". When this adjustment has been made, tighten locknut "C".

Anchor bolt "H" is used to center the reverse band evenly about the drum. With the reverse gear in the forward or neutral position the re-

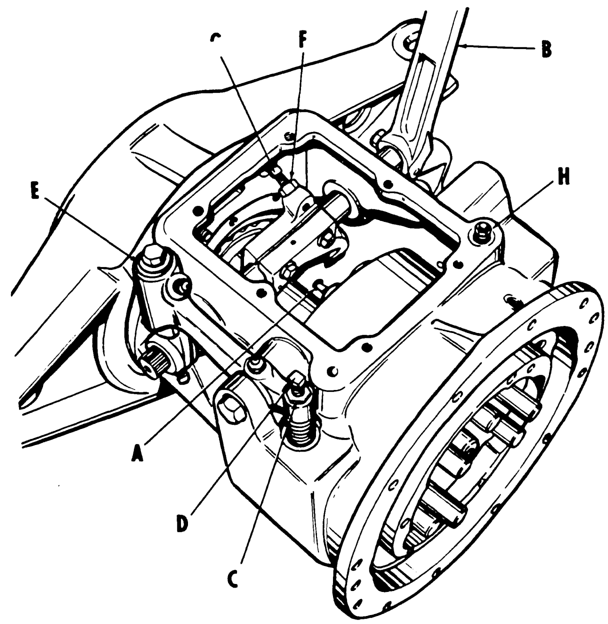


Fig.73 Sta-Nu-Tral - Reverse Gear

verse band should be free of pressure contact with the drum, i.e., you should be able to "wiggle" the band easily with the fingers. If the band is dragging against the drum, it can be raised or lowered slightly by adjusting the nuts on the anchor bolt "H".

12. OIL PRESSURE REGULATOR ADJUSTMENT

The oil pressure regulator is set at the factory for proper pressure and further adjustment should not be necessary. However, if adjustment should become necessary, proceed as follows:

(1) Run the engine until it has reached operating temperature.

(2) Loosen the pressure regulator locking nut. See Fig. 75. Located inside oil pan on six cylinder engines. See Fig. 76.

(3) Hold the locking nut and turn

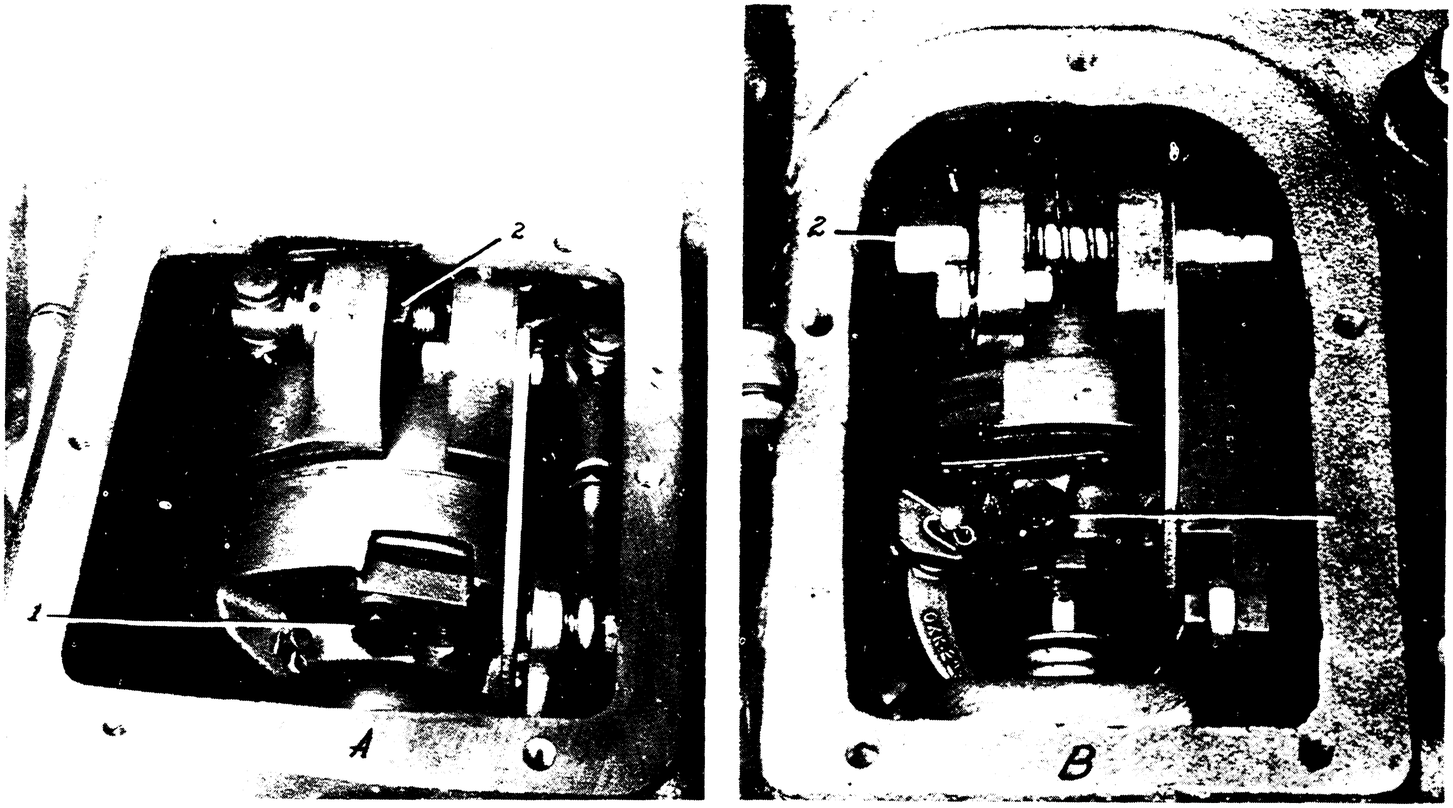


Fig. 74 Reverse Gear - Adjustment - Paragon

the pressure regulating screw in or out until the proper pressure shown in Table 4 is reached.

(4) Hold the regulating screw in place with a screwdriver and tighten the locking nut.

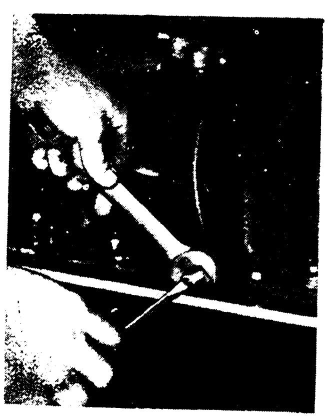


Fig.75 Oil Pressure Regulator - Adjustment

13. SPARK PLUG MAINTENANCE

Spark plugs should be inspected and cleaned from time to time and the gap between the electrodes set for proper clearance. Table 10 gives the proper size spark plug

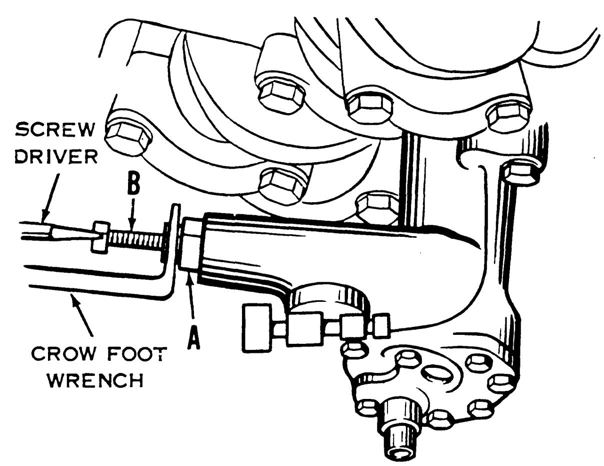


Fig.76 Oil Pressure Regulator - Adjustment

and gap setting for each engine covered by these instructions.

14. FUEL PUMP MAINTENANCE (See Fig.77)

a. Disassembly

(1) Disconnect fuel lines and remove pump from engine.

(2) Loosen nut holding bale to sediment bowl and remove bowl.

(3) Remove screen and gasket.

(4) Remove screws holding primer to bottom of pump.

(5) Remove springs and retaining caps.

(6) Remove spring clips from pin, holding cam lever to diaphragm plunger, and remove pin.

(7) Remove screws holding pump cover to pump body. Be careful not to damage diaphragm when separating cover from pump body.

b. Inspection

(1) Inspect screen for tears and holes.

(2) Inspect diaphragm for cracks, breaks and punctures.

(3) Check diaphragm return springs.

(4) Check cam roll and cam arm for worn parts.

c. Replacement of Parts

(1) Replace all parts which are damaged or show signs of wear.

(2) A special fuel pump repair kit is available from the Universal factory.

d. Assembly

(1) Put diaphragm assembly in place on pump body.

(2) Insert pin securing diaphragm plunger to cam lever.

(3) Replace retaining clips on pin.

(4) Replace primer pump cover. Be sure springs are in place and properly seated on retaining plugs in cover.

(5) Replace pump cover. Tighten all screws evenly and check to be sure diaphragm lies flat and smooth.

(6) Replace screen, gasket and sediment bowl.

(7) Replace fuel pump on engine and reconnect fuel lines.

Table 10
SPARK PLUG DATA

ENGINE	NUMBER (Champion)	SIZE	GAP SETTING
Blue Jacket Twin	D-16M	18 mm.	.025
Atomic Four	J-8	14 mm.	.035
Utility Four	D-16M	18 mm.	.030
Unimite Four	J-8	14 mm.	.035
Super-Four	D-16M	18 mm.	.030
Arrow	J-7	14 mm.	.030
Bluefin	J-7	14 mm.	.030
Marlin	J-7	14 mm.	.030
Tarpon	J-7	14 mm.	.030
Knight	J-7	14 mm.	.030
Little King	UJ-6M	14 mm.	.028
Big King	F-11Y	14 mm.	.033 - .038

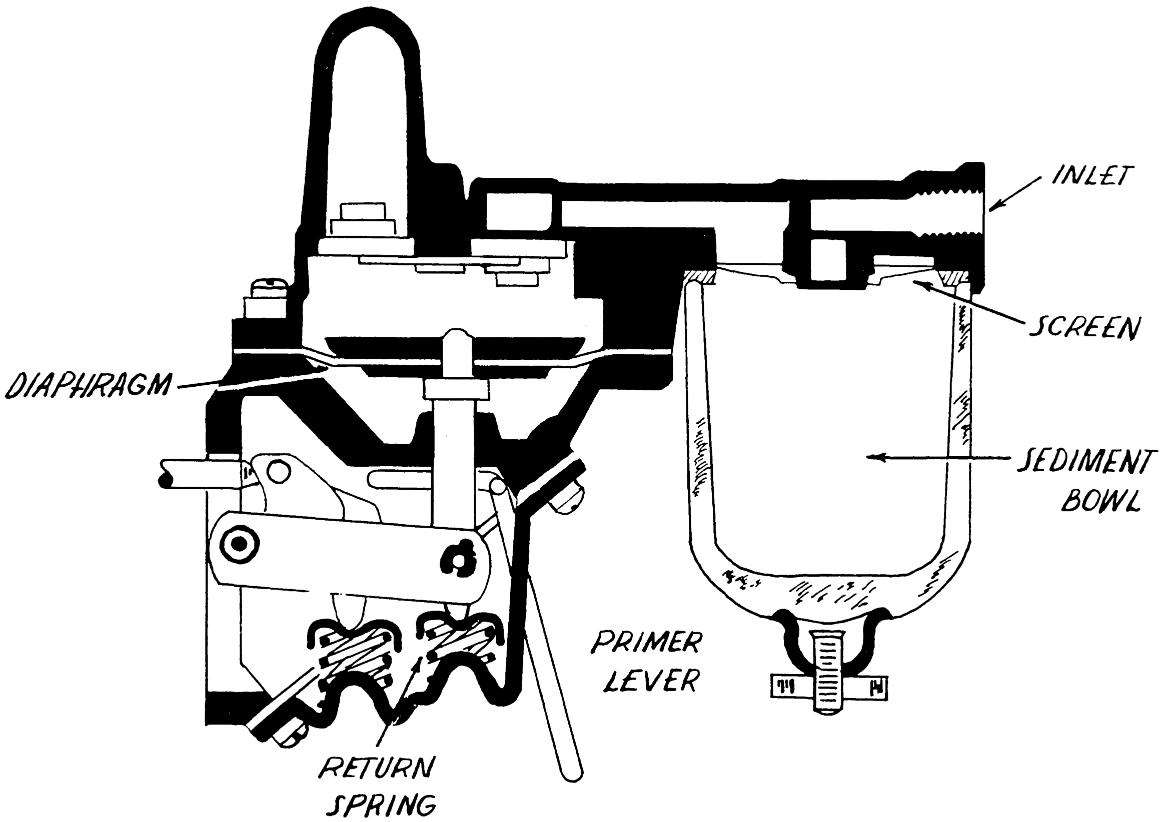


Fig.77 Fuel Pump

15. MAINTENANCE OF V-DRIVE UNITS

a. General

(1) The Universal V-Drive unit is incorporated into the Atomic, Unimite, Bluefin and Knight models, and is designed as an integral part of the engine. The unit is directly coupled to the engine by a spline shaft and coupling.

(2) The V-Drive unit is a self-contained, non-adjustable, water-cooled unit. Water cooling is accomplished by direct connection to the main water supply of the engine.

(3) The unit requires no adjustment and very little maintenance with the exception of proper lubrication and the maintenance of proper water circulation.

b. Lubrication

(1) The unit must be kept filled to the full mark on the bayonet stick. Use a good grade EP-90 universal gear lubricant.

CAUTION

New units shipped from the factory do not contain lubricant. Fill and check unit carefully before starting engine.

(2) After the first 50 hours of operation, drain unit and refill to full mark on the bayonet stick. Clean magnetic drain plug before refilling.

(3) Change lubricant every 500 hours of operation.

16. REPAIR PARTS KIT

A factory packaged repair parts kit is available for all models of engines covered by these instructions. Parts included in the kit have been selected by the Universal Motor Company Service Department based on years of experience in engine maintenance. The kit contains parts most likely to require replacement through normal engine operation. Each part is carefully wrapped in a waterproof wrapping and packed in a convenient size metal box designed for lasting storage.

SECTION VII
TROUBLE SHOOTING

Any gasoline engine depends upon three main factors for proper operation: an unfailing fuel supply, uninterrupted ignition, and good compression. When any one of these is not present or present only intermittently, engine failure will result. The following "trouble shooting" information is designed to help the operator locate and overcome some of the most probable causes of engine failure or improper operation. In Table 6 "Probable Causes" are listed in the most likely order of occurrence. Only one correction should be attempted at a time and that possibility eliminated before going on to the next.

Table 6

TROUBLE SHOOTING PROCEDURES

Trouble	Probable Cause	Correction
Starter will not crank engine	Discharged battery	Charge or replace battery
	Corroded battery terminals	Clean terminals
	Loose connection in starting circuit	Check and tighten all connections
	Defective starting switch	Replace switch
	Starter motor brushes dirty or worn	Clean or replace brushes. See Par. 4, Sec. VI.
	Jammed Bendix gear	Loosen starter motor to free gear
	Defective starter motor	Replace motor
Starter motor turns but does not crank engine	Partially discharged battery	Charge or replace battery
	Defective wiring or wiring of too low capacity	Check wiring for worn or acid eaten spots. See Table 3, Sec.I for proper size wire.
	Broken Bendix drive	Remove starter motor and repair drive. See Par. 4, Sec. VI.
Engine will not start (Defective fuel system)	Empty fuel tank	Fill tank with proper fuel. See Table 5 for fuel oil models
	Flooded engine	Remove spark plugs and crank engine several times. Replace plugs.

Table 6
TROUBLE SHOOTING PROCEDURES
(Cont.)

Trouble	Probable Cause	Correction
Engine will not start (Defective fuel system) (Cont.)	Water in fuel system	If water is found, clean tank, fuel lines and carburetor. Refill with proper fuel.
	Inoperative or sticking choke valve	Check valve, linkage, and choke rod or cable for proper operation.
	Improperly adjusted carburetor	Adjust carburetor. See Par. 6, Sec. VI.
	Clogged fuel lines or defective fuel pump	Disconnect fuel line at carburetor. If fuel does not flow freely when engine is cranked, clean fuel lines and sediment bowl. If fuel still does not flow freely after cleaning, repair or replace pump. See Par. 14, Sec. VI.
	NOTE: On fuel oil-kerosene models, be sure three-way valve is in proper position for starting on gasoline.	
Engine will not start (Defective ignition system)	Ignition switch "off", or defective	Turn on switch or replace.
	Fouled or broken spark plugs	Remove plugs and inspect for cracked porcelain, dirty points, or improper gap. See Par. 13, Sec. VI.
	Improperly set, worn or pitted distributor points. Defective condenser. Defective ignition coil.	Remove center wire from distributor cap and hold within 3/8 inch of motor block. Crank engine. Clean sharp spark should jump between wire and block when points open. Clean and adjust points. See Par. 1, Sec. VI. If spark is weak or yellow after adjustment of points, replace condenser. If spark still is weak or not present, replace ignition coil.
	Wet, cracked, or broken distributor	Wipe inside surfaces of distributor dry with clean cloth. Inspect for cracked or broken parts. Replace parts where necessary.
	Improperly set, worn, or pitted magneto breaker points (Magneto models only)	Remove spark plug wire and hold within 3/8 inch of engine block. Clean sharp spark should jump between wire and block when engine is cranked. If spark is weak or not present, clean and adjust breaker points. See Par. 1, Sec. VI.
	Improperly set, worn, or pitted timer points. Defective coil. (Battery in good condition) (Timer models only)	Remove spark plug wire and hold within 3/8 inch of engine block. A clean sharp spark should jump between wire and block when engine is cranked. Clean and set timer points. If spark still is not present when engine is cranked, replace coil.
	Improper timing	Check and set timing. See Par. 1, Sec. VI for electrical ignition models, Par. 5, Sec. VI for magneto models.

Table 6
TROUBLE SHOOTING PROCEDURES
(Cont.)

Trouble	Probable Cause	Correction
Engine will not start (Poor compression and other causes)	Air leak around intake manifold	Check for leak by squirting oil around intake connections. If leak is found, tighten manifold and if necessary replace gaskets.
	Loose spark plugs	Check all plugs for proper seating, gasket and tightness. Replace all damaged plugs and gaskets.
	Loosely seating valves	Check for broken or weak valve springs, warped stems, carbon and gum deposits, and insufficient tappet clearance. See Par. 7, Sec. VI.
	Damaged cylinder head gasket	Check for leaks around gasket when engine is cranked. If a leak is found, replace gasket.
	Worn or broken piston rings or damaged cylinder walls	Replace broken and worn rings. Check cylinders for "out of round" and "taper"
Excessive engine temperature	No water circulation	Check for clogged water lines and restricted inlets and outlets. Check for broken or stuck thermostat. Look for worn or damaged water pump or water pump drive.
Engine temperature too low	Broken or stuck thermostat	Replace thermostat
No oil pressure	Defective gauge or tube	Replace gauge or tube
	No oil in engine	Refill with proper grade oil. See Table 4.
	Dirt in pressure relief valve	Clean valve
	Defective oil pump, leak in oil lines or broken oil pump drive	Check oil pump and oil pump drive for worn or broken parts. Tighten all oil line connections.
Low oil pressure	Too light body oil	Replace with proper weight oil. See Table 4.
	Oil leak in pressure line	Inspect all oil lines. Tighten all connections.
	Weak or broken pressure relief valve spring	Replace spring.
	Worn oil pump	Replace pump
	Worn or loose bearings	Replace bearings
Oil pressure too high	Too heavy body oil	Drain oil and replace with oil of proper weight. See Table 4.
	Stuck pressure relief valve	Clean or replace valve
	Dirt or obstruction in lines	Drain and clean oil system. Check for bent or flattened oil lines and replace where necessary.

Table 6
TROUBLE SHOOTING PROCEDURES
(Cont.)

Trouble	Probable Cause	Correction
Sludge in oil	Infrequent oil changes	Drain and refill with proper weight oil
	Water in oil	Drain and refill. If trouble persists, check for cracked block, defective head gasket and cracked head
	Dirty oil filter	Replace filter
Loss of RPM (Engine)	Obstructed fuel line, air leak in fuel line, dirty filter or air cleaner, defective fuel pump or carburetor out of adjustment	Correction of these difficulties is covered under "Engine will not start" portions of this table
	Fouled or broken spark plugs, distributor points out of adjustment, or incorrect timing	Correction of these difficulties is covered under "Engine will not start" portions of this table
	Valve tappets out of adjustment, warped or burned valves, worn piston rings, too heavy lubricating oil or leaking cylinder head gasket	Correction of these difficulties is covered under "Engine will not start" portions of this table
Loss of RPM (Boat or associated equipment)	Damaged propeller Bent rudder Misalignment Too tight stuffing box packing gland Dirty boat bottom	
Vibration	Misfiring or pre-ignition	See correction under misfiring and pre-ignition
	Loose foundation or foundation bolts Propeller shaft out of line or bent Propeller bent or pitch out of true	
Pre-ignition	Defective spark plugs	Check all spark plugs for broken porcelain, burned electrodes or electrodes out of adjustment. Replace all defective plugs or clean and reset.
	Improper timing	See Par. 1, 2 and 5, Sec. VI.
	Engine carbon	Remove cylinder head and clean out carbon
	Engine overheating	See correction under "Engine Overheating" portion of this table.
Misfiring	Defective spark plugs, improperly adjusted distributor points, or defective wiring	See correction under "Engine will not start" portions of this table
Backfiring	Insufficient fuel reaching engine due to dirty lines, strainer or blocked fuel tank vent. Water in fuel.	See correction under "Engine will not start" portions of this table.
	Poorly adjusted distributor	See correction under "Engine will not start" portions of this table.

SECTION VIII
REPAIR

1. MAJOR REPAIRS

a. It is not recommended that the operator perform any repairs more complex than those covered under the maintenance section of this instruction book. If repairs of a major nature should become necessary, the engine should be serviced by an authorized Universal dealer or shipped direct to the Universal factory. However, should the operator prefer to make his own repairs, Tables 7 through 9 list proper clearances and torque wrench settings for all models covered by these instructions as an aid in making these repairs.

b. Only genuine Universal parts, specially designed for marine engines, should be used. Repair parts for all models of Universal engines up to 21 years old are available for immediate shipment from Universal dealers or directly from the Universal factory. When ordering parts it is essential that the following information be included with the order.

(1) Model and serial number of the engine.

(2) Part number or full description and sketch of part.

(3) Method of shipment desired: parcel post, express, truck, or rail freight. If freight shipment is desired, give name of truck line or railroad and specify closest freight station.

2. CONCLUSION

a. Our interest in you does not diminish after you have purchased our product. Our claims will always be made good. We agree to give you satisfactory service within the limits of our specifications and are ready at all times to assist you in obtaining satisfaction. Do not hesitate to come to us if you feel that we can be of any assistance. Your inquiries will be promptly answered and you will be advised with care in a manner easily understood. We want every UNIVERSAL owner to be a living, talking advertisement and a friend.

b. We feel that you are willing to do your part and that you will use care and judgment in the running of your engine. Do not expect the impossible, and remember that by using good quality lubricants, by careful attention to detect the first sign of trouble, and by prompt correction of troubles as they occur, the length of life and usefulness of your engine will be greatly increased.

CRANKSHAFT JOURNAL SIZE

MODEL	MAIN BEARING	CONNECTING ROD
Blue Jacket Twin	1.748 +.000/-.001	1.748 +.000/-.001
Atomic Four	1.9880 +.0005/-.0000	1.5625 +.0000/-.0005
Utility Four	1.498 - 1.497	1.498 - 1.499
Super Four	1.9985 +.0005/-.0005	1.9985 +.0005/-.0005
Unimite Four	1.988 - 1.987	1.748 - 1.747
Arrow	2.498 - 2.497	1.988 - 1.987
Bluefin	2.498 - 2.497	1.988 - 1.987
Marlin	2.498 - 2.497	1.988 - 1.987
Tarpon	2.498 - 2.497	1.988 - 1.987
Knight	2.498 - 2.497	1.988 - 1.987
Little King	2.2978 - 2.2988	1.999 - 2.000
Big King	2.899 - 2.900	2.599 - 2.600

Table 7
VALVE AND PISTON DATA

MODEL NAME	PISTON CLEARANCE	PISTON RING GAP	VALVE SEAT ANGLE INTAKE AND EXHAUST	VALVE TAPPET CLEARANCE COLD INT.	EXH.	VALVE STEM CLEARANCE IN GUIDE INTAKE	EXHAUST
Blue Jacket Twin	.0015"	.009 - .014"	45°	.008"	.010"	.0015 - .002"	.0015 - .002"
Atomic Four	.0015"	.007 - .015"	45°	.008"	.010"	.001 - .0015"	.0015 - .0025"
Utility Four	.002"	.008 - .013"	45°	.006"	.008"	.0015 - .002"	.0015 - .002"
Super-Four	.0015"	.010 - .015"	45°	.010"	.012"	.0015 - .002"	.0015 - .002"
Unimite Four	.003"	.015 - .020"	30°	.010"	.010"	.001 - .0015"	.0025 - .003"
Arrow	.0025 - .003"	.015 - .020"	30°	.010"	.014"	.0025 - .003"	.0025 - .003"
Bluefin	.0025 - .003"	.015 - .020"	30°	.010"	.014"	.0025 - .003"	.0025 - .003"
Marlin	.004 - .0045"	.015 - .020"	30°	.012"	.016"	.0025 - .003"	.0025 - .003"
Tarpon	.004 - .0045"	.015 - .020"	30°	.012"	.016"	.0025 - .003"	.0025 - .003"
Knight	.005 - .0055"	.015 - .020"	30°	.012"	.018"	.0025 - .003"	.0025 - .003"
Little King	.0006 - .001"	.010 - .020"	46°	.010"Hot	.020"	.001 - .0027"	.0017 - .0034"
Big King	.0011 - .0029"	.015 - .025"	30° Int. 45° Exh.	.020"	.022"	.001 - .0024"	.001 - .0024"

Table 8
TORQUE WRENCH TENSION
In Foot/Pounds

MODEL NAME	CYLINDER HEAD BOLTS OR NUTS	CONNECTING ROD NUTS	MAIN BEARINGS FRONT & INTER.	MAIN BEARINGS CENTER & REAR	MANIFOLD STUDS	SPARK PLUGS
Blue Jacket Twin	40	40	60	60	35	35
Atomic Four	35	33	60	60	35	30
Utility Four	40	25	60	60	40	35
Super-Four	55	50	100	100	45	35
Unimite Four	40	42	77	77	35	30
Arrow	60	39	70	60		30
Bluefin	60	39	70	60		30
Marlin	65	56	70	60		30
Tarpon	65	56	70	60		30
Knight	65	56	70	60		30
Little King	65	33	65	65	30	23
Big King	95-105	45-50	95-105	95-105	23-28	15-20

Table 9
BEARING DATA

MODEL NAME	CONNECTING ROD CLEARANCE (Diameter)	CONNECTING ROD END PLAY	CRANKSHAFT MAIN BEARING CLEARANCE (Diameter)	CRANKSHAFT THRUST CLEARANCE AT THRUST BEARING	CAMSHAFT BEARING CLEARANCE (Diameter)
Blue Jacket Twin	.0015 - .0025	.002 - .003	.0015 - .0025	.002 - .003	.0025 - .003
Atomic Four	.001 - .0025	.004 - .008	.001 - .0025	.002 - .003	.002 - .0025
Utility Four	.0015 - .0025	.002 - .003	.0015 - .002	.002 - .003	.0025 - .003
Super-Four	.002 - .003	.002 - .003	.002 - .003	.003 - .004	.0025 - .003
Unimite Four	.001 - .0015	.005 - .010	.002 - .0025	.002 - .004	.0015 - .0025
Arrow	.0015 - .002	.005 - .010	.0015 - .003	.002 - .004	.0015 - .0025
Bluefin	.0015 - .002	.005 - .010	.0015 - .003	.002 - .004	.0015 - .0025
Marlin	.002 - .0025	.005 - .010	.0015 - .003	.002 - .004	.0015 - .0025
Tarpon	.002 - .0025	.005 - .010	.0015 - .003	.002 - .004	.0015 - .0025
Knight	.0025 - .003	.005 - .010	.0015 - .003	.002 - .004	.0015 - .0025
Little King	.001 - .004	(2).008 - .014	.001 - .004	.002 - .006	.0015 - .0035
Big King	.0006 - .0026	.005 - .015	.0009 - .0029	.004 - .008	.001 - .003

Table 11
VALVE TIMING

MODEL NAME	INLET VALVE OPENS	INLET VALVE CLOSES	EXHAUST VALVE OPENS	EXHAUST VALVE CLOSES
Blue Jacket Twin	5° after TDC	45° after LDC	40° before LDC	TDC
Atomic Four	5° before TDC	50° after LDC	45° before LDC	10° after TDC
Utility Four	5° after TDC	45° after LDC	40° before LDC	TDC
Super-Four	5° after TDC	55° after LDC	50° before LDC	TDC
Unimite Four	5° before TDC	55° after LDC	45° before LDC	15° after TDC
Arrow	5° before TDC	55° after LDC	45° before LDC	15° after TDC
Bluefin	5° before TDC	55° after LDC	45° before LDC	15° after TDC
Marlin	5° before TDC	55° after LDC	45° before LDC	15° after TDC
Tarpon	5° before TDC	55° after LDC	45° before LDC	15° after TDC
Knight	5° before TDC	55° after LDC	45° before LDC	15° after TDC

TDC means TOP DEAD CENTER
LDC means LOWER DEAD CENTER
See Table 7 for Valve Tappet Clearance

SECTION IX
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