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HELPING THE HUNDRED-THOUSANDER DRIVER

Central Drivers Club of Moscow City

by

Engineer D.M.Levin, and Driver P.F.Ogloblin

WINTER OPERATION OF AUTOMOBILES

MASHGIZ

State Scientific and Technical Publishing House

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This book gives the basic rules of winter operation of automobiles, the operating conditions of the individual units and mechanisms of automobiles in winter, and the necessary measures to maintain their efficiency.

It gives recommendations on the use of the fuels, oils, greases, coolants, and brake fluids designed for winter use and indicates their effect on the operation of the automobile. It presents methods of facilitating the starting of a cold engine, and discusses the features of driving an automobile in winter.

The book is written for drivers of class I, II, and III and may be used as a textbook for amateur drivers and the junior technical personnel of automobile transportation enterprises.

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PREFACE

The mass production of automobiles of modern USSR makes and the extensive development of the Stakhanovite movement in automobile transport has prompted the Moscow Central Drivers' Club and the State Scientific and State Publishing House Mashgiz to arrange for the publication of a series of books "Helps to the Hundred-Thousander Driver".

Each book covers questions connected with the operation of one of the new makes of Soviet automobiles or is devoted to a detailed discussion of some problem of the technical operation of automobiles or of the economics of truck transportation and of drivers' labor unions. The books are intended to help drivers to raise their cultural and technical level and improve their economic knowledge, as well as to attain high productive results.

The authors of each book are government-employed engineers and Stakhanovites of automobile transportation organizations. The Stakhanovites contribute their advanced experience to the book and guide the discussion of the material to make it accessible to the driver. Their co-authors, the engineers, supplement and edit the materials in accordance with data of science and technology.

The manuscripts prepared in collaboration with workers of science and production are then given a preliminary review and are discussed at conferences of activist truck drivers and technical-engineering workers. The authors took the principal comments made by the participants in the discussion into account in the final drafts of the manuscripts.

The series of books "Helps for the Hundred-Thousander Driver" are being issued with the participation of an editorial board consisting of Comrades L.L.Afanas'yeva, V.V.Broksh, B.V.Lavrovskiy, and D.V.Pingatet.

This book, written by Engineer D.M.Levin (TsNIIAT) and I.F.Loginov, driver of the First Bus Depot of Moscow City, gives the experience and recommendations on operating automobiles in winter.

The Central Drivers Club of Moscow City and the Mashgiz Publishing House asks readers to send their comments and criticisms of this book to the Editorial Board, addressing: Moscow, Novo-Ryazanskaya ul., 26, Central Drivers' Club.

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INTRODUCTION

The operating conditions of automobiles in winter differ substantially from those in summer.

At low temperatures, strong winds, snow drifts, when layers of ice and mud form on the roads, there are many difficulties in the operation of automobiles.

When the automobile is parked in the open, without a garage, and also after prolonged standing on the line, the starting of a cold engine is difficult because of congealing of the oil, interference with proper formation of a combustible fuel mixture, and poorer spark formation (in carburetor engines). On icy and snow-covered roads, travel at high speed is difficult. Unplowed country roads become difficult for an automobile to pass.

In winter, more fuel is consumed than in summer, because of improper formation of the fuel mixture, increased heat losses of the engine, increased viscosity of the oil in the engine, transmission units, and chassis, and also because of the poorer traction between tires and road.

The parts wear out faster at lower engine operating temperatures, and during starting.

During long parking there is danger that the water in the engine cooling system and the electrolyte in the storage battery will freeze. If the driver is not careful enough, this may lead to complete breakdown of the radiator, cylinder block, and cylinder heads; storage batteries frequently fail because of freezing of the electrolyte.

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The work conditions for the driver are likewise impaired, due not only to the above conditions but also due to the fact that daylight is considerably shorter and the visibility in driving poorer.

Inexperienced drivers who have not properly conditioned their automobile for winter operation have an additional difficulty: The need for making repairs in the cold, and often in the wind and snow, when trouble occurs on the road (as shown by experience, trouble occurs more often in winter with poorly conditioned cars).

However, the extensive experience of Hundred-Thousander Drivers shows that under severe winter conditions, the use of modern technical measures and strict observance of the rules of winter operation will permit high quotas of fulfilling the Transportation Plan, dependable and trouble-free operation of the automobile, considerable saving in fuel, and long runs between overhauls.

The experience of Hundred-Thousander Drivers under conditions of a winter lasting 240-270 days, at a temperature of -70°C on some days, may serve as an example of such work.

For example, M.Ye.Semenyura, Hundred-Thousander Driver, working on a ZIS-150 truck, had the following productive indexes for nine months of work, including one winter:

Coefficient of truck utilization	0.76
Mean monthly productivity of truck in ton-kilometers	16 600 (175% of Plan)
Mean monthly fuel saving, in liters	228
Mean daily run, in km	185

These indexes indicate that, Comrade Semenyura, under severe climatic conditions, still achieved fulfillment of the Plan, obtained saving in equipment and materials; despite this fact, the results of his work were not inferior to those of many drivers, working under considerably milder climatic conditions.

A socialist attitude toward work, knowledge of the latest achievements of

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Soviet automobile technology, initiative, inventiveness, and exchange of experience, give brilliant results in the work of the advanced workers in automobile transport.

In their practical work, Hundred-Thousander Drivers are guided by the historical speech of Comrade Stalin at the First All-Union Conference of Stakhanovites:

"Now, let us look at the Stakhanovite comrades. What sort of people are they? They are mainly young or middle-aged working men and women, well-trained people and technically skilled, showing exemplary precision and accuracy in their work, who know how to evaluate the time element in work and who have learned to figure time not only in minutes but even in seconds. Most of them have had what is called minimum technical education and continue to supplement their technical training. They are free from the conservatism and stagnation of certain engineers, technicians, and managers; they march boldly forward, surpassing the obsolete work norms and setting up new and higher ones. They introduce corrections into the planned power and into the economic plans drawn up by the leaders of our industry, and they supplement and guide the engineers and technicians. Often they teach them and prod them, since they are people who have fully mastered the technique of their work and who know how to extract from technology the maximum obtainable" (Bibl.20).

This book, one of the series "Helps for the Hundred-Thousander Driver", uses the experience of advanced drivers, the recent accomplishments of Soviet automotive technology, the work of the Central Research Institute for Automobile Transport (TSNIAAT), and many other data.

Besides giving practical advice as to maintainance of reliable operation of the truck in winter, particular attention has been paid to explaining the causes responsible for the difficulty of winter operation. In the authors' opinion, this will make it possible for a driver who has assumed the socialist obligation of becoming a Hundred-Thousander to understand the essential nature of the phenomena taking place in an automobile in winter, and will enable him to manifest initiative in improving his methods and technique of servicing and driving an automobile under dif-

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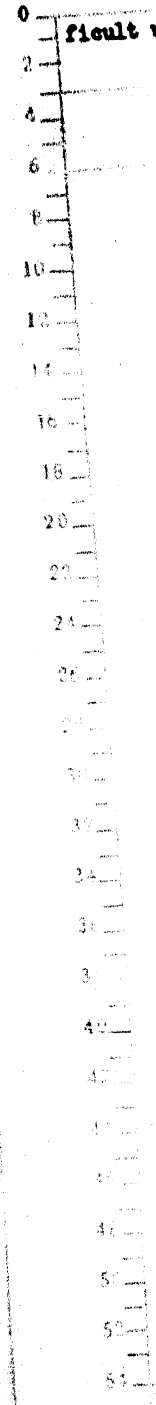
ficult winter conditions.



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PREPARATION OF THE AUTOMOBILE FOR WINTER OPERATION

Procedure in Preparing the Automobile for Winter

In winter all troubles and disorders of an automobile are considerably more frequent, and usually lead to more unpleasant consequences, than in summer.

Increased wear of the crankshaft bearings is dangerous in automobile operation during any time of the year. In winter, increased wear may lead to even more rapid failure of these parts.

For example, in starting a cold engine, so long as the oil has not warmed up and is not supplied to the clearance in sufficient quantities, the bearings will run with an inadequate amount of lubricant, or even entirely without it. This may result in rapid wear, and in some cases the bearings and crankpins may be ruined (by seizing).

When the cylinders, piston rings, and pistons are badly worn, with unadjusted clearance between the valves and the push rods, the engine usually starts less easily than when these parts are in good order. In winter, when it is difficult enough to start a cold engine even without this, defective conditions that make starting even more difficult are impermissible.

Various troubles in the electric equipment are more frequent in winter than in summer. Slight current leaks or loosening of electric contact in the low-voltage circuit may remain unnoticed in summer, but in winter, when the capacity of the storage battery drops and the spark, in starting the engine, is weaker, such leaks make it hard to start the engine. Current leaks in the high-voltage circuit are

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still more troublesome. Trouble in the ignition, generator, or lighting system, not corrected in time, may cause long halts on the road, and in many cases may make it necessary to call for technical assistance and have the automobile towed to a garage.

Such examples might be continued indefinitely, but those given above are enough to warrant the conclusion that trouble or increased wear of individual parts will lower the reliability of operation of an automobile more in winter than in summer. For this reason, before beginning the specific preparation of the vehicle for winter operation, the general condition of the working parts and mechanisms must first be checked, and, wherever necessary, the required overhaul and adjustment must be done.

The specific preparation of an automobile for winter operation has the object of ensuring its reliable operation and travel on winter roads. It is designed to facilitate the starting and running of a cold engine, to save fuel, to reduce the wear on parts, and to eliminate the possibility of freezing of the cooling system and storage battery.

For this purpose, the cooling system, fuel supply system, and engine lubrication system must be checked and prepared for winter, and the engine warmed up. The parts of the transmission system must be flushed and the oil changed, and the steering wheel, brake mechanism, and chassis checked and adjusted. Particular attention must be paid to the electric equipment and storage battery. The condition of the cab in trucks and the body of light automobiles must also be checked and the windshield wipers adjusted.

All the above measures relate merely to the preparation of the automobile itself, and do not include additional equipment for facilitating starting of the cold engine and increasing the road ability and safety on winter roads.

The Engine Cooling System

The temperature of the engine, which, particularly in winter, has an important effect on fuel consumption and the wear of parts, depends to a considerable extent on the good condition of the cooling system. With the cooling system in good order

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the engine does not overheat and will not be overcooled, and the temperature of the water leaving the engine is kept constant at the level of 80-90°C.

The following are the principal troubles that most often affect the normal operation of the cooling system: clogged cooling system, extensive scale formation, leakage of the coolant in the flexible hose, incorrect adjustment of the fan belt, incorrect operation of the thermostat.

As the engine operates, the cooling system becomes clogged with various water-deposited impurities and with rust, which interferes with normal circulation of the liquid. When working with hard water, scale is deposited on the radiator walls and in the engine water jacket. Scale not only impairs the circulation of the liquid in the system, but also decreases the effectiveness of the engine coolant, since its thermal conductivity will be lowered.

As a result of the fouling of the cooling system and of the deposit of scale, the circulation of the liquid is impaired, causing the engine to overheat, while the radiator will become overcooled. In summer this leads to a drop in engine power and excessive fuel consumption, while, in winter, it also may result in freezing of the water in the radiator.

It is therefore desirable to change the water every two or three months, and before beginning winter operation it is compulsory to flush the cooling system.

If the scale deposits are not extensive, the system is flushed with water. The best procedure is to flush the radiator, engine water jacket, and body heating system separately, by passing a stream of water through these parts for 10-15 min. in a direction opposite to that of normal circulation, as shown in Fig.1.

Still better results may be obtained by injecting compressed air under a pressure of 1.5-2.0 atm (no higher) together with the water. A special cap is used for this purpose. One hose for the water from the water line and another hose for compressed air from the compressor are attached to this cap; a set of special extension hoses, used only for flushing the cooling system, must also be provided.

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In the engines GAZ-51, ZIS-150, GAZ M-20, ZIS-110, in order to obtain uniform cooling of the cylinder block, the water is supplied from the pump to a water manifold provided with slits facing the exhaust valves. On each flushing of the cooling system, this manifold must be cleaned with wire hooks or go-devils. If the pipe is badly clogged or rusted, it must be removed from the block and, depending on its condition, either thoroughly cleaned or replaced by a new one. If no ready-made pipe is available, it can be assembled from a sample or from a drawing, using galvanized, lead-coated or tinned sheet iron 0.5-0.8 mm thick.

If there are considerable scale deposits in the cooling system, the deposits must be loosened and partly dissolved before flushing. For this, a heated solution consisting of 750-800 gm of caustic soda and 150 gm of kerosene per 10 liters (one tub) of water is filled into the cooling system and left for a few hours, usually overnight. In the morning, the engine is started and run until thoroughly warmed up. The solution is then drained and the system flushed with pure water and scavenged with compressed air, as indicated above.

The use of caustic soda solution to softening scale in engines with a cylinder head of aluminum alloy is impermissible. In particular, the Gor'kiy automobile plant forbids flushing the GAZ-51 and GAZ M-20 engines with alkali solutions, since the aluminum cylinder heads of these engines may be damaged. In such engines, scale can be removed from the radiator with this solution only if the radiator is first disconnected from the engine block. The scale can be removed from the water jacket of the cylinder block only when the engine is disassembled for overhaul.

After flushing the cooling system and removing the scale, an extremely careful inspection must be made for water leaks and their location.

Leaks of liquid make up 30-35% of all cases of cooling-system trouble. Practice shows that in winter about 50% of the coolant losses from the system during the operating time of an automobile are due to leaks through loose hose connections and water pumps, cracks and damage to the soldered spots in radiators, etc., while

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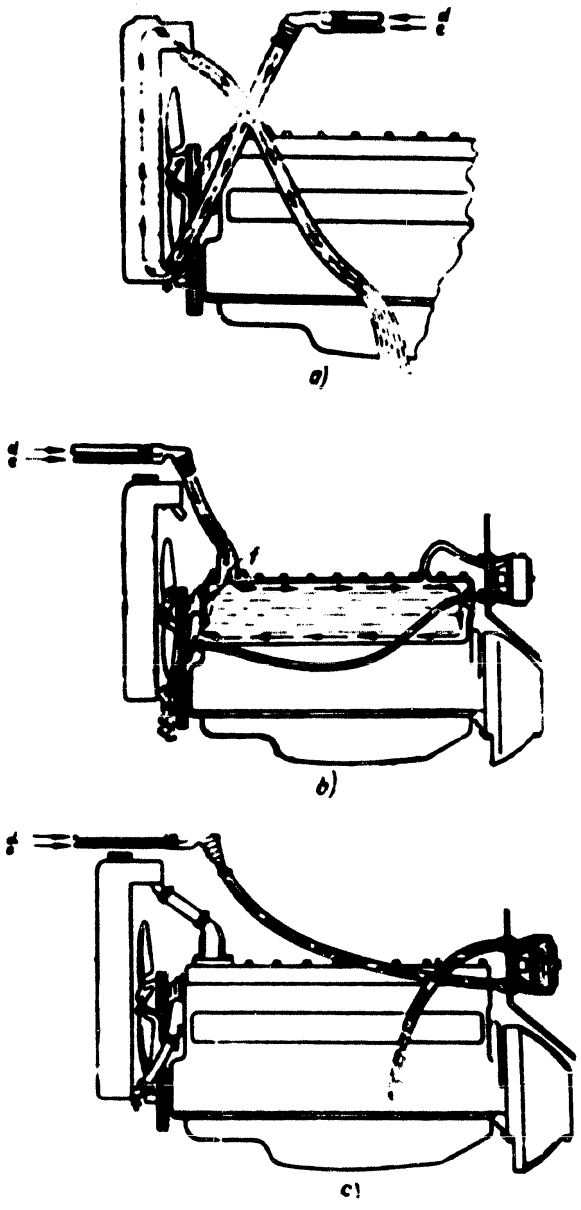

Fig.1 - Diagram for Flushing the Cooling System

a) Flushing the radiator; b) Flushing the engine water jacket; c) Flushing the heating system of the body; d) Water; e) Air; f) Thermostat removed.

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40-45% escapes through the inspection pipe or the valve of the radiator plug when the water forms a deposit due to engine overheating, and that only an insignificant amount is lost by evaporation. Thus, when leaks in the cooling system are entirely absent, and the driver maintains the required temperature with a running engine, the leaks of coolant and, consequently, the quantity of liquid that must be added to the radiator, may be very insignificant.

On the other hand, considerable leaks from the cooling system while the automobile is running will cause a drop in the coolant level, which interferes with normal circulation of the liquid and, at very low levels, may lead to overheating the block and cylinder head and to overcooling; in very cold weather, this may also lead to freezing of the water in the radiator, especially at the bottom. It is more convenient to find the water leaks when the engine is cold, since, when it is hot, a slight leak may pass unnoticed, owing to the rapid evaporation. Some spots in the cooling system are hard to reach for direct inspection, and it is therefore advisable to leave the automobile overnight in a clean place in the garage, and then check the floor for traces of leaks in the morning.

Leakage of water through the stuffing boxes of the water pump is often observed.

In the engines ZIS-5, GAZ-M, leaks in the water pump are eliminated by tightening the stuffing nuts. If further tightening does not eliminate the leak, the packing of the stuffing box must be changed.

The engines GAZ-51, M-20, and ZIS-120 have a self-tightening stuffing box on the water pump, consisting of a rubber cup with strips, textolite disks, and a compression spring (Fig.2). The stuffing-box parts are interchangeable in the ZIS and GAZ automobiles. Leaks with this design of stuffing box result mainly from wear of the textolite disks and are detected by the escape of water from the inspection hole (16) in the barrel of the pump. This leakage cannot be stopped by wetting the insulating strip, since water would reach the fan bearings and ruin them. To stop the leakage, the water pump must be removed and disassembled and the textolite disk

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and rubber cup replaced. If the textolite disk is only slightly worn, it may be used further by placing the unworn side toward the face of the barrel. Disassembly and reassembly of the water pump require great care, the use of a stripper for the fan boss and a hand press for removing and inserting the fan shaft, and must therefore be done in the shop.

The so-called "internal" leaks through a damaged gasket or crack in the inner wall of the water jacket (Fig.3) constitute a still greater danger for the engine.

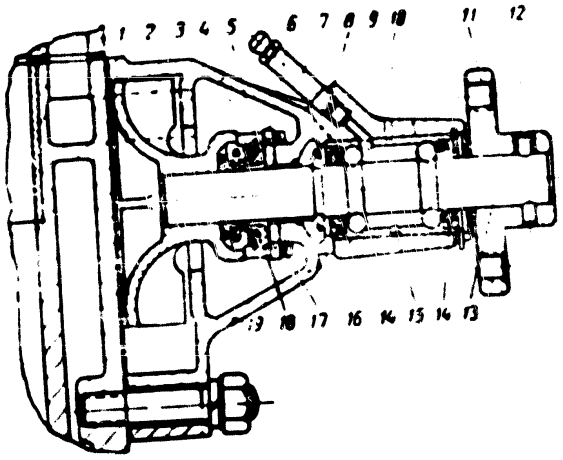

Fig.2 - Water Pump of the M-20 Automobile

1) Cylinder head; 2) Bypass for water to reach the pump with the thermostat valve closed; 3) Impeller of pump; 4) Stuffing-box spring; 5) Rubber cup of stuffing box; 6) Textolite sealing disk of stuffing box; 7) Oil shutter; 8) Water catch ring; 9) Bearing; 10) Opening for checking lubricant leaks from pump barrel; 11) Fan boss; 12) Pin; 13) Shaft of water pump; 14) Stuffing boxes; 15) Opening for checking lubricant leaks from bearing strips; 16) Opening for checking water leaks through stuffing box; 17) Check ring of stuffing box; 18) Hoop of stuffing box; 19) Water-pump barrel.

If penetrated into the combustion chamber, water or antifreeze makes it extremely

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difficult to start the engine, and if the quantity of water is considerable, starting is impossible. When reaching the cylinder walls and entering the crankcase, water forms an emulsion with the oil, leading to increased wear of the engine parts. Internal leaks can be detected from the presence of water drops on the sparkplugs and in the crankcase oil. To locate the place of a leak accurately, the engine must be disassembled. In the best case, the job can be limited to changing the gasket of the cylinder head. In the case of a cracked block or head of the block, the part must in most cases be exchanged. If the cracks are small, an emergency measure of some automobile mechanics is to fill the cooling system overnight with a weak solution of copper sulfate which coats the crack with a thin layer of copper. But this method does not give good results in all cases, since the copper is deposited only on the fresh (still unoxidized) surfaces and since the incipient crack may continue to grow. Small external cracks in the block may be repaired by welding, bonding, insertion of a wedge, or by coating with a litharge-glycerol paste.

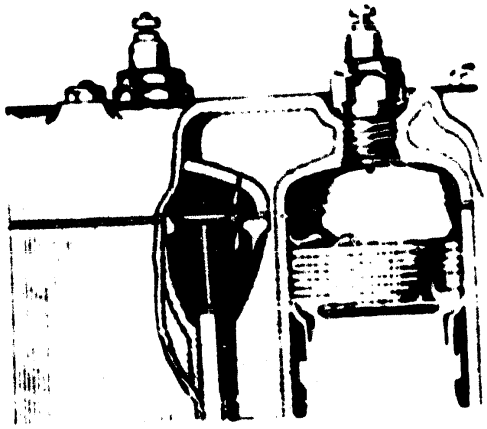

Fig.3 - Internal Leaks of Coolant in Engine.

If the fan belt is loose, the circulation of liquid in the system may be poor and its cooling in the radiator may be insufficient. In operation, the fan belt loosens and begins to slip. Besides impairing the circulation of water and reducing the flow of cooling air through the radiator, a slipping fan belt also diminishes the generator charging current.

The fan belt in the automobiles GAZ-MM, GAZ M-1, GAZ-51, "Pobeda" and ZIS-120 is adjusted by moving the generator, while on the ZIS-5, ZIS-16, and YaG-6 the adjustment is made by a screw installed in a bracket and screwed into the fan shaft. When the fan belt is squeezed by

the thumb midway between the pulleys (with a force of 3-4 kg), the belt should bend by 12-20 mm on the GAZ engines and by 10-15 mm on the ZIS and YaAZ engines. Excessive tightening is also harmful, since it increases the wear of the fan and of the fan and generator bearings. Oil on the fan belt must be wiped off with a rag or cotton waste, moistened with gasoline.

At the same time the fan belt is checked, the condition of the fan blades and the firmness of their attachment to the boss, as well as the clearance between the shaft and bearings, should also be checked, and, if necessary, proper adjustment or repairs should be made.

The cooling system of the GAZ-51, ZIS-120, "Pobeda", ZIS-110, and YaAZ-204 engines are equipped with a thermostat which automatically regulates the circulation of coolant according to its temperature. Figure 4 is a diagram of the installation and mechanism of action of the engine thermostat. It consists of a hermetically soldered corrugated brass cylinder (1), filled with a mixture of ethyl alcohol and water and soldered to the bracket (2), which is attached to the body of the thermostat (3), and the valve (4) connected with the cylinder by the rod (5). At a low temperature, the thermostat cylinder is compressed, and the valve is held against the body. The coolant liquid in this case passes from the engine water jacket through an opening in the upper part of the thermostat valve and through the pass in the cylinder head and cylinder block into the water pump, without entering the radiator.

As soon as the coolant is warmed to a temperature of 68-72°C, the thermostat cylinder, under the action of the expanding vapor of the liquid, begins to expand, raising the valve and permitting the liquid to flow from the engine to the radiator; at 80-86°C the valve will open completely.

With the thermostat operating properly, there will be rapid warming of the coolant after the engine is started as well as constant maintainance of normal temperature in the engine during operation. Some drivers, fearing that in very cold

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weather, the water in the radiator may freeze while the engine is warming up, remove the thermostat before the winter season. They should not do this; when the engine is well warmed up, a point that will be discussed below, overcooling of the radiator and freezing of the water can be avoided, and if low-temperature coolants are used,

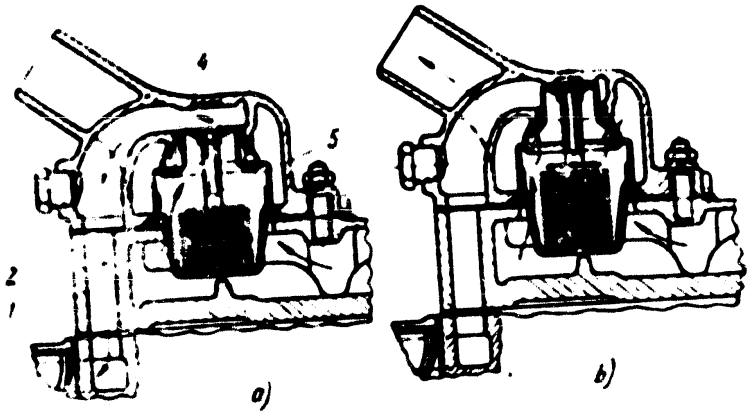

Fig.4 - Diagram of Installation and Action of Thermostat:

a) Valve closed; b) Valve open.

1 - Cylinder; 2 - To yoke; 3 - Body; 4 - Valve; 5 - Rod.

the danger of freezing is entirely eliminated.

The simplest check on thermostat operation may be made by touching the radiator: When the engine is warming up, the radiator should be cold; when the warming up is completed, with the pointer of the water temperature indicator in the engine water jacket approaching 80°C, the upper tank of the radiator will be hot to the touch.

Proper functioning of the thermostat can be checked more accurately by heating it in a vessel with water, as shown schematically in Fig.5.

Leaving the thermostat in its position, it must be inspected for integrity of its parts and firmness of the soldering. Dirt and scale must be cleaned off with a wooden rod, and straight position must be checked. Insertion of a rubber gasket

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between the guide valve of the thermostat and the branch pipe of the cylinder head is compulsory.

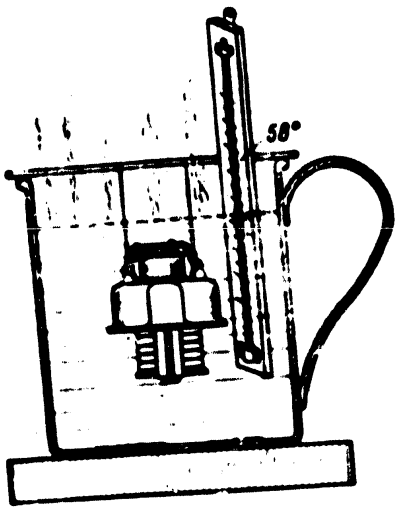

Fig.5 - Checking the Thermostat for Proper Functioning by Heating it.

The cooling system of the engines GAZ-51, "Pobeda", and ZIS-120 is airtight, i.e., does not communicate with the atmosphere. This is ensured by a suitable design of the radiator plug, which has two valves: an outlet valve, opening when the pressure in the cooling system rises 0.25 to 0.35 above atmospheric, and an inlet valve, which prevents overpressure in the radiator on condensation of vapor in the system, and opens at a vacuum of 0.2 atm.

The airtight cooling system makes it possible to raise the engine temperature, since the contained water will start boiling only when heated to 108°C. If the engine is not overheated, however, there will be no boiling nor losses of water. The valves of the radiator plug operate properly only if a fiber gasket is inserted in the radiator neck, and a rubber gasket in the barrel of the plug. These gaskets must be periodically inspected.

Warming the Engine

Proper warming of the engine and correct adjustment of the quantity of cold air entering through the radiator makes it possible, even in very cold weather to maintain the temperature of the air in the space unde the hood at around 30-40°C when the automobile is running. This ensures good quality of the fuel mixture arriving at the engine cylinders.

In addition, a heated engine freezes considerably more slowly, and therefore

it is impossible to obtain normal temperature conditions without these, since a large amount of cold air enters the space under the hood at all times, bypassing the radiator. It is often precisely this fact that is the main cause of a large overconsumption of fuel, even when the automobile is in good condition and properly adjusted.

Before the beginning of winter the integrity of the windguards must be checked and they must be firmly attached.

To adjust the quantity of air aspirated under the hood with the engine running, the automobiles GAZ-51, "Pobeda", and ZIS-110, and the buses ZIS-154 and ZIS-155 have louvers in front of the radiator, which can be controlled from the driver's seat on the GAZ-51 and "Pobeda", while on the ZIS-110 and the ZIS-154 bus they are regulated automatically by a thermostat. Figure 6a shows as an example the arrangement of the radiator louvers on the GAZ-51.

The louvers and their controls must be regularly inspected and any mud and dust cleaned off with a brush and blown out with compressed air, and the shafts of the slats and joints of the rods must be lubricated with oil (on the ZIS-110, the spindles of the slats need not be lubricated). The slats must abut snugly when closed and must completely open, while there must be no large clearances or play in the joints of the rods and cable.

The thermostat controlling the ZIS-110 louvers is inspected like the thermostat of the cooling system. The louvers on the ZIS-110 and the ZIS-154 bus are adjusted according to the plant instructions delivered with each automobile.

On automobiles not equipped with louvers, it is very useful to install a shutter in front of the radiator. This shutter is controlled from the driver's seat by means of a cable or a strong rope.

Figure 7 shows the construction of such a radiator shutter for the ZIS-150 automobile, developed at the TsNIIAT*. The shutter (12) is made of two layers of

*Proposed by driver Comrade Gavrilin.

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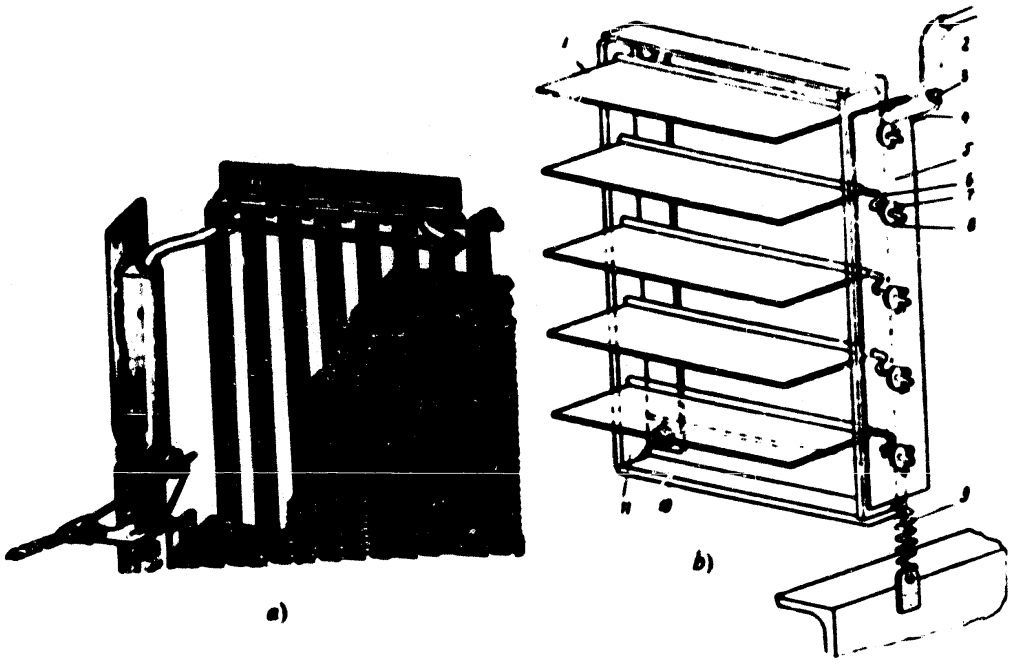

Fig.6

a) Radiator louvers in GAZ-51 automobile; b) System of louvers installed by Hundred-Thousander Driver Ya.I.Titov on ZIS-16 Bus. 1 - Louver slat; 2 - Lever; 3- Spindle of lever; 4 - Pin; 5 - Rod of louver spindles; 6 - Shaft of louver; 7-Disk; 8 - Cotter pin; 9 - Ring; 10 and 11 - Angles.

canvas, the upper edge is wrapped around the metal spindle (9) and is stretched tight. The lower edge is beaded with 1 mm thick sheet iron and is attached by two bolts to the radiator cross-piece. The shafts of the shutter are provided with freely rotating wooden rollers (7), which facilitate its motion. The upper and lower edges of the shutter are held in place by the elastic rubber strap (6). The cable (3) is used to lift the cover. It is wound around the guide roller (5) and is passed through an opening in the front and into the cab to the driver's seat. When the cable is pulled the shutter is lifted, covering the radiator, and when it is released the shutter is pulled down by the rubber strap.

In building these shutters it must be borne in mind that some types of rubber lose their elasticity in the cold, therefore, if no suitable rubber is available, it is preferable to install a spiral spring on the shutter.

Home-made louvers may be used instead of a radiator shutter. The Hundred-Thousander Driver Ya.I.Titov installed louvers on a ZIS-16 autobus. These consisted of five horizontal slats controlled from the cab by means of a cable. It is slightly more complicated to build louvers than it is to make a radiator shutter but they operate more conveniently (Fig.6b).

A protective cowl or cover (Fig.8) is absolutely necessary equipment for an automobile in winter (Fig.8). When the automobile is parked in freezing weather, covers placed on the hood and the radiator about double the time required for the engine to freeze. During motion the protective cover prevents high heat losses, maintains normal engine temperatures, and thus helps to save fuel and reduce the wear of engine parts.

To have the cover effectively protect the engine from heat losses, it must be made with a padding not less that 8-10 mm thick. The cover should be lined with leatherette to prevent it from getting wet. The cover should fit well and anugly, tightly fitting to the radiator front and the hood, and the fastenings must reliably hold the cover. The loops of the cover should be faced with sheet metal eyelets.

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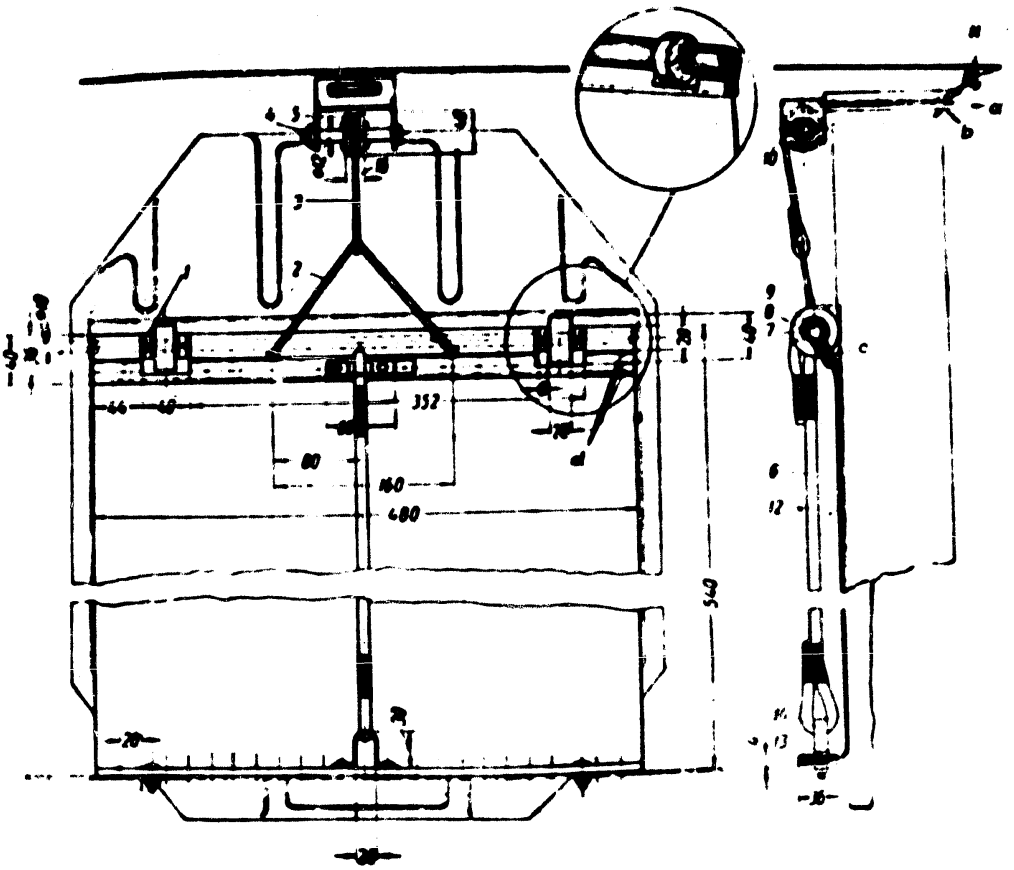
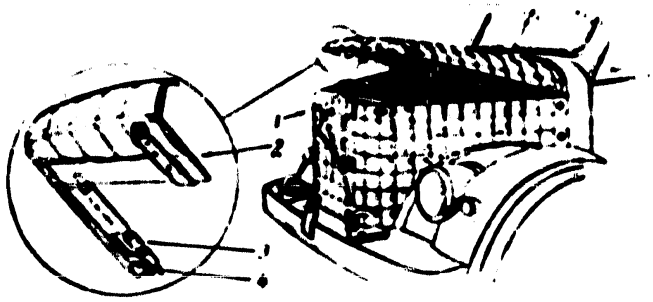
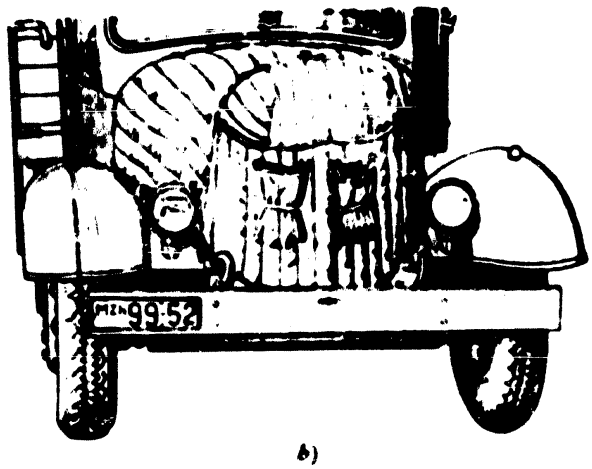


Fig.7 - Protective Shutter for the Radiator of the ZIS-150:

1 - Stop ring; 2 - Suspension; 3 - Rope; 4 - Shaft of guide pulley; 5 - Guide pulley; 6 - Rubber strap seal; 7 - Wooden pulley; 8 - Gasket; 9 - Shaft of shutter; 10 - Bracket for pulley; 11 - Insert; 12 - Radiator shutter (two layers of canvas); 13 - Facing of radiator shutter; 14 - Loop. a) To driver cab; b) Opening in casing for rope, cut-out point; c) Leatherette; d) Seam of canvas in three rows of stitches.



a)



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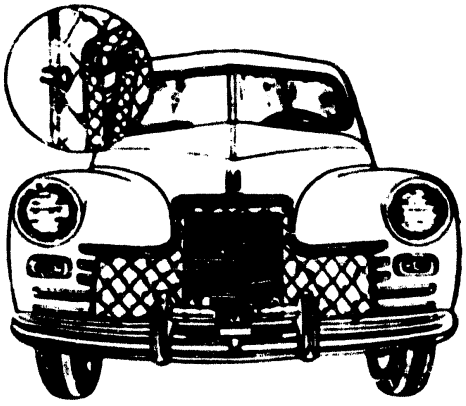

c)

Fig.8 - Protective Covers for Automobiles

a) GAZ-51; 1 - Pin of hood; 2 - Attachment clip for upper part of canvas cover; 3 - Loop of side attachment of upper part of canvas cover; 4 - Drop pin
b) ZIS-180; c) GAZ M-20 "Pobeda".

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Folding flaps with buckles are provided in the front part of the protective radiator cover.

For the ZIS-5, ZIS-150 and GAZ-MM, the protective covers are usually made of two sections, one for the hood, the other for the radiator. Both parts are attached with straps and buckles.

The cover for the GAZ-51 automobile consists of one part covering the side and face of the radiator, and another part covering the hood, which opens upward.

The use of covers must start not with the onset of subzero weather, but considerably earlier, beginning in autumn, when the mean temperature of the air drops below +5°C. The cover should be removed only when warm weather with temperatures above +5°C has become established.

The Fuel Supply System

Trouble with the fuel supply on the road is rather frequent. In winter this is particularly unpleasant, since the cause of the trouble must be found and corrected

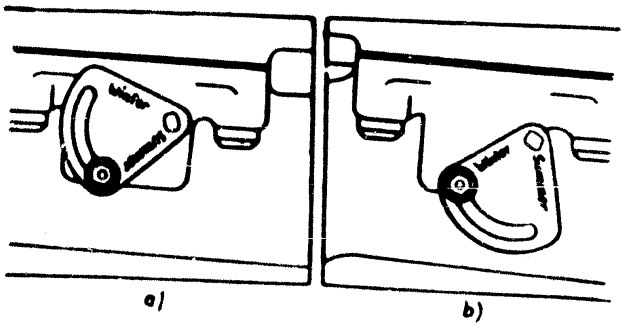

Fig.9 - Control of Warming of the Intake Pipe on the Engine of the GAZ-51:
a) In summer; b) In winter

in the cold, and often in snow and wind as well. During this time the engine may cool off, and it will then be very difficult to start, while in strong frosts the water may freeze.

Besides dirt and water, which may get into the fuel during filling, there may

also be mud and sediment, accumulated during summer operation, in the fuel system.

Therefore, before the beginning of winter the fuel system must be thoroughly cleaned: Remove and flush the fuel tanks, scavenge the fuel lines with compressed air, disassemble the fuel filters, and flush the filter cartridges and sumps.

Proper operation and correct adjustment of the fuel pump and carburetor must also be checked. These must be cleaned of dirt and the ducts scavenged with compressed air. Adjustment of the carburetor idling system is particularly important to ensure dependable starting of the engine. The idling operation, on most carburetors, is adjusted by screwing in the stop screw on the lever of the throttle pin to reduce its opening, and by screwing in the fuel-mixture adjusting screw. The idling must be adjusted in the warm engine that has reached its minimum steady running speed.

The booster pump on the carburetors K49A (GAZ-51), K22, K22A ("Pobeda"), and K24 ("Moskvich") must be adjusted for increased supply by placing the rod in the opening of the yoke, depending on the season.

In GAZ-51 engines, which have a seasonal adjustment for warming the fuel admission line, the lever of the warming-up shutter must be placed in the winter position as shown in Fig.9. There is also a manual adjustment for heating the fuel lines in some models of the "Pobeda" car; this lever is placed on the side of the exhaust line. The winter warming corresponds to the end position of the lever closest to the block.

Engine Lubricating and Crankcase Ventilating Systems

The wear of the engine parts depends on the satisfactory operation of its lubrication system.

The pressure produced by the oil pump must first be checked. The pressures in the lubrication system of a fully warmed engine in perfect condition are shown in Table 1.

A pressure lower than that shown in Table 1 may lead to considerable wear of

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Table 1

Pressure in Lubricating System of Warmed-Up Engine

Engine Model	Pressure in Lubrication System in kg/cm^2		Remarks
	Normal	Minimum Permissible	
"Moskvich" GAZ M-20	2.0-3.5	1.0	At speeds of 30-50 km/hr
"Pobeda"	2.0-4.0	1.0	The same
GAZ-51	2.0-4.0	1.0	"
ZIS-120	2.5-4.0	1.0	"
ZIS-110	3.0	1.0	"
GAZ-M	1.3-1.4	-	"
ZIS-5, ZIS-8	1.2-1.5	-	"
GAZ-20A	-	1.7	At 2000 rpm
GAZ-20A	-	0.3	At minimum idling speed

the bearings and crankpins, to wear of the oil-pump parts, to a deficiency of oil in the lubrictating system, and to considerable dilution of the oil by fuel.

A pressure above that indicated may be the result of clogging of the lubrication system or of excessive viscosity of the oil.

In the winter season, the proper winter grade of oil is filled into the engine (the oils used are discussed in detail in the following Section).

Before filling with fresh winter oil, the lubricating system must be flushed to remove dirt and tar deposits in the oil ducts, on the crankcase walls, and the engine parts. A low-viscosity oil, such as spindle oil 3, or a mixture of 70-80% motor oil 6 and 20-30% kerosene is used for the flushing. Pure kerosene cannot be used for flushing, since it would completely wash the oil out of the clearances,

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which might lead to increased wear and seizing on starting the engine. After draining the used oil, together with the sediment from the oil-filter cylinders, removing the filter element, and filling the crankcase with the flushing oil to the level of the lower mark of the oil indicator, the engine is started and allowed to operate at low idling speed for 5-8 min. The oil is then drained, the course-filter body and the oil ducts are scavenged with compressed air, and fresh oil is poured into the system. At the same time, a new fine-filter element is installed.

Many engines of USSR passenger cars have forced crankcase ventilation. Its purpose is to remove the exhaust gases and fresh fuel-mixture entering the crankcase over the piston rings, fouling and diluting the oil.

With the crankcase ventilation system in poor operating order, the wear of the engine parts may be 15-20% more, and the oil dilution may be 1.5 to 2 times as much as the usual fuel content of the oil. A particularly marked dilution of the oil takes place in winter when a large amount of over-rich fuel mixture reaches the crankcase when the engine is started.

It is therefore necessary to make sure that the crankcase ventilation system is operating properly, to clean out the ventilating pipes and hoses, and to pack their connections. On the GAZ-51 engine it is also necessary to pack the ventilation valve and its barrel.

Control Mechanisms and Chassis

The safety of automobile operation on winter roads depends on the technical condition and adjustment of the brakes, the steering gear, the articulations of the front axle, and the attachment angle irons of the front wheels. Unadjusted steering gear and front axle will impair the roadability of the automobile, possibly leading to skidding, slipping into roadside ditches, etc. Driving an automobile with unadjusted steering gear and chassis is particularly dangerous at high speeds. In these cases, no matter how much the driver attempts to manipulate the steering wheel, he will not be always able to bring the automobile out of its dangerous position and

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prevent an accident.

The tire pressure is also of great importance. Proper and uniform inflation of the tires, especially of the front tires, reduces the danger of skidding, and of "dragging" into snow drifts, and improves the roadability on country roads.

Incorrect adjustment of the brakes, even in summer, when driving on asphalt, cobblestones or block pavements in light rain or drizzle and sharply applying the brakes will inevitably lead to skidding. For this reason, brake adjustment, under winter road conditions, is one of the most important factors in operating without accident. In winter the brakes must be checked everyday. Before leaving the garage, after the engine has been started, the driver must try the brakes and make sure they are in good order.

Truck brakes must be so adjusted that the rear wheels are braked at the same time are made to "grip" at the end of the pedal stroke while the front wheels, with a certain lag relative to the rear wheels, are simultaneously and smoothly braked. Most winter accidents, collisions, and transport incidents, are mainly due to incorrectly adjusted brakes and to incorrect use (sudden application of brakes).

Frequently, when the seal at the gaskets is poor and when the oil level in the rear axle housing is high, or when the wrong grade of oil is used, the brake linings get oily. Oily brake linings do not provide reliable braking and may freeze fast in winter, due to freezing of the oil. The causes of oil leakage into the brakes must be found and corrected, and the oily brake shoes must be rinsed with gasoline and cleaned with a metal brush. In the GAZ-51 and ZIS-150 passenger cars, the breather in the upper part of the rear axle housing (GAZ-51) or on the housings of the semifloating axles (ZIS-150) must be regularly cleaned out.

In working on a line, the driver must be sure that no water, wet snow or mud gets into the brake shoes, since this may lead to the brake shoes freezing to the brake drums when parking, making it difficult to move the automobile. To avoid freezing of the brake shoes of the hand brake, leaving the brake applied on long

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standing is not recommended. It is preferable to use chocks under the wheels instead of the brake.

A hydraulic brake drive, if properly adjusted and filled with high-grade brake fluid, operates very reliably in winter. If, at very low temperatures, the brake pedal is hard to move, the brake fluid must be checked for excessive viscosity and, if necessary, replaced by fresh fluid. The drained fluid is then mixed with a thinner (the type of alcohol used for the given type of brake fluid) for re-use*.

For the air-brake drive installed in the ZIS-150, YaAZ-200 cars and the ZIS-154 and ZIS-155 buses, a careful check and preparation is required before the beginning of the winter season, supplemented by constant inspection during the period of winter operation. First the compressor supplying the system with air must be checked for good order, and a test must be run to check whether the lubricating oil of the wearing parts of the compressor leaks into the air system. The filters in the air stream between air system and compressor must be periodically removed(every 5000 km), the filter body washed, and the filter element changed. The condensate formed in the receiver (air reservoirs) must be drained several times a day, especially in damp weather. Despite this, the condensate may still freeze in the pipelines and particularly in the bends of the pipelines (pipe ells) in very cold weather.

During the severe winter of 1949/1950, the Moscow bus depot used the following measures for preventing freezing of the condensate in the air-brake system:

A small quantity of rectified spirits was poured into the air scoops;

Sharp bends of the pipe lines were straightened wherever possible;

Some ZIS-154 buses were provided with an additional air scoop in the motor compartment**.

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*Information on theccomposition of the brake fluids is given in the Section "Filling and Lubrication of Automobiles in Winter".

**More details on the operation of the ZIS-154 bus are given elsewhere (Bibl.21).

Electric Equipment and Storage Battery

The technical condition of the ignition devices and of all instruments for the electric equipment largely determines the dependability and economy of operation in all seasons and under all climatic conditions, but particularly in winter.

Interrupter-distributor, ignition coil, sparkplugs, ignition lock, starter, generator, storage battery, and high- and low-voltage leads must be in perfect condition, the connections must be in good electrical contact, and the adjustable clearance in the interrupter and the electrode gaps of the sparkplugs must be within the established limits.

A separate book of this series (Bibl.22) is devoted to the servicing of automotive electric equipment; therefore, we will confine our discussion to pointing out the importance and necessity of inspecting and accurately adjusting, all electric equipment before the onset of winter. More details, however, will be given on the instruments whose winter servicing is characterized by special features (storage battery or generator) or is of particular importance in working at low temperatures (coolant-temperature indicator).

Proper preparation of the storage battery for winter operation is of exceptional importance.

First of all, at low temperatures there is the danger of the electrolyte freezing if its density (specific gravity) is not high enough. The freezing point of electrolyte at various densities is as follows:

Freezing Point of Electrolyte in Storage Battery at Various Densities

Density of electrolyte at +15°C	1.32	1.29	1.25	1.20	1.15	1.12
Freezing point of electrolyte in °C	-64	-78	-50	-25	-14	- 9

The lowest freezing point is for electrolytes of 1.29 sp. gr., which corresponds to a fully charged battery. If the density is either increased or decreased from this point, the freezing point of the electrolyte rises. With respect to

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freezing, a higher density of the electrolyte is not dangerous, since even pure battery acid, which is never poured into a storage battery, freezes at -34°C. At the same time, electrolytes of a density reduced to 1.20 (which corresponds to a 50% discharge of a battery with an original electrolyte density of 1.29), freezes at -25°C. Electrolyte increases in volume on freezing, causing the battery tanks to crack, and the electrolyte in the pores of the active mass of the plates to disintegrate these plates to the point of complete uselessness.

To prevent the density of the electrolyte from dropping to values at which it might freeze a fully charged battery must have the electrolyte brought up to winter standard (Table 2) by adding electrolyte of 1.383 sp. gr. to the cells and by not allowing the battery to be discharged by more than 25%. The degree of discharge of a battery can be determined from the measured density of the electrolyte (Table 2), or by means of a charging plug.

Table 2

Density of Electrolyte in Storage Battery Under Various Climatic Conditions

Region and Climatic Conditions of Battery Operation	Recommended Density of Electrolyte in Fully Charged Battery (at 15°C)	Density of Electrolyte (at 15°C) on discharge	
		by 25%	by 50%
Far North, with temperatures below -35°C, winter	1.31	1.27	1.23
Central and northern regions with temperatures down to -35°C, winter	1.29	1.25	1.21
Central regions and north, in summer, southern regions, in winter	1.27	1.23	1.19
Southern regions, summer	1.24	1.20	1.16

It must be borne in mind that the density of the electrolyte must be measured at 15°C; if the measurement is made at a different temperature, a temperature correction of 0.0007 per degree must be applied. The correction must be added to the

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hydrometer readings for electrolyte temperatures above +15°C and subtracted for electrolyte temperatures below +15°C. For example: The temperature of the electrolyte at the time of measuring its density is -15° C, i.e., it differs by 30°C from the standard temperature (+15°C). The actual reading of the hydrometer is 1.28. In this case the correction will be 0.0007 × 30 = 0.021, and the density of the electrolyte, reduced to +15°C, will be 1.28 -0.021 - 1.259 or, rounded off, 1.26. This shows that measuring the density without application of the correction will indicate more than 75% charge of the storage battery having an original electrolyte density of 1.31, while it actually is less than 75% charged.

With the onset of warm weather, the density of the electrolyte must be brought to the summer standard, since the sulfuric acid content promotes disintegration of the separators.

In determining the degree of charge of a storage battery by means of a charge plug, a voltmeter reading of 1.7-1.8 v corresponds to full charge of the battery, a reading of 1.5-1.6 v to 50% charge, and a reading of 1.3-1.4 v to complete discharge.

A second peculiarity of operation of a storage battery in winter is that, at low temperature, the capacity of the storage battery and its electromotive force are decreased markedly. For each degree of electrolyte temperature decrease, the capacity of the battery decreases by 1-1.5%. For example, if the capacity at +20°C is 100%, it will drop to 40-60% at an electrolyte temperature of -20°C.

To increase the efficiency of a battery, it should be warmed by placing it in a covered wooden box with double walls, packed with felt, glass wool, or some other insulating material of about 30 mm thickness. There are special cut-outs in the box for the leads to the starter and the ground (car body). In such a box, the temperature of a battery, at an outside temperature of -15°C, will drop by about 1° an hour, while an unprotected battery cools by 2°an hour.

Figure 10 shows the arrangement of such a box for the ST-80 storage battery (GAZ-MM car), developed at the Scientific Automotive Institute (NAMI).

An insulated box retains the heat in a battery, but on prolonged storage in winter, a battery without outside heat supply will still cool off, even though slowly. Heating of the battery by additional charging in a running car is insufficient to compensate these heat losses. Therefore, in very cold weather, when a car is to be parked for a long time, it is better to remove the battery and store it in a warm room. This does not refer to cars having the battery installed under the hood, which are additionally warmed when the engine operates. Such a warmed battery will hold sufficient heat after 10-12 hrs. of standing in the cold, and its capacity will not drop too much.

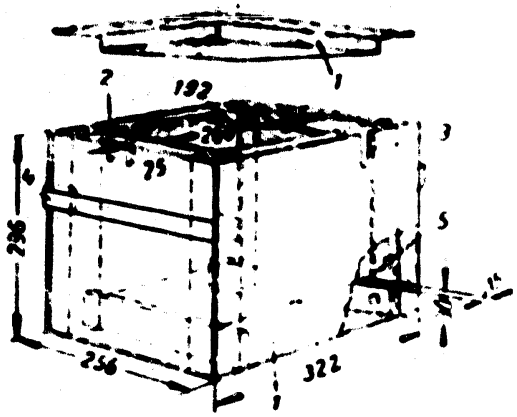

Fig.10 - Warming Box for Storage Battery ST-80 (GAZ-MM Car)

1 - Warming layer; 2 - Cut-out for lead from ground; 3 - Cut-out leads from starter; 4 - Strap handles (for carrying the battery); 5 - Base plate of battery.

Attempts to heat the storage battery with an outside source of heat, for example, by means of circulating the hot water from the engine cooling system through a special line, have not been widely used, because of the complexity and inadequate effect of such an arrangement. The invention of a device for warming a storage battery, that would be simple to manufacture and still be reliable, is therefore one of the future tasks for rationalizers and inventors in automobile transportation.

Since a storage battery discharges more in winter, the charging current from the generator must be increased. In the GAZ-51, ZIS-150 and "Pobeda" cars, the charging current is increased automatically by a control relay. In the GAZ-MM and ZIS-5 cars, however, the third brush of the generator must be moved in the direction of armature rotation, and the charging current must be increased to 12-14 amp, or

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to 16-18 amp in the "Moskvich" car.

The correct readings of the coolant-temperature indicator, installed in new car models, are of exceptionally great importance for maintaining normal engine temperature under winter conditions.

Figure 11 shows a diagram of the temperature indicator. When current flows, the spiral (4) heats a bimetal plate (5), which, because of the higher temperature, will buckle, breaking the contacts (1) and (3). When the plate (5) cools, the contacts again close the circuit. The higher the temperature of the water surrounding the pickup cartridge, the more frequently will the pickup plate (5) deflect and, accordingly, the less will the plate (6) of the indicator be bent, so that the pointer (10) will show the actual temperature of the water in the engine block. The instrument operates only when the ignition is turned on. With the ignition turned off, the pointer remains stationary at the left of the "100°" scale division of the indicator.

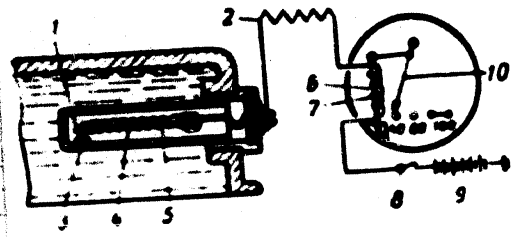

Fig.11 - Water-Temperature Indicator
1 - Pulsating contact; 2 - Additional resistor; 3 - Fixed contact; 4 - Heating coil of pickup; 5 - Bimetal plate of pickup; 6 - Bimetal plate of indicator; 7 - Heating coil of indicator; 8 - Ignition lock; 9 - Storage battery; 10 - Indicator pointer.

If there is any suspicion that the indicator is inaccurate, its condition must be checked, together with the reliability of the electric connections and the accuracy of reading. The reading accuracy of the pickup can be checked by measuring the water temperature with a mercury thermometer through the radiator neck, and at the same time noting the instrument readings at the instrument board. It must be borne in mind in this case that the pickup is enclosed in the water jacket of the block, so that the tests can be made only with the thermostat valve completely open,

i.e., at a water temperature above 80°C.

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FILLING AND LUBRICATING THE AUTOMOBILE IN WINTER

Fuel

Easy starting of a cold engine, fuel consumption, and dilution of oil in the engine crankcase, all depend to a considerable extent on the properties and quality of the fuel used in winter.

No less important is strict adherence to the rules for storing fuel and filling the automobile fuel tank. Fuel obtained from the fuel dump, even if it entirely meets the standard, may be contaminated by various admixtures if it has been incorrectly stored and filled; water may get into it or there may be sedimentation in old fuel. As a result, during starting, as well as during operation, the carburetor passages and fuel jets will clog, and the water will freeze in the fuel lines during cold weather, thus completely stopping the fuel flow. In Diesel engines, contamination or water in the fuel may also lead to engine damage.

The use of fuel corresponding in grade and quality to the engine involved, and strict observance of the rules for fuel storage and filling automobiles, is therefore mandatory.

Gasoline for carburetor engines is now produced in three brands: A-66, A-70, and A-74.

Gasoline A-66 is intended for "Moskvich", ZIS-150, GAZ-MM, GAZ-M1, and ZIS-5 automobiles; gasoline A-70 for GAZ-51 and "Pobeda" automobiles; gasoline A-74 for ZIS-110 automobiles.

Gasolines A-66 and A-70 are ethylated cracked gasolines. Gasoline A-74 is a straight-run product from the distillation of crude, without addition of ethyl fluid.

For winter operating conditions, the fractional composition of a gasoline is particularly important. In contrast to many liquids which boil and evaporate completely at one and the same temperature (like water, for example, which evaporates at 100°C), gasoline, like other petroleum products used in automobiles, is a mixture of constituents boiling at various temperatures. The lightest constituents (fractions) begin to evaporate at about 35-40°C, while the heaviest fractions begin to come over at about 200°C.

The ease of starting an automobile engine is characterized by the boiling point of 10% of the gasoline, which must lie within definite limits. If the boiling point of the first 10% of the gasoline is too high, the evaporation during the starting of the engine will be insufficient for forming an easily inflammable fuel mixture; while when it is too low, vapor lock will form in the fuel lines, and the engine will operate intermittently. In gasolines A-66 and A-70, 10% of the gasoline comes over to 79°C.

The distillation temperature of 50% of the gasoline characterizes its evaporation during engine warm-up, while the distillation temperature of 90%, and the end-point characterize the evaporation of the fuel at a fully warmed engine. The higher these temperatures, the greater will be the quantity of unevaporated gasoline entering the cylinders when the engine is insufficiently warmed up, the more must the fuel mixture be enriched to obtain the required power, and the more will the oil be diluted.

For A-66 and A-70 gasolines, the temperature at which 50% has come over is 145°C, the 90% point is 195°C, and the end point 205°C.

A-66, A-70, and A-74 gasolines differ substantially in their indexes from the previously produced gasoline which had inferior antiknock properties and an inferior fractional composition.

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As shown by experience, in operating on A-66 or A-70 gasoline in high-compression engines, there is no knock. The absolutely reliable starting of a cold engine, with adequate rotary speed of the crankshaft and the ignition system in good condition may be effected at temperatures down to -10 to -15°C without preliminary warming up.

The ethyl gasolines A-66 and A-70 are toxic, and the precautionary measures against poisoning must be strictly observed in handling.

It is very important in winter to prevent dirt, rust, and particularly water, from penetrating into the gasoline. The filling must be done through a funnel with a screen and three or four layers of gauze. It is even better to place a piece of chamois into the funnel. If water gets into the gasoline, all of it must be drained out of the crankcase, and the liquid allowed to settle, after which the sediment is drained off and the gasoline carefully filtered before use.

Liquid substitutes for gasoline are used today in a few automotive systems. Benzol, ethyl alcohol, and methyl alcohol (wood alcohol) are the main substitutes used. The above gasoline substitutes cannot be used in the pure state for the following reasons:

Benzols freeze at +5 to -12°C* and they almost entirely lack a fraction coming over below 78-80°C. In addition, in working with benzol, a large amount of deposit is formed in the engine. The alcohols, methyl and ethyl, show poor evaporation in operating an automobile engine. For this reason, it is exceedingly difficult to start a cold engine on these fuels, so that they can be used only when mixed with gasoline.

It must also be borne in mind that benzol is toxic and that its use in mixtures with gasoline in proportions over 25% is forbidden by health regulations.

The following binary and ternary mixtures are the most applicable for winter

*Winter aviation benzol, however, freezes at -20°C.

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conditions, in percent:

Binary mixtures:

1	Motor gasoline	80-85
	Motor benzol	15-20
2	Motor gasoline	65-70
	Absolute alcohol	30-35

Ternary mixture:

3	Motor gasoline	50
	Alcohol	30
	Motor benzol	20

With mixture (2), a cold engine can be started at temperatures as low as -12 to -15°C. Only absolute alcohol (pure, without additives) can be used for this mixture, since rectified spirit does not give stable binary mixtures with gasoline, and separates into layers.

In ternary mixtures, benzol prevents the mixture from separating into layers, so that absolute alcohol need not necessarily be used, as rectified spirits will do.

Diesel fuel by the new standard (GOST 4749-49) is produced in four grades: DA, arctic, intended for operation of automotive Diesel engines at temperatures below -35°C; DZ, winter, for operation of automotive Diesel engines at temperatures from 0°C to -35°C; DL, summer, for operation at temperatures above 0°C; DS, special.

The most important indexes of the properties of Diesel fuel, which determine its operating quality, are cetane number, viscosity, and pour point.

The cetane number of Diesel fuel determines its ability of rapid ignition on injection into the engine cylinder. The higher the cetane number, the shorter will be the time from the injection of fuel into the cylinder to its spontaneous ignition, the more smoothly and knock-free will the Diesel engine operate, and the more readily will it start. The cetane number is 40 for fuels DA and DZ and 45 for DL.

The viscosity characterizes the mobility or flow of a fuel. The viscosity is

largely dependent on the temperature of the fuel; the lower the temperature, the less will be the mobility of the fuel (the higher its viscosity), the harder it is to pump by the fuel pump through the fuel lines, and the less well can it be atomized on injection into the cylinder. Diesel fuel must have low viscosity at the prevailing temperatures of starting and operation of the engine.

At the same time, an excessively low viscosity is also inacceptable, since this type of fuel will increase the wear of the fuel-system parts as well as the possibility of leakage. Operation on fuels with the same viscosity as kerosene is therefor impermissible in summer, and in winter only for a short time.

The pour point of Diesel fuels is of particular importance for winter operating conditions. Diesel fuel flows properly in fuel lines if its pour point is at least 10°C below the temperature of the ambient air.

The pour point of Diesel fuels is as follows: -60°C for DA, -45°C for DZ, and -10°C for DL.

The presence of dirt, rust, and other admixtures in Diesel fuel is completely impermissible. The filters in the fuel system of a Diesel engine cannot completely clean a fuel if there is a large amount of dirt. Mud and other admixtures entering the pump nozzle interfere with its normal operation. The presence of water in the fuel, even in small amounts, is particularly dangerous. At freezing temperature, water droplets in the fuel form ice crystals which accumulate on the screen of the fuel intake and filter, thus completely interrupting the supply.

The fuel released from fuel dumps must contain no contaminating admixtures or water. During storage, transportation, and filling, complete cleanliness must be observed, and no water must be allowed to enter the fuel. At the filling stations the fuel must be allowed to stand not less than 10 days, and must then be thoroughly filtered. The filling is best done directly from the filling hose into the automobile fuel tank, but if it is impossible to fill it directly from the hose, it must only be filled from a thoroughly clean vessel, using a funnel with a small strainer.

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The filling must be done daily at the end of work, filling the tank before the old fuel has become cold.

In the YaAZ-200 passenger car and the ZIS-154 bus, 0.1 liter must be drained from the body of the coarse fuel filter and 0.2 liter of fuel from the body of the fine fuel filter, after which the engine is allowed to run 2 or 3 min at low speed (up to 1000 rpm).

Low-octane tractor kerosene with 3-4% by weight of MK aviation oil added may be used as a substitute for Diesel fuel for short periods of time.

Oil for the Engines

Before starting the engine, the oil is at the same temperature as the ambient air. After starting the engine, the oil temperature gradually rises and, under difficult operating conditions, may reach 80 and even 100°C. For this reason, the primary requirement as to properties of a motor oil is that it must, at the low temperatures at the time of starting, impede the rotation of the engine crankshaft as little as possible, and must be easily pumpable by the oil pumps through the ducts of the lubrication system to the wearing parts, while at high temperatures, when the engine is fully warmed up, it must still maintain adequate lubricating properties and must not thin to impermissible limits. The ability of a given grade of oil to satisfy these demands is determined by its viscosity measured at various temperatures. The quantity characterizing the flowability or mobility of an oil is called viscosity.

In the standards for oil, the values of the so-called kinematic viscosity in centistokes (cst) are usually given, and in some cases also the values of the Engler viscosity in degrees Engler.

The value of the kinematic viscosity is determined by the time required for an oil to flow from a capillary (fine) tube under the action of its own weight. This corresponds to the behavior of the oil in the clearances between parts, i.e., the higher the kinematic viscosity, the lower will be the fluidity of the oil, and vice

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verse.

The Engler viscosity reflects only approximately the real properties of the oil. Therefore, recent standards and specifications for oil give the kinematic viscosity as the basic index of the viscous properties, while the Engler viscosity is given as a secondary index.

The viscosity of all petroleum products, including oils, varies greatly with the temperature. At too high a viscosity and at low temperature, the starting of the engine is difficult, leading to an increase in the starting wear. On the other hand, marked reduction in the viscosity of oil on heating leads to a displacement of the oil film from the clearances of the engine parts, thus increasing the wear of the most vital parts.

The viscosity of summer motor oils rises sharply with decreasing temperature. For example, the viscosity of motor oil 1[illegible], when the temperature drops from 100°C to 50°C, increases 7.8 times, and when further cooled from 50°C to 0°C it becomes about 500 times as high as the viscosity at 100°C. The viscosity of ordinary (not winter) motor oil 6 varies in almost the same way. However, on variations in temperature, the viscosity of petroleum oils of different grades varies differently.

The viscosity of special winter oils of the better grades increases only 90-110 times on cooling from 100°C to 0°C. At high temperature, their viscosity is not lower than the viscosity of motor oil 1[illegible]. Therefore, such oils are the most suitable for work under winter conditions. In the absence of special winter oils, motor oil 1[illegible] or ordinary motor oil 6 is used in winter. To decrease the viscosity of these oils while starting the engine and to make it easy for the crankshaft to rotate, they must be warmed. The next index of the properties of an oil is its solidification point, i.e., the temperature at which the oil completely loses its fluidity. However, this index only partially characterizes the properties of an oil at low temperature. If an oil has a low solidification point, while its viscosity sharply rises on cooling, the starting of the engine will be difficult. For

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example, according to the standard, the pour point of motor oil is 10-25°C, but its viscosity increases so much with increasing* temperature that at -2 to -3°C it is very difficult to turn over the crankshaft of an unheated engine.

Many of the oils produced today contain special additives which considerably improve the lubricating properties of the oils.

Table 3 gives a list of the oils standardized in the USSR for automobile engines for summer and winter use.

Of the oils given in Table 3, the best oils for carburetor engines in operating at low temperatures are the thickened winter oils by TU 375-51. When thickened oil of brand 4 is used, the engine crankshaft can easily turn over at temperatures as low as 26-28°C below zero, and when thickened winter oil of brand 6 is used this is possible down to -20 to -22°C. Only when the weather is still colder is it necessary to warm up engines using these oils. According to the specification TU 375-51, oil of brand 4 is recommended in regions with severe climate, and thickened winter oil of brand 6 in the central, western, and northwestern regions of the USSR.

In addition to the special winter oils, the oil AS_p-5 or AS-5) is also more or less suitable for winter use. With this oil the engine can be started without warming at -6 to -8°C.

All remaining oils for carburetor engines shown in Table 3 (motor oils 6 and 10, sulfuric-acid purified, oils AK_p-5, AS-9.5, AS_p-9.5, AK_p-9.5) do not ensure easy starting of the engine in winter. When they are used at temperatures of -2 to -3°C or lower, the engine must be warmed up.

In winter, when no winter oils of special grades are available, certain industrial oils or mixtures of oils of different viscosity can be used. A number of such mixtures, especially mixtures of SU machine oil with spindle oils, are even better in quality and starting properties than ordinary sulfuric-acid or selective-purification motor oils. Oils of the basic grades used in winter and the mixtures

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*Translator's note: Should be decreasing temperature.

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Table 3

Oils for Automobile Engines

Grade and Brand of Oil		Kinematic Viscosity in Centistokes			Solidification point in °C not over
		at 100°C, not below	at 50°C not above	at 0°C not above	
Motor oils, purified with sulfuric acid (by GOST 1862-42)*	4	-	25-29	not covered by standard	-30
	6	5.0	42		-30
	10	9.6	75		-25
Oils for tractors, selective purification (by GOST 5239-50)**	AS-5	5.0	35		-30
	AS-9.5	9.5	70		-20
Motor oils with additive (by GOST 5303-50)	AS_p -5	5.0	35		-30
	AK_p -5	5.0	43		-30
	AS_p -9.5	9.5	70		-20
	AK_p -9.5	9.5	84		-20
Winter motor oils, (by TU375-51)*	4	6.0	25	550	-40
	6	10.0	45	1100	-40
Special motor oil (by GOST 3829-47)	Summer	--	45-60	not covered by standard	-20
	Winter	--	29-33		-25
Diesel oil with additive Aznii-4 (by GOST 5304-50)	Summer	10.4	74	not covered by standard	-15
	Winter	8.3	55		-20

*By GOST 1862-51, approved instead of GOST 1862-42, motor oil 4 is excluded from the assortment, motor oil 6 is marked AK-6, and motor oil 10, AK-10. The winter oils by TU 375-51 are also included in GOST 1862-51 and have the following markings: motor oil winter 4 - AKZ_p-6 and motor oil winter 6, AKZ_p-10.

**By GOST 5239-50, approved instead of GOST 5239-50, the oil AS-5 must have a viscosity at 100°C not less than 6 cst, at 50°C not more than 42 cst, and at 0°C not more than 1500 cst.

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used as substitutes, are indicated in Table 4.

Table 4

Substitutes for Oils for Automobile Engines

Basic Grade of Oil	Substitute	Content of Substitute in Mixture, in %
Motor winter oil, brand 4	1) Mixture {Machine oil SU or motor oil 6, spindle oil AU or spindle oil 2	65-70 35-30
	2) Mixture {Machine oil SU or motor oil 6, spindle oil 3	50 50
	3) Mixture {Motor oil 10, spindle oil AU or spindle oil 2	55 45
	4) Machine oil L	--
	5) Turbine oil UT	--
Motor winter oil, brand 6 Motor oil brand AS_p-5 (or AS-5)	1) Machine oil SU	--
	2) Mixture {Motor oil 10, machine oil L	45 55
	3) Mixture {Motor oil 10, spindle oil AU Spindle oil 2	75 25
	4) Mixture {Motor oil 10, spindle oil 3	65 35
	5) Mixture {Motor oil 18, spindle oil 2	60 40
	6) Mixture {Motor oil 18, spindle oil 3	45 55
	7) Machine oil S	--
	8) Motor oil M	--

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For ZIS-110 Automobiles, a special motor oil is provided and for Diesel automobiles, Diesel oils. In winter the corresponding winter grade is used.

As the engine operates the oil circulating in the lubricating system is contaminated by the tars formed in it at high temperatures, by carbon deposits, dust entering the engine with the intake air, and by metal particles entering the oil as a result of wear of the parts. In winter high dilution of oil by fuel entering the crankcase through the cylinder during the time of additional "suction" on starting the engine is particularly dangerous.

An extensive dilution of the oil (above 8-10%) may occur if the ignition is interrupted, if the level of gasoline in the carburetor rises, or if the temperatures of the coolant in the engine drops. This requires careful watching of the oil condition, changing it regularly at the intervals given in the instructions for each automobile, regularly draining the sediment from the oil filters, and exchanging the fine-filter cartridge. If the oil is badly diluted by fuel it must be immediately changed. The first sign of excessive dilution is a rise in the oil level in the crankcase.

Oil for the Transmission Mechanisms of the Automobile

In the gear box and the rear axle it is very important that oil corresponding to the season be used. Figure 12 schematically shows the behavior of oils of different viscosity and of different pour points in the gear mechanism in summer and winter. If the gear box or rear axle is filled in winter with a summer oil of high viscosity and high pour point, it will solidify at low temperatures and, on starting the car, will interfere with the rotation of the gears; in very cold weather, this may lead to breaking of the gear teeth, ruining of the clutch disk, etc. When the gears revolve, the solidified oil will not flow into the space between the teeth, so that they will run "dry", resulting in accelerated wear. During the motion of the car, the oil will warm up slightly, but its viscosity will still be very high and the power loss in the rotation of the gears will be considerably

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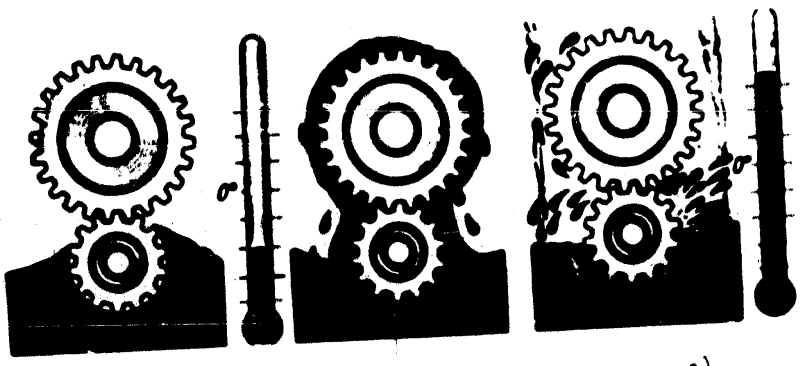
greater than usual. As a result, fuel consumption, even at relatively high subzero temperatures, may increase by 8-10%.



a) b) c)

Fig.12 - Process of Lubricating a Gear Transmission:
a) Behavior of summer lubricant in winter; b) Process of correct lubrication;
c) Behavior of winter lubricant in summer

It should be pointed out, incidentally, that it is quite as harmful to use winter oil in summer as summer oil in winter, since a low-viscosity winter oil in warm weather will spatter and will be forced out of the clearances between the gear teeth.

A mixture of motor oil and nonfluid oil cannot be used in the crankcase of the transmission unit. In the successive heatings and coolings that continually occur during operation of an automobile, a mixture of motor oil and nonfluid oil will either stratify, i.e., separate into a low-viscosity (liquid) oil and a sediment, or will be converted into a thick mass in the form of a jelly which already solidifies at +20 to +25°C.

In neither case will normal lubrication be ensured, either when winter oil is used in summer or when summer oil is used in winter.

Table 5 gives the types of oil for use in the transmission mechanisms of an

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automobile.

Nigrol is used for all trucks and light cars except the ZIS-110, for which the special oils shown in Table 6 are produced. Viscosin may be used as a substitute for summer Nigrol.

Table 5

Oils for Automobile Transmission Mechanisms

Oil Grades		Engler Viscosity in Degrees Engler at 100°C	Pour Point in °C, not over
Tractor transmission oil (Nigrol, GOST 542-50)	summer winter	4.0-4.5 2.7-3.2	-5 -20
Automobile transmission oil (GOST 3781-47)	summer	3-4	-5
Crankcase and steering-gear oil, special (GOST 4002-48)	summer winter	3.0-4.5 2.0-3.5	-5 -15
Oil for hypoid transmissions, special (GOST 4003-48)	summer winter	3.0-4.5 2.0-3.5	-5 -15

Besides the transmission box and the rear axle, Nigrol (but special oils in the ZIS-110) are used for lubricating the steering gear and the needle bearings of the universal joints.

At temperatures below -20°C, winter Nigrol solidifies; dilution with 10-15% Diesel fuel or kerosene is therefore permissible.

Nonfluid lubricants

Nonfluid lubricants or greases are designed for lubricating the bearings of water pumps, wheel bearings, spring pins, pivot pins, hinges of the steering wheel rods, shafts for disengaging the clutch and brake, support bearings of the clutch, slots of the universal drive shaft, leaf springs and other similar wearing connections, indicated in the lubrication chart for each automobile.

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The grade of grease is selected according to the operating conditions of the connection or junction to be greased.

In particular, for a water pump, the greases M (summer) and L (winter) are used, since they will not wash away in contact with water*.

It is recommended that the wheel bearings be lubricated in summer with the high-melting lubricant 1-13, and in winter with Constalin.

The spring pins, the pivot pins, the hinges of the steering wheel rods, the rollers for disengaging the clutch and brake, the slots in the universal shafts are lubricated with pressure grease, the softest of the available greases, and one which is easily removed with the grease gun. Besides the fatty greases, synthetic greases may also be used. These are produced in three brands: US-s1, a substitute for pressure grease, US-s2 and US-s3, substitutes for M and L greases.

The springs should be greased with graphite grease.

In winter it is often difficult to force the solidified grease by means of the grease gun through the grease cup into the oil lines to the parts to be lubricated. For this reason, the grease gun should be used only after the parts to be lubricated have been warmed up in the servicing room at at least +5°C. If the fresh grease does not enter the clearances between the parts, the grease cups must be removed and cleaned with a wire, and the ducts to the parts must be cleaned; if necessary, the entire mechanism must be disassembled and cleaned. Ungreased parts cannot be operated further, since they would rapidly wear out.

Particular attention must be paid to regular and proper lubrication of the pivot pins, to prevent accelerated wear.

To avoid disassembling the unit or mechanism into which it is impossible to force the lubricant, it is useful to assemble a hydraulic grease-cup cleaner

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*Besides fatty greases industry also produces so-called emulsion greases, which are intended for other purposes, and are unsuitable for automobiles.

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designed at the TsNIIAT* (Fig.13).

The cleaner consists of a hollow steel cylinder (2), with screw connections for parts at both ends, the threaded driftpin (1) with a handle, the stub pipe (3), and the capped grease cup (5).

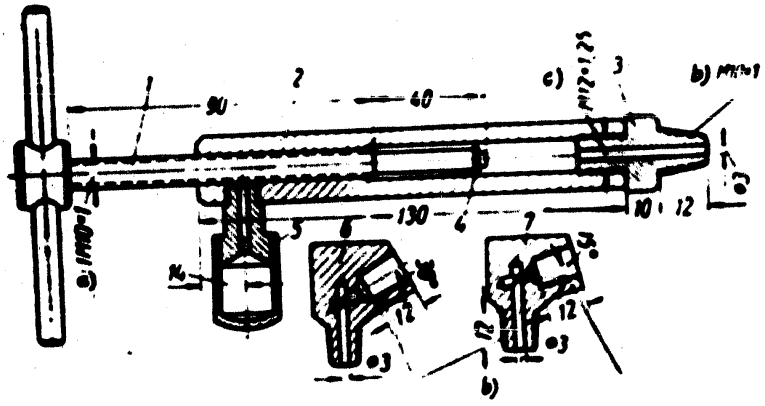

Fig.13 - Hydraulic Grease-Cup Cleaner

1 - Threaded Driftpin; 2 - Barrel; 3 - Plug of barrel; 4 - Stop disk;

5 - Cap for grease cup; 6 and 7 - Angle end pieces

a) Thread M10 × 1; b) Thread M10 × 1, conical; c) Thread M12 × 1.25;

d) Thread M10 × 1, conical

In building the cleaner, the thread for the driftpin and the female thread in the cylinder must be coated with soft solder to obtain an airtight seal when using the cleaner.

The clogged grease ducts are cleaned out by the hydraulic piercer as follows: With the screw (1) backed off to refusal, the cavity in the cylinder is filled with grease, screwing in the cap of the grease cup (5). The piercer is then placed on the part with the clogged grease duct, screwing in replacing the removed grease cup by the stub pipe (3). When the pressure screw (1) is screwed in, its threaded part

*Designed by Engineer S.M.Garasev.

covers the connection between the pocket of the oil cup from the pocket of the cylinder, in which a pressure as high as 2000 kg/cm^2 is produced; under the action of this pressure, the fresh grease displaces the contents of the grease duct. At spots where the hydraulic piercer cannot be screwed directly into the thread of the grease cup nipple, an angle adapter must first be screwed in, allowing the piercer to be slanted at an angle of 15 or 30° with respect to the axis of the grease-cup nipple.

Fluids for Hydraulic Brakes and Shock Absorbers

The special hydraulic brake fluid produced by the chemical industry consists of a mixture of castor oil and butyl alcohol, with an added coloring matter. The freezing point of this liquid is -55°C. If no prepared brake fluid is available, a mixture of one of the following compositions may be used:

1) castor oil, 50%; butyl alcohol 50%;

2) castor oil, 40%; diacetone or isoamyl alcohol, 60%. In winter, these alcohols may be replaced by alcohol (rectified spirits).

A mixture consisting of 35% purified glycerol and 65% rectified spirits may also be used in winter.

It is categorically forbidden to fill the hydraulic brake system with motor oil or other mineral oils, or to add them to the system, or to mix different types of hydraulic brake fluids, since this will lead to rapid disintegration of the rubber parts and gaskets of the brake system.

The fluid for shock absorbers consists of a mixture of 50% transformer oil and 50% turbine oil L.

Coolants

The water filled into the engine cooling system must be free from sand, mud, and various impurities. Unfiltered, muddy, or turbid water must not be filled into the engine.

In large cities, tap water is well purified and can be poured into the cooling

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system of an automobile without first being filtered. When water from natural water bodies (rivers or lakes) is used, the water must be filtered before filling it into the cooling system of an engine, a water boiler, oil boiler etc., from which the automobile is to be filled.

For this purpose, special filtering devices must be installed in the garage, passing the water slowly through a heavy layer of river sand and gravel. In extreme cases when no proper filtering arrangement is available, the water must be passed through a heavy cloth folded in four.

The water must not form scale in the cooling system. Scale is formed when hard water is used. Water is considered hard if it contains a considerable amount of dissolved lime, chalk, or various salts. Underground waters from wells and springs usually have a considerable hardness. The household indication of hard water is the fact that soap will not foam. The scale deposited in the radiator tubes and the water jacket when hard water is used interferes with normal cooling of the engine. When the scale deposits are large, the engine overheats and starts knocking, its power decreases, while fuel and oil consumption increase.

When automobiles are stored without a garage in winter and the cooling system is drained every night, the use of hard water for daily filling is particularly bad. In this case, each new portion of water will deposit scale and large deposits will rapidly accumulate in the system.

Hard water, whether from the tap or from rivers, wells, etc., must be softened.

The simplest way of softening water is to boil it. In this case, the scale will be deposited in the boiler or other vessel in which the water is heated, and when the water is poured into the engine it is already considerably softened.

Water may also be softened by adding calcined sodium carbonate or potassium bichromate.

Sodium carbonate is used at the rate of 0.5-1 gm/liter of water. Bichromate is added to the water in the form of a 10% solution, 30-50 cm^3/liter of water.

The vapor from bichromate is toxic and the solution must be prepared under a hood or wearing a gas mask, and the hands must be washed with soap after the solution is prepared.

The water must be poured steadily and not too rapidly into the radiator, through a funnel with a strainer. In engines with a thermostat, the air in the cooling system is unable to escape when the water is poured in too rapidly. In this case, the cooling system will be filled only half-way (Fig.14) so that, when the engine is warmed to the temperature at which the thermostat opens, the water level will drop.

Antifreeze V-2. When antifreeze V-2 is used in winter, the danger of freezing of radiator and engine is eliminated during lengthy stops in the cold (in the ZIS-110 automobiles and ZIS-154 buses, antifreeze is also used in the heating system of the cab).

If the automobile is stored without a garage, and V-2 antifreeze is used, it need not be drained every day. But it is advisable to use antifreeze only in connection with reliable means for facilitating the starting of cold engines (winter grades of oil, starting heaters, etc.).

In the USSR, the antifreeze V-2 is standardized (GOST 159-41) and is produced by the chemical industry. It consists of a mixture of 55 vol.% technical ethylene glycol and 45% water. It also contains a special additive (inhibitor) which prevents corrosion of the metal parts. The freezing point of standard antifreeze must be no higher than -40°C. At a temperature of -40°C, standard antifreeze is a mixture of ice crystals and liquid solution. A valuable property of antifreeze is that, even when completely frozen, its volume only increases by 0.25%, while water increases 9% in volume when it turns to ice.

At ratios of water to ethylene glycol other than those of the standard antifreeze V-2, the freezing point of the solution varies. The lowest freezing point (-75°C) will be that of a mixture consisting of 33.3% water and 66.7% ethylene

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glycol.

Technical ethylene glycol is inflammable, but when mixed with water in the form of antifreeze it is not a fire hazard.

Antifreeze V-2 expands on heating considerably more than water; therefore, to prevent overfilling of the cooling system in a warmed-up engine, the amount of antifreeze used must be 5-6% less than the total volume of the cooling system.

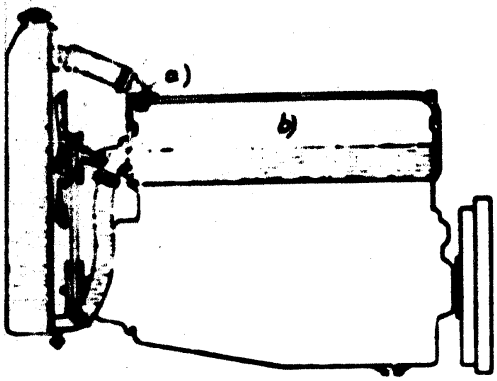

Fig.14 - Air Pocket in Water Jacket of Engine, Formed when the Water is Poured in too Rapidly
a) Thermostat closed; b) Air

During operation of the engine, the antifreeze may foam. The foaming is particularly intense, and leads to ejection of antifreeze from the cooling system, if petroleum products (gasoline, Diesel fuel, motor oil, etc.) get into it.

For this reason, containers used for storing antifreeze must be carefully cleaned to remove all residues of petroleum products, flushed with an alkali solution, and boiled; the antifreeze must be poured out or filled in only by means of well flushed pumps and clean filling vessels specially assigned for this purpose. Failure to observe this rule involves large losses of antifreeze. This has, in fact, happened in a number of automobile concerns, where antifreeze was transported and stored in gasoline containers.

Cases of foaming and loss of antifreeze may also occur where the engine cooling system is out of order (oil radiator of engine YaAZ-204, gaskets, water pumps of ZIS-5, etc.).

Antifreeze V-2 is poisonous and dangerous when taken internally. The accidental swallowing of evsn a small amount of antifreeze V-2 may cause severe poisoning, with fatal outcome. In transferring antifreeze with a hose, it is categorically

forbidden to aspirate it by mouth. Antifreeze in contact with the skin is not dangerous, but to prevent it from getting into the stomach with the food, the hands must be washed after working with it.

The period for using antifreeze is fixed in accordance with the local climatic conditions. The antifreeze must be filled into the cooling system before the onset of the first frosts and removed when warm weather becomes established.

To obtain good results when using antifreeze it is most important: first, to prepare the automobile carefully for the use of antifreeze; second, to maintain the necessary level and concentration of antifreeze in the cooling system during operation of the automobile; and third, to take measures for reliable starting of the cold engine. If the proper measures for meeting the above requirements are not taken, the use of antifreeze will not facilitate winter operations, and might even lead to additional difficulties.

Before filling with antifreeze, the cooling system of the engine must be flushed, and any leaks must be repaired. Before the flushing is finished, the cooling system must be inspected for any remaining water, since mixture with the antifreeze will raise the freezing point.

During operation, the level of the antifreeze must be checked daily. Since the amount of antifreeze used in the cooling system is 5 to 6% less than the total capacity of the system, it is difficult to check its level (when unheated) through the radiator neck. The level should be checked only with a fully warmed-up engine. To check the level before departure or during inspections, when the engine has not yet been warmed to 85-90°C, it is advisable to place a special overflow pipe on the inside of the upper reservoir of the radiator, at the level to which the antifreeze is filled.

As a rule the water evaporated from the antifreeze during the operation of the engine is replaced with fresh water. However, in actual operation it is often necessary to add not only water to the cooling system but also antifreeze to maintain it-

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necessary freezing point.

Practical experience with the use of antifreeze at a number of car manufacturers has shown that its water content and, consequently, also its freezing point, increases rather often. The basic cause for this is the drivers' habit of filling the radiator with water to the level of the radiator neck, every day before leaving, while the engine has not entirely warmed up. By acting in this way, when antifreeze is used, the driver is deliberately increasing the water content, since the antifreeze, which has a high coefficient of volume expansion, floods the system on heating to 80-90°C, and the excess is discharged through the overflow pipe or the safety valve (in automobiles with a hermetically sealed cooling system). If this operation is repeated every day, the antifreeze in the cooling system will finally have a very low ethylene glycol content, with a freezing point little different from that of water. It may also become necessary to add more antifreeze to the cooling system if not all the water has been removed from the system before filling it with antifreeze, if there are losses due to foaming of the antifreeze, if there are leaks in the cooling system, if the system has been filled up by adding water during operation, without checking or recording it, or for any other reasons. For this reason it is necessary, at each first technical inspection to regularly check the antifreeze (and in case of a sharp drop in the level of the liquid in the cooling system, immediately on return of the automobile to the garage).

In cases where the concentration of antifreeze is within the limits of tolerance, water or antifreeze are directly added to the cooling system: water, if the freezing point is below -40°C, and antifreeze, if it is above -40°C. After filling up the radiator, the antifreeze is retested.

If the antifreeze has a concentration outside the permissible limit (specific gravity, 1.05-1.08), it must be drained from the cooling system and corrected with the exactly established amount of water or ethylene glycol. If ethylene glycol is unavailable, an antifreeze with an elevated water content may be corrected by evap-

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orating the water from it at a temperature of 90-100°C.

Under garage conditions, the freezing point of antifreeze can be checked, with an accuracy sufficient for practical purposes, by determining its specific gravity

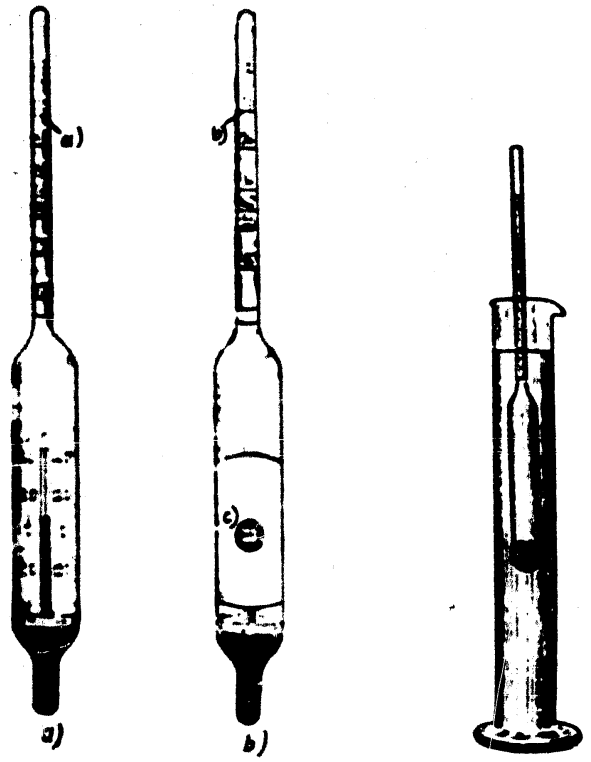

Fig.15 - Hydrometer for Determining Freezing Point of Antifreeze

a) Glycol, in volume-%; b) Freezing point, °C; c) Hydrometer readings correct at 20°C

(density) by means of a special hydrometer or, if this is unavailable, with an areometer having a scale from 1.000 to 1.100, and an accuracy of reading within 0.001.

The hydrometer (Fig.15) has two scales. The first scale "Glycol in percent by volume" indicates the percentage content of ethylene glycol in the antifreeze over

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the interval from 20 to 100%, while the second scale "freezing point in °C" (on the reverse side) indicates the freezing point of the antifreeze within the limits from -8° to -67°C. To determine the freezing point, 250-300 cm^3 of antifreeze is drained through the drain cock of the cooling system into a clean dry glass cylinder, and the hydrometer is submerged in it (Fig.16). When the oscillations of the floating hydrometer have stopped, the readings are taken on the upper meniscus of the liquid. While the measurements are being made, the hydrometer must not touch the walls of the cylinder.

At an antifreeze temperature of 20°C (permissible fluctuation 1°C), the hydrometer will give the actual readings. If the determination is made at a temperature above or below +20°C, however, a temperature correction based on Table 6 must be applied to the results of the measurement.

Table 6

Temperature Corrections for Determining the Actual Ethylene Glycol Content of Antifreeze

Temperature of Test Antifreeze in °C	Hydrometer Readings						
+40	5	14	23	32	42	46	50
+30	8	17	27	36	46	50	55
+20	10	20	30	40	50	55	60
+10	11	22	33	44	54	59	65
0	12	24	35	47	58	63	69
-10	13	26	37	50	62	67	73
-20	14	28	39	52	65	71	77

We present below an example for using Table 6: At a temperature of -20°C for the test liquid, the hydrometer shows a 71% ethylene-glycol content in the anti-

freeze.

Using Table 6, locate the figure 71 in the column for a temperature of -20°C; then in the same column, above, in the line for the temperature +20°C, locate the figure 55. This is the true ethylene glycol content of the antifreeze.

Knowing the ethylene glycol content, the freezing point of the antifreeze can be determined from the hydrometer scale, or from Table 7.

In determining the specific gravity of antifreeze by an areometer, the procedure for the measurement is analogous to that indicated above for the hydrometer. The temperature correction in this case is calculated in the following way:

The correction for 1°C, equal to 0.0006, is multiplied by the difference between the temperature at which the measurement is made and the standard temperature (+20°C); the product obtained is added to the directly measured specific gravity at the given temperature (if the measurement was made at a temperature over +20°C) or subtracted from it (if the measurement was made at a temperature lower than +20°C).

The freezing point of antifreeze is determined from its specific gravity by using Table 7.

Table 7

Freezing Point and Specific Gravity of Mixtures of Technical Ethylene Glycol with Water

Water Content in % (by Volume)	Freezing Point in °C	Specific Gravity at 20°C	Water Content in % (by Volume)	Freezing Point in °C	Specific Gravity at 20°C
0	-12	1.115	45	-42	1.073
10	-30	1.106	50	-34	1.068
21	-49	1.099	60	-24	1.057
28	-58	1.091	70	-13	1.043
33	-75	1.086	80	-9	1.029
40	-55	1.079			

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STARTING A COLD ENGINE

Conditions Necessary for Easy Starting of a Cold Engine

For easy starting of automobile carburetor engines, the following three conditions must be satisfied:

1) The engine crank shaft must rotate easily at a speed sufficient for fine atomization of the fuel, and for enabling the force of explosion in one cylinder to turn the crankshaft to the position at which an explosion will take place in the next cylinder;

2) The finely atomized fuel must be well vaporized, ensuring its ignition;

3) There must be strong spark between the electrodes of the sparkplugs, able to explode the fuel mixture.

In Diesel engines, the rate of rotation of the crankshaft during the time of starting must provide a cylinder-air temperature at the end of the compression stroke of sufficient value to ensure proper ignition of the injected fuel.

All these conditions are of equal importance; if even a single one is absent, the engine will not start. In addition, as soon as the engine starts running, the oil must be pumped in sufficient quantity to the wearing parts to avoid excessive wear.

In summer, and also in winter when the automobile stands in a warm garage, checking whether the engine has been filled with the proper kind of oil is not difficult. The temperatures of the engine parts and of the suction air are entirely adequate for a satisfactory vaporization of the gasoline in carburetor engines, or

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for a dependable ignition of the fuel in Diesels. The starting of an engine in good shape causes no trouble under these circumstances, and the wear of the parts does not increase.

An entirely different situation occurs in winter when the automobile is kept in the open (without garage) or on long standing in line during the working day, when a completely cold engine must be started.

In this case the oil that has solidified in the gaps between the moving parts has a viscosity so high that it is difficult for the crankshaft to rotate at the necessary speed. If the engine is filled with a summer grade of oil, for example, with motor oil 10, it is almost impossible to turn it over by the usual methods (starter or crank in very cold weather. The low crankshaft speeds do not provide the necessary atomization of the fuel, and its vaporization is impaired as a result of this poor atomization, and also because of the fact that, at the low temperatures of the intake air, of the walls of the intake manifold, cylinders and cylinder head, the fuel does not receive the heat necessary for vaporization. As a result, a large part of the aspirated fuel (90-95%) accumulates as a liquid film at the lower part of the intake manifold, and only 5-10% of fuel(in very cold weather, even less than that) in an atomized and partially vaporized state enters the cylinders. Thus, in order to accumulate the minimum amount of working mixture in the cylinders necessary to obtain an explosion, the engine must be turned over for a long time with the throttle valve of the carburetor closed, which means, in colloquial language, that the fuel is "sucked in". As soon as the first explosions occur, the entire mass of liquid unatomized fuel, accumulated in the intake manifold during the suction stroke, is aspirated into the cylinders. If the throttle valve is not opened at the very first explosions, the mixture will be far too rich, liquid gasoline will cover the walls of the combustion chamber and of the cylinders, large drops will settle on the sparkplug, and the engine will stall. At the same time the unevaporated gasoline will dilute the oil and wash it off the walls of the cylinders,

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pistons and piston rings, thus increasing the wear of these parts.

The force required for turning the crankshaft of a cold engine by means of the starter is many times increased, the voltage of the 6-volt storage battery drops to 3-4 v, the voltage induced in the high-voltage circuit decreases correspondingly, and the spark on the electrodes of the sparkplugs becomes considerably weaker.

In Diesel engines, at a crankshaft speed insufficient for starting, the air will give off a considerable amount of heat to the cold walls of the combustion chamber, and its temperature at the end of the compression stroke will be insufficient for proper ignition of the fuel.

The oil in the gaps between bearings, crankpins, distributor shaft, pusher rods and their guides, will drain out as soon as the engine starts operating, while fresh oil no longer will reach these gaps since not enough of the stiffened oil can be pumped through the ducts of the lubricating system. Similarly, the oil lubricating the cylinders, pistons, and piston rings will spread poorly. As a result, the wearing parts will be improperly lubricated, and their wear will increase.

At first glance, the wear on the engine during starting may not seem important, since the time spent in starting the engine is short, relative to the total operating time of the automobile on the line. In reality, however, the wear of the engine parts during starting and warming up may amount to 50-60% of the total wear for the entire operating period of the automobile. To illustrate this statement, it has been found that, during a single starting and warming up of the engine at a temperature of +5°C, i.e., the usual temperature of a heated garage in winter, the same wear occurs as during a 30-40 km run of the automobile with a warmed-up engine. However, on starting a cold engine, filled with high-viscosity oil, in cold weather, the wear will be still greater and, for a single starting, may amount to as much as the wear during a run of 200-250 km.

The above difficulties require special technical measures and special methods for dependable starting of a cold engine in winter. The importance of rapid start-

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ing of the engine in winter is obvious. All drivers know the excessive stopping and loss of operating time of automobiles in winter if the vehicle is not equipped with the necessary means for facilitating the starting of a cold engine.

In very cold weather, the difficulties of starting are still greater. At temperatures down to -10 to -15°C the driver is still somehow able to cope with the job of starting the engine, while still colder weather often requires towing, heating the crankcase with a torch, and other inefficient starting aids, which are at the same time harmful and dangerous for the engine.

Modern automotive technology nas several means available for facilitating the starting of a cold engine, while in practice many procedures have been worked out, particularly by the advanced workers in automobile transport, the Hundred-Thousander Drivers, for dependable starting of the engine in any weather.

Many of these methods are widely known to drivers and are not novel; however, it occurs frequently that drivers, even after long experience, make elementary mistakes and are unable to start an engine in very cold weather.

Methods for easier starting of a cold engine in winter, i.e., easier turning over of the crankshaft, and methods for obtaining an easily inflammable fuel mixture as well as low starting wear of the engine parts, can be arbitrarily classified as follows:

1) Facilitating engine starting by preheating;

2) Facilitating engine starting by the use of special winter oils or their substitutes, and of devices for improving fuel atomization and evaporation.

The principal requirement for any method of facilitating the starting is that it must make it possible to turn over the crankshaft of a carburetor engine at a speed of at least 40-60 rpm, and of a Diesel engine at a speed of at least 100-150 rpm. The higher the speed of the crankshaft in starting, the better will be the atomization and evaporation of the fuel in carburetor engines, and the better the ignition quality of the fuel in Diesels.

The rotation of the engine crankshaft at the required speed is opposed by the force of friction between the parts, which increases many times at low temperatures, due to the increased viscosity of the oil. The force necessary for rapidly rotating the crankshaft also increases accordingly. Therefore, the first requirement to be met by any method for easier starting of a cold engine is that it must reduce the viscosity of the oil in the clearance between piston and cylinder rings, or crankpins and bearings, as well as in the gaps between other parts. This problem is best solved by using special winter oils, but in very cold weather, warming up may still be necessary. If motor oil 10 or ordinary motor oil 6 must be used in winter, its viscosity can be reduced only by considerable heating. In this case, the most important point is to warm up the cylinders, since, of the total friction between engine parts, the friction between pistons and piston rings and cylinders amounts to 70%, while from 10 to 20% consists of the friction between crankpins and bearings, while the friction of all other parts is only 10-15%. Thus, if conditions are obtained under which the viscosity of the oil on the cylinder walls and on the crankpins is not excessive, the power necessary for rapid turnover of the engine crankshaft can be supplied by the starter.

Before describing the methods for easier engine starting and discussing their advantages and disadvantages, it must be pointed out that the method must be selected in accordance with the operating conditions, the climate, and the properties of the fuel, oils, and coolant used.

For example, if an automobile is making short trips, returns every day to its starting point, and has no long stops in line, it will be entirely sufficient to provide for engine warming only before leaving the garage.

For long trips, facilities must be provided for starting the engine under difficult conditions, that is, the necessary devices and equipment for starting the automobile itself must be available.

The climate in which a given vehicle operates is of no less importance for

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proper selection of starting aids. In the north, where the winter is long, and the temperature drops below -30°C, a combination of as many starting aids as possible is necessary, i.e., winter lubricating oils, warming up, devices for mixture control, etc. In regions where temperatures below -20°C are rare, a smaller number of different starting aids will be sufficient.

When winter grades of oil or their substitutes (for example, mixtures of SU machine oil and AU spindle oil) are available, the starting of a cold engine is considerably facilitated, so that heating, in a temperate climate, may be necessary only on very cold days; for this purpose it is sufficient to have hot water available for pouring into the cooling system.

When antifreeze is used in the cooling system, the starting methods necessarily differ from those used when water is the coolant. In this case, the use of winter oils to facilitate turning the crankshaft is a prime requisite; it is advisable to use devices for injection of atomized fuel into the intake manifold in order to improve mixture formation. In very cold weather, if it is still necessary to heat the antifreeze, a starting heater installed in the automobile should be used. It is useless to drain the antifreeze, heat it, and then pour it hot into the engine like water, since this reduces the advantages of antifreeze to zero.

Thus the various methods and devices for easier starting of a cold engine, described below, must be selected only on the basis of specific conditions. There is no point in using a large number of complicated and expensive devices where this is not necessary, but all necessary technical means of ensuring a reliable starting of the engine must be used under severe conditions.

Warming Up the Engines

Heating is the most widespread and practically tested starting and for a cold automobile engine. It should be mentioned, however, that even the best special winter oils still require warming the engine before starting. Winter oils that permit starting of an engine without warming at temperatures down to -20 to -28°C,

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are unable to ensure entirely reliable starting at still lower temperatures. In addition, heating is very useful even at higher temperatures. For example, according to the data of tests made at the Central Research Institute for Automobile Transport, at outside temperatures of -3°C and operation on motor oil 6, the average starting time, using the starter, was 7 sec for a preheated engine and 41 sec for an unheated engine. At the same time, the starting wear of a heated engine was 30% less than of an engine started from cold.

All methods of warming engines of automobiles stored in the open can be divided into the following two groups:

1. Heating the engine immediately before starting it. In this case, the automobile remains cold during the entire inoperative period while the water is drained from the cooling system. It is only before the beginning of the working day that the engine is warmed to a temperature sufficient for easy starting. This method of heating includes the following: heating the engine by pouring hot water into the cooling system, heating by steam, heating by a starting heater permanently installed on the automobile, as well as a few other less popular methods.

2. Keeping the engine in a heated condition during the entire period of standing between shifts, by continuous introduction of hot water or steam into the cooling system, or by means of electric heaters.

When any of the above heating methods are used, the engine must be warmed to a temperature not lower than +30°C.

Warming the engine by pouring hot water into the cooling system is the simplest method of facilitating starting and is widely used in garage practice. In spite of the simplicity of this method, however, it gives good results only if certain rules are observed, to ensure proper warming of the engine and safeguard against freezing of the water after filling.

The water for warming the engine must be heated to boiling and poured into the cooling system before the system has cooled off. The temperature of this water

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should be 90-95°C. Water at a temperature lower than this should not be used, since it will cool off at once, the engine will not be thoroughly warmed, and, in addition, the danger of the water freezing during the filling process is very much increased.

The water must be poured into the engine cooling system through a suitable funnel, without removing the protective cover, which should cover the hood and radiator.

When pouring begins, the drain cocks should be open. If the water does not flow out, the pouring must be immediately stopped, and the openings of the cocks cleaned out with a wire, or, if they have frozen, the lower part of the radiator and the lower water pipe must be heated.

It is preferable to do this heating by turning a jet of steam on the frozen parts of the system. This is not always possible, however; therefore, rags are usually wrapped around the frozen places and hot water poured over them.

It has been established by practice that, at temperatures down to -10°C, the amount of hot water required to warm an engine equals 1.5 times the capacity of the cooling system, at temperatures from -10 to -20°C, 1.5 - 2 times that capacity, and at temperatures below -20°C, not less than 2.5 times that capacity. At ambient temperatures of -10 to -15°C, 8-10 minutes after pouring is started, the temperature will reach 20-25°C in the cylinder head and the cylinders, 5-8°C in the crankshaft bearing, and 2-3°C in the fuel intake manifold.

The oil in the crankcase is entirely unwarmed and remains at the same temperature as before the beginning of the warming. Within 10 or 15 minutes after pouring begins, the temperature of the water in the water jacket of the engine and the metal of the block becomes about the same, and further warming up of the engine stops. At this moment, the engine should be started.

At still lower outside temperatures, and especially in strong wind, the time for warming up is increased accordingly.

Thus pouring hot water into a cold engine provides proper warming of the cylinders, less efficient warming of the crankshaft bearings, and no warming at all of

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the crankcase oil.

When summer grades of oil (motor oil 10 or ordinary motor oil 6) are used in winter, it is advisable to use hot water for facilitating the starting at outside temperature as high as +5°C.

If the engine is filled with a winter grade of oil (motor oil 1 or a mixture of SU machine oil and spindle oil), it can be turned over at the necessary speed, at temperatures down to -10 to -15°C, even without warming; at lower temperatures than this, warming with hot water will reduce the viscosity of the oil on the cylinder walls, making it easy to turn over the crankshaft. At the same time, the heated fuel intake manifold improves the mixture formation.

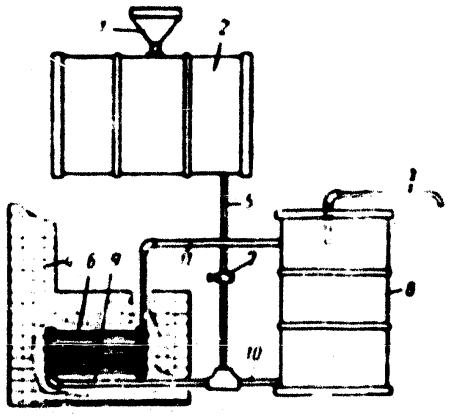

Fig.17 - Diagram of Continuous-Action Water Heater

1 - Filling funnel; 2 and 3 - Metal tanks; 3, 5, 9, 10 and 11 - 1.5" pipes; 4 - Brick oven; 6 - Section of heating battery (or pipe coil); 7 - Cock

A boiler may be used at the hot-water source in large garages. In the absence of a boiler, or if its capacity is insufficient, it is advisable to use water heaters of the "Vulcan" and "Titan" types.

The use of water heaters has the advantage that the discharged water is softened, thus reducing scale formation in the cooling system.

In automobile concerns, the simplest stationary water-heating installations may be installed by the personnel themselves.

Figure 17 is a diagram of such a continuous-action installation.

Cold water from the tap or the metal tank (2) fills the entire system of the heater when the cock (7) is opened. The system is completely filled when the water shows in the tube (3). As the sections

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of the heating battery (6), embedded in the brick oven (4) are heated, the heated water passes through the pipe (11) to the upper part of the drum (8), while the cold water from the lower part of the drum (8) passes through the tube (10) into the battery. In 15-20 min after the start of heating, with a good fire, the water in the upper part of the drum (8) is heated to 70-80°C, while the water in the lower part of the drum remains cold.

To fill the system with hot water, the cock (7) is opened so that the cold water from the main or from the drum (2) begins to enter the lower part of the system through the pipe (5), displacing the heated water from the upper part of the drum (8) through the pipe (3) into a vat catch basin.

An even simpler batch-type water-heating installation can be installed by using an ordinary drum set into a brick oven (Fig.18). With such a device, about 200 liters of hot water an hour can be obtained from a 250-liter drum.

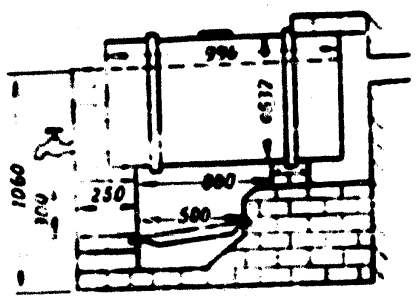

Fig.18 - Water Heating Installation using a Gasoline Drum

The portable water and oil heating system developed by Engineer A.A.Antonov and manufactured by the GARO Trust (Fig.19 is widely used in small automobile concerns. The installation consists of a boiler with heat insulation, an oil tank, a firebox, a fire tube, a smoke box, a flue, a return flue, a stack, and sled runners. The boiler is made of 1.5-2 mm gage iron and is heat-insulated with three layers of tar paper and felt, covered with wooden planking. A flue runs from the furnace through which the heated gases pass to the rear smoke box, where they are returned through a side passage to the front wall of the boiler into the smoke box, and then enter the smoke tube.

The oil tank (4) is made of (2) mm iron and consists of a pipe placed in the

the water space of the boiler.

The water-oil heater is filled with water or snow through the port (9), and with oil through the funnel (3). The heated oil is discharged through the cock (11), and the water through the cock (10).

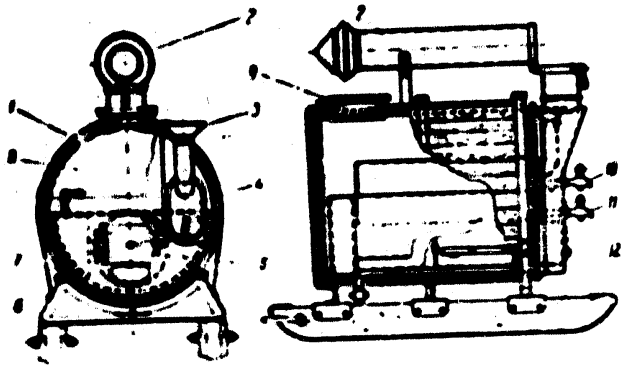

Fig.19 - Portable Water-Oil Heater GARO:

1 - Barrel of water heater; 2 - Flue of furnace; 3 - Funnel for filling in oil; 4 - Oil tank; 5 - Stove; 6 - Supporting frame; 7 - Spring clip; 8 - Water reservoir; 9 - Hatch for filling water or snow; 10 - Cock for draining hot water; 11 - Cock for draining heated oil; 12 - Runners of sled

Because of the type of grate used, any solid fuel can be used in the heater.

The capacity of the water reservoir of the water-oil heater is 180 liters and that of the oil tank 54 liters; the length of the water -oil heater is 2000 mm, its width 1020 mm, its height with lowered flue 1725 mm, with raised flue 2272 mm, and its weight empty is 440 kg.

It may be necessary to heat the crankcase oil, if the engine is filled with motor oil 10 or motor oil 6, in addition to heating the engine with hot water, at temperatures below 10-15°C. Despite the fact that the engine cylinders are heated by pouring in hot water, the inadequately warmed crankshaft bearings and other parts will still offer considerable resistance to the rotation of the crankshaft.

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In addition, the solidified oil cannot be pumped into the lubricating system, and the wear of the parts will increase.

The crankcase oil can be heated by pouring it into a clean, covered vessel when the automobile returns from the line, before the oil has cooled, and leaving it in a warm room until morning. Before the beginning of the working day, the oil is heated to a temperature of 80-90°C and is poured into the crankcase of the engine, already heated by hot water.

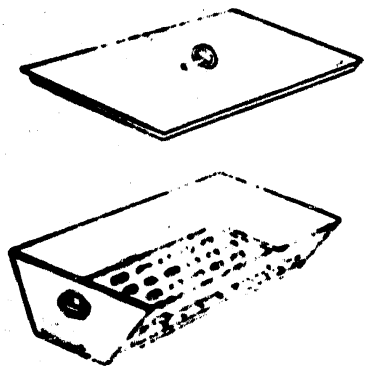

Fig.20 - Fire Pan for Warming the Crankcase

It is useless to pour in oil at a lower temperature, since it will immediately stiffen.

Oil from each engine must be drained into a separate vessel. The oil from different engines, with different degrees of contamination, should not be mixed in one container, since this will interfere with the normal system of changing the oil in the engines.

A second method is warming the crankcase with a brazier, without draining the oil. This method represents a fire hazard and needs special care and attention during the time of heating. Oil should be warmed by this method only if it is impossible to arrange for heating by the first method.

The brazier (Fig.20) consists of a metal trough, with a grate, installed at a height of 50-60 mm from the bottom of the trough, and a cover. To admit air under the grate, openings are made in the sidewall of the trough. These openings may be partly or entirely covered by means of a movable shutter. The fuel for the brazier is charcoal with which the trough is three-quarter filled. The heated brazier is placed under the crankcase on any support, in such a way as to make maximum use of

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its heat. The hood and radiator must under all circumstances be covered with the protective cover. Before proceeding to start the engine, removal of the brazier from under the automobile is compulsory.

The temperature of the cylinder block can more rapidly be raised to 30-40°C when the engine is warmed with steam than with hot water. For this method of heating, a boiler generating the necessary amount of steam at a positive pressure of 0.30-0.35 atm is needed, as well as a parking space provided with steam lines and devices for feeding the steam. Each automobile must also have special fittings for introducing the steam. The stub pipe for introduction of the steam is usually attached to the lower water pipe in such a way that the steam jet is directed along it toward the cylinder block.

Figure 21 shows an installation for supplying steam to the water jacket of the ZIS-5 engine. The same equipment can be used for feeding steam to engines of other models. A cold engine is heated by steam as follows: a flexible hose from the steam line, with a nozzle and connector nut, is filled with steam and connected to the cock (4), tightly compressed by the connector nut; by opening the cock, the steam is passed. The radiator plug must first be opened, and the engine hood and radiator covered with the protective covers. In 4-5 min after passage of the steam, water can be filled into the radiator. The water must not be poured in all at once, but in portions of 6 - 8 liters at intervals of 2-3 min. When all of the water has been filled in, it is heated to a temperature of 45-50°C. After starting the engine, the cock (4) is closed, and the hose with the connector nut is detached from the cylinder of the cock.

The use of steam at a pressure of 0.30 to 0.35 atm makes it possible to heat the cylinder walls of the engine to 30°C, at outside temperatures as low as -20°C, in 30-50 min.

Steam may be used not only for warming the cylinders but also for heating the oil in the engine and transmission units, by applying a steam jet from the hose to

their casings.

Warming the Engine by a Starter Preheater. An individual starter preheater, permanently installed on the automobile, provides for entirely reliable warming up

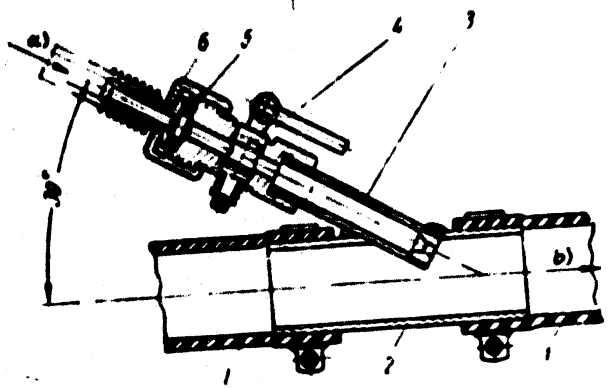

Fig.21 - Fittings for Introducing Steam into the Water Jacket of ZIS-5 Engine

1 - Lower water hose; 2 - Pipe 40 × 2 diameter; 3 - Lead-in Pipe with calibrated plug (opening 3.5 mm diameter in plug); 4 - Cock; 5 - Rubber gasket; 6 - Connector nut with stub pipe and hose. a) Steam from steam line; b) To water pump.

of the engine. When a liquid, freezing at low temperature is used, warming with a starter preheater is the fastest method of preparing an engine for starting. The advantage of such preheaters over the above-described methods lies also in the fact that the engine can be warmed up not only at the garage, but at any place on the line. This advantage is particularly important if the automobile is used for long trips and does not return to its base for several days.

In automotive transport, various designs of starter preheaters are known. At present, the most suitable design is the starter preheater with a heating (torch) lamp installed by the Gor'kiy Automobile Plant imeni Molotov on GAZ-51 automobiles.

Figure 22 gives the operating diagram for the GAZ-51 starter preheater. The gasoline torch (11) is installed in the pipe of the preheater boiler (5) underneath

the right front fender through a special opening; for convenience in maneuvering the torch, the rear wheels of the automobile are turned to the extreme left position.

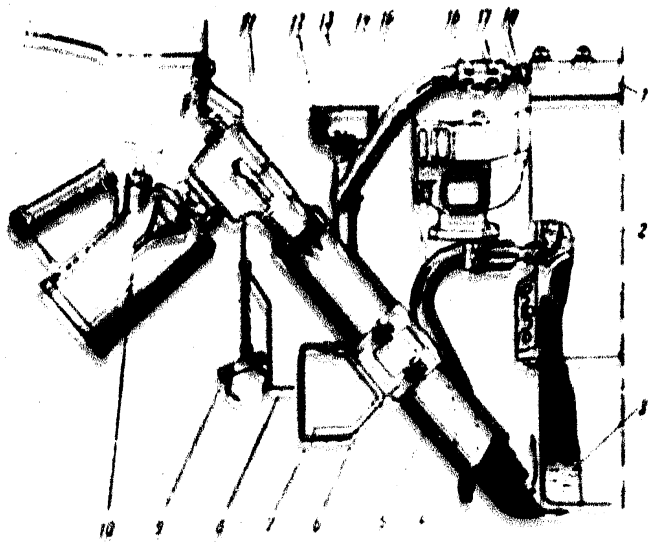

Fig.22 - Operating of the Starter Preheater SMD-5:

1 - Cylinder head; 2 - Jacket of liner; 3 - Oil from engine crankcase; 4 - Drain cock of boiler; 5 - Preheater boiler; 6 - Exhaust; 7 - Right engine support front mount; 8 - Impeller cover; 9 - Cover of boiler; 10 - Funnel for filling torch; 11 - Torch; 12 - Funnel for filling water into boiler; 13 - Water plug; 14 - Upper pipe of boiler; 15 - Lower pipe of boiler; 16 - Connecting pipe; 17 - Drive shaft; 18 - Stud pipe of cylinder head.

If water is used as engine coolant, the following procedure is used in the warming operation. The torch is lit, the drain cocks of the cooling system are closed, the plug (13) is unscrewed from the funnel (12), the torch is inserted in the preheater pipe, and the preheater and water jacket of the cylinder block are immediately filled with water through the funnel (about 3 liters); then, the plug in the funnel is again screwed shut. The engine is heated by the steam formed in the boiler of the starter preheater.

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It takes 15-20 min to heat the engine to a temperature of 45-50°C, at an outside temperature of -15 to -20°C, and 30-40 min at an outside temperature as low

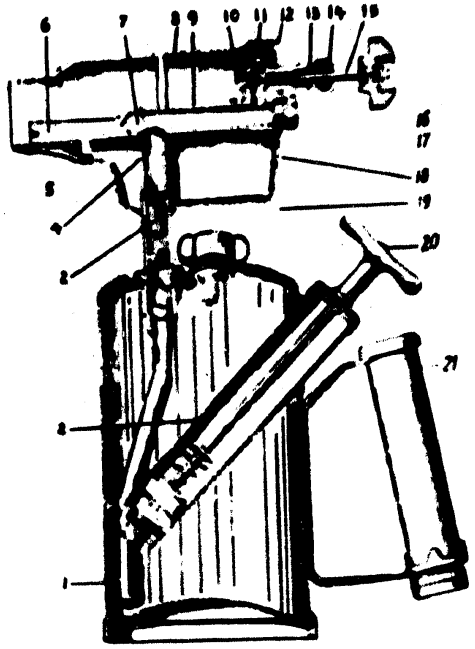

Fig.23 - Heating (Torch) Lamp:

1 - Receiving pipe; 2 - Air pump; 3 - Filter strainer; 4 - Vertical pipe; 5 - Glow rod; 6 - Shell of funnel; 7 - Horizontal passage of burner; 8 - Cover of burner; 9 - Strainer; 10 - Burner nozzle; 11 - Slit in cover; 13 - Stuffing box of valve; 14 - Nut of stuffing box; 15 - Adjusting valve; 16 - Vertical passage of burner; 17 - Plug of horizontal passage of burner; 18 - Burner pan; 19 - Plug of reservoir; 20 - Handle of pump; 21 - Handle of torch

as -30°C. The pipe of the preheater is so arranged that the hot gases from its exhaust port heat the engine crankcase and warm the oil. When the engine is warmed through, the hood is opened to permit the combustion products of the torch to escape, the engine is started, and the cooling system is completely filled with water through the radiator plug.

If a liquid freezing at low temperatures is used in the engine cooling system,

the torch is inserted in the boiler pipe without preliminary operations. On very cold days, it is important to check whether the antifreeze V-2 in the cooling system is in a liquid state. Solidified antifreeze will not circulate, and the boiler may burst when heated. Incidentally, installation and rules for handling the heating lamp (torch) should be mentioned briefly, since the reliability of the warming up depends entirely on the quality of its operation.

Figure 23 shows the structural diagram of the torch. The gasoline is filled through a funnel and through the filling plug (19) into a reservoir of 3 liter capacity. The pressure in the reservoir is produced by pumping in air by means of the pump (2). The gasoline reaches the burner through the tube (1), after passing through the screen filter (3). In the horizontal duct (7), the gasoline is partially evaporated. The evaporation is encouraged by the strong heating (to red heat) of the incandescent rod (5) during operation of the torch. The gasoline and gasoline vapors then pass through the vertical duct (16) to the upper part of the burner, where the gasoline is atomized through the nozzle (10) into the burner casing, where combustion takes place. The set valve (15) is used for regulating the length of the flame. To light the lamp, the burner cover (8) is lifted, and gasoline is poured into the drip pan (18) and lit. In all, 10-15 minutes are needed to heat the glow rod, after which the control valve may be opened. A torch in good condition burns with an even blue flame, with a low hiss. To prevent the pressure from dropping too rapidly during the time of warming up and to prevent frequent pumping of air, the reservoir must be only two thirds filled with gasoline. After every 40-50 hours of operation, the lines of the torch must be cleaned with wire scrapers and special brushes after opening the plugs (17) and (11). The nozzle (10) is cleaned with a primus-burner pin.

Prolonged Warming of Engines. In some automobile companies, the engines are kept warm during the entire period of standing between shifts. Such warming is effected by steam, hot water, or electric energy. For any of these methods of

extended heating, a well equipped parking space is required. For steam warming and hot-water warming, the automobile depot must have a boiler, a steam or hot-water system, devices for feeding steam or hot water into the engine, and on each motor vehicle a fitting for introducing the steam or hot water. The arrangement of such fittings is shown in Fig.21. In heating with hot water, a fitting for draining the water that has cooled in the engine into a return pipe running to the boiler is also necessary. The steam for warming is introduced directly into the engine cooling system filled with water. The steam transfers its heat to the water, i.e., the steam condenses and is converted into water. The excess water formed in the cooling system raises the level in the radiator and overflows through the test pipe to the ground.

If the motor vehicle is connected with the steam line as soon as it returns to the garage, and 4-5 kg of steam under 0.3-0.4 atm pressure is fed per hour, then the cylinder walls will be kept steadily at 60-80°C during an outside temperature of -20°C. The oil in the crankcase however, will cool off with this method of heating, and after 5-6 hours of standing, the temperature of the oil in the vehicle will reach 0°C and will continue to drop gradually.

In warming engines with hot water, in addition to the fitting for introducing it into the engines, a special air-tight connection is built for the radiator neck for draining the water into the return line, while an adapter with a cock, which latter is closed during the time of warming up, is soldered or welded onto the test pipe.

The water, heated to 70-80°C, is fed under pressure of not more than 0.4 atm by a pump through the hot-water boiler into the distributing manifold, placed in warmed boxes near the parking spot. Each vehicle stall has a rubber hose with an adapter connected with the line for filling hot water into the lower pipe of the cooling system. After passing through the engine and the radiator, the hot water is drained to the return line through the adapter and rubber hose connected to the

radiator.

With this heating method feeding 1.5 - 2 liters of hot water per minute into each vehicle, the temperature of the cylinder walls is kept at least at +4.0°C, but the oil cools off rather fast. After 3 or 4 hours of parking, its temperature drops to 0°C.

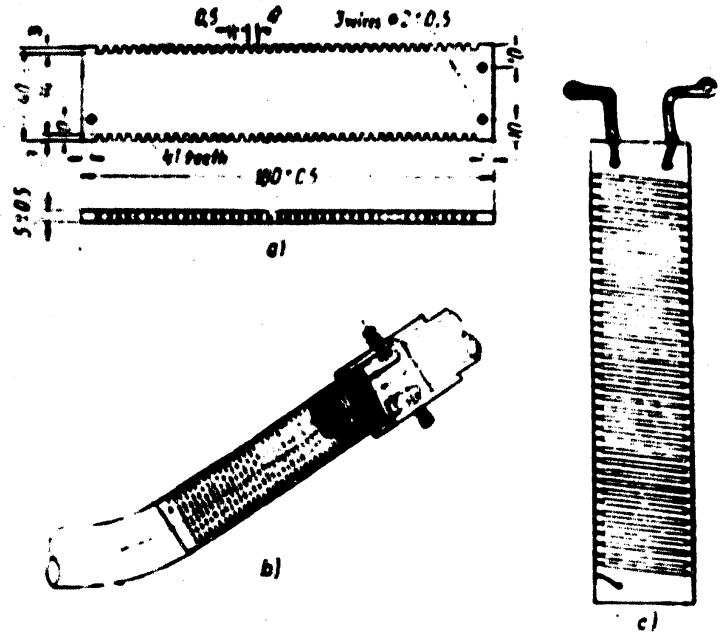

Fig.24 - Simplified Electric Heater for the GAZ-M Engine

a) Core; b) General view of the element; c) Mounting of the element into the pipe of the cooling system

The main disadvantage of extended warming against the warming up before starting the engine, is the high consumption of steam or hot water.

As an example, it may be pointed out that when 4-5 kg of steam per hour is supplied for 8 hours into the standing automobile in a garage, the total consumption of steam necessary for keeping the engine warmed up amounts to 32-40 kg, while only 7-8.5 kg of steam or roughly one fifth is needed to heat up a cold engine. But heating is advisable only when the storage time of the automobile is short, and

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also if, owing to the operating conditions, it must be kept ready to start.

Electric warming. In service garages where a large amount of electric power is available, electric heaters are sometimes used for keeping engines warm. The efficiency of the electric heaters is so selected as to supply, when the current is turned on, an amount of heat suffucient to maintain a constant temperature of the coolant, in moderately cold weather, during the entire period of standing between shifts. For the rapid heating of the engine before starting, electric heaters are not used, since this would take very strong electric heaters, and the increased consumption of electricity during the starting time of the engines, especially in large service stations, would produce a strong fluctuation in the electric system.

The simplest device for electric heating of automobile engines is shown in Fig.24. The device consists of a flat textolite or wooden core with serrations on which a high-resistance alloy wire is wound. At a voltage of 110-120 v for GAZ-MM automobiles, 2-2.5 m of wire of 0.4 mm diameter is used, and for the ZIS-5 automobiles 1-1.5 m wire of 0.5 mm diameter.

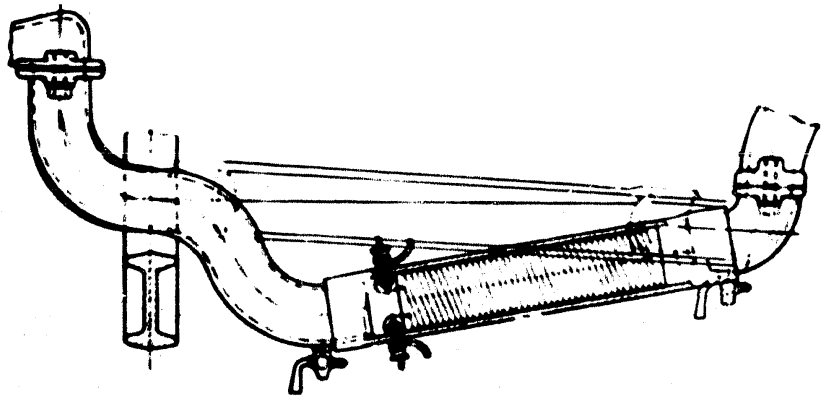

Fig.25 - Mounting of the Heating Element into Pipe of Cooling System of ZIS-5 Engine

The winding is carried through serrations. At the lower end of the core, the wire is passed through the opening and the winding is then continued in the opposite direction.

Over the entire length of the core, the loops of wire must not cross or touch. The ends of the high-resistance alloy wire are attached and soldered to a multi-strand copper wire connected with screw clamps.

When the electric heater is installed, the proper circulation of the cooling liquid in the engine must be assured.

In heating the engines of GAZ-MM automobiles, the heater is inserted into the bottom pipe of the cooling system and the screw connections are passed through a rubber hose. The circulation to the block in this case is due to the inclination of the lower pipe (Fig.24c).

For the installation of this same heater in the ZIS-5 engine, the branch pipes in the system must be replaced by new ones so that the lower pipe of the cooling system has an upward slope toward the water pump, as is shown in Fig.25.

To avoid accidents in electric heating, it is mandatory to ground the automobile body. For this purpose, a third contact "to body" is installed near the contacts of the electric heater. A three-wire line is used for connections with the electric power system. Two of these conductors run to the contacts of the heating spiral, while the third connects the automobile body with a ground wire. For convenience, this latter may be connected into the same outlet.

An advantage of this form of heating over steam and water heating is the simplicity of the equipment in the service garage and the starting of the heaters. In addition, electric heating allows the simultaneous warming of the low-temperature cooling system.

The disadvantages of electric heating consist in the relatively large consumption of electric power, the need for very attentive supervision of the electric fittings to avoid accidents, the heavy losses of current, and the fact that if the electric wiring of the heating coil burns out, the water may freeze.

DEVICES FOR IMPROVING THE ATOMIZATION AND EVAPORATION OF FUEL IN STARTING

One of the principal conditions of easy starting of a carburator engine is

the fine atomization and maximum possible evaporation of the fuel.

The basic condition for improving the starting mixture is the speed with which the crankshaft turns over. In addition, especially in starting an engine from cold, special devices for fine atomization and evaporation of the fuel during starting may be used.

There are many different designs for devices of this type. Here only the two will be mentionsd, which gave the best results in operation and have been standardized:

1) the AP device for injecting starting fuel (GOST 4687-49);

2) the automobile starting-gas generator PGG-1 (GOST 4768-49).

The AP device is designed to inject finely divided fuel into the intake pipe of a cold carburetor engine immediately before and furing starting. It must be borne in mind that well-atomized fuel, by itself does not ensure easy starting, and therefore the crankshaft must turn over easily also when using the AP device. When using low-viscosity winter oils (brands 4 and 6 by TU 375-51) and standard gasoline the AP device will produce a smooth starting of the engine without preheating, at temperatures down to -15 to -20°C. In colder weather, a special starting gasoline must be used, or the engine must be prewarmed. The use of the AP device is useful at outside temperatures of +5°C and lower.

The AP device is shown in Fig.26. It consists of a hand plunger pump with a suitable cylinder volume of 10 cm^3 and a working pressure up to 8 atm, a tank for the starting fuel, of 1 liter capacity, a system of fuel lines, and nozzles with diffusors. The pump is mounted on the panel board near the driver's seat. The nozzles are screwed into openings especially drilled for this purpose into the intake pipe. The tank for the starting fuel is installed, depending on the design of the automobile, for the maximum convenience of access in filling with starting fuel, and in the use of the stop cock. The tank must not be located in the immediate vicinity of the starting system of the engine, to avoid heating.

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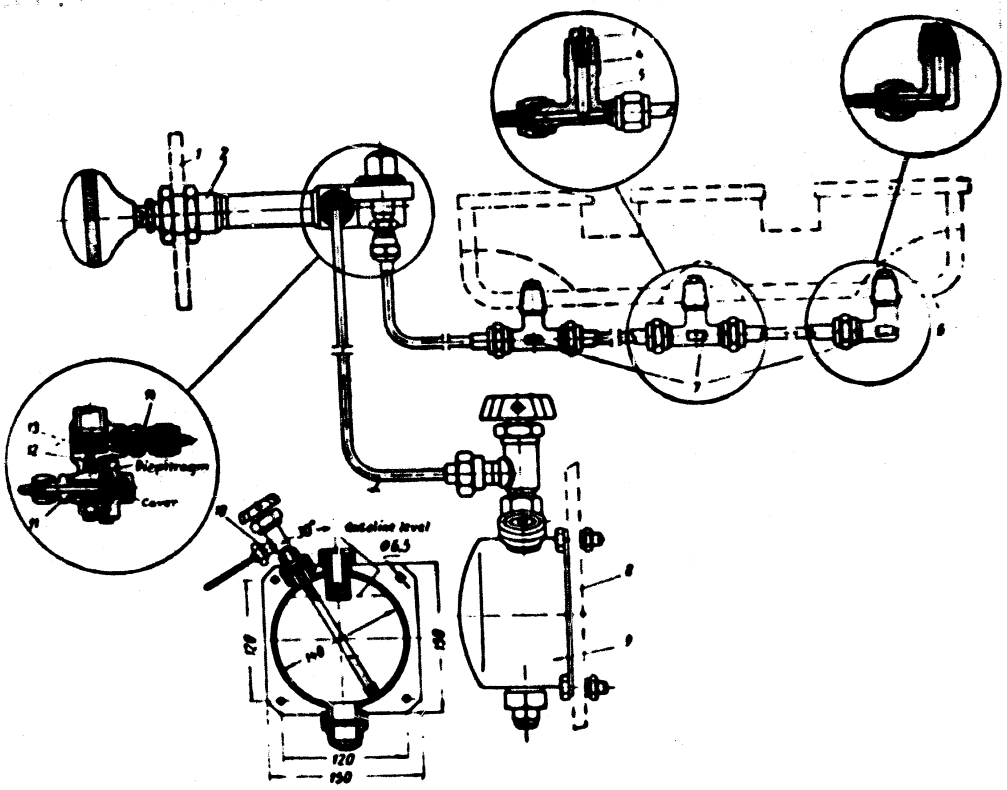

Fig.26 - Diagram of AP Device for Injecting Starting Fuel:

1 - Instrument board; 2 - Hand pump; 3 - Jet; 4 - Diffuser; 5 - Body of nozzle; 6 - Intake pipe of engine; 7 - Nozzles; 8 - Front panel of cab or side panel of hood; 9 - Tank containing starting fuel; 10 and 11 - Outlet fitting; 12 - Exhaust valve; 13 - Cup; 14 - Inlet valve.

Before the hand pump is installed, the starting-fuel tank, the nozzles and the gasoline lines must be flushed with kerosene or with unleaded gasoline and blown out with compressed air. During the use of the device, the part of the piston rod moving in the stuffing box must be greased, and the filter of the starting-fuel tank must be periodically cleaned.

The procedure for starting the engine using the AP device is as follows:

1) Test the ease with which the engine crankshaft is turned over by hand;

2) close the air shutter of the carburetor;

3) pull out the control of the throttle valve as for ordinary starting (on the carburetors of new models, this operation is automatic and the choke cannot be pulled out);

4) open the stop cock of the feed tank, slowly draw the handle of the pump toward yourself, and then energetically inject fuel by exerting a strong pressure on the handle;

5) turn the ignition on and, start the engine by turning over the crankshaft;

6) as soon as the engine starts to operate smoothly, open the air valve of the carburetor and close the stop cock of the feed tank.

In starting the engine by the aid of the AP device, no gasoline must be pumped by means of the accelerating pump of the carburetor.

The starting-gas generator for motor vehicles PZG-1 is designed to supply fuel vapor to the air tubes of the carburetor at outside temperatures of -5°C to -45° or -50°C. The gas generator is used to facilitate the starting of a group of automobiles and is permanently installed in the garage, not on the individual vehicle like the AP device. If the crankshaft turns over easily, the fuel vapor entering the intake tube from the gas generator makes it possible to start the engine easily at outside temperatures as low as -45 to -50°C without warming the intake tube.

Figure 27 shows a scheme of the device and a general view of the starting-gas generator. The gas generator consists of a gasoline tank with a pump valve and

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safety valve, a coil evaporator with a burner enclosed in a mutual housing, a base, and a cover. It is 350 mm long, 190 mm wide, 315 mm high and weighs 4.3 kg without the casing and 6.3 kg with the casing. The gasoline tank holds 2.4 liters. The gas generator operates on the standard automobile gasoline which is filled into the gasoline tank through a funnel with a strainer to a level 10-15 mm below the neck.

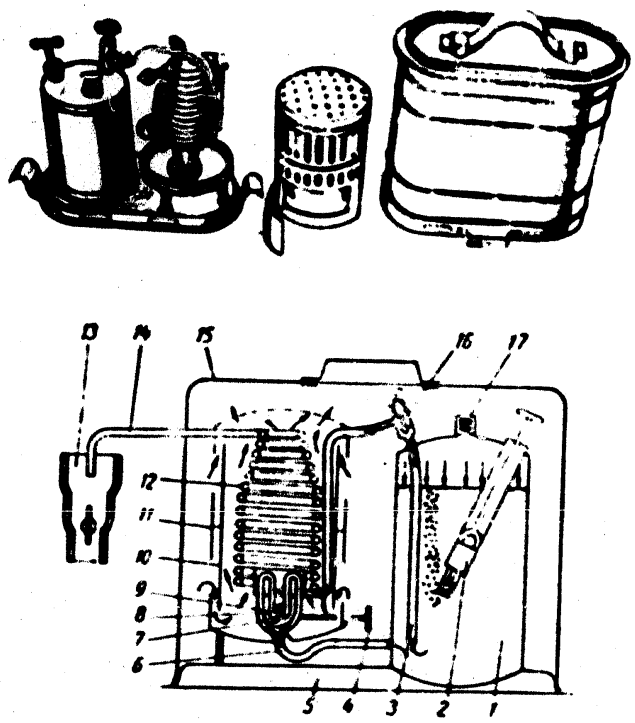

Fig.27 - General View and Layout of the Starting-Gas Generator, Portable Type, with Coil Evaporator:

1 - Gasoline tank; 2 - Hand pump; 3 - Feed pipe; 4 - Burner valve; 5 - Base of gas generator; 6 - Feed pipe; 7 - Needle for mechanical cleaning; 8 - Burner nozzle; 9 - Gas line; 10 - Inner cylinder of coil evaporator; 11 - Outer cylinder of coil evaporator; 12 - Coil evaporator; 13 - Air line of carburetor; 14 - Exhaust pipe; 15 - Casing; 16 - Valve; 17 - Filler neck and safety valve.

To avoid fires, the gas generator is lit not closer than 5 m from an automobile. Before lighting, air is forced by means of the handpump into the gasoline tank to a pressure of 2.5 atm (the safety valve is gaged to the same pressure). The valve of the coil evaporator and burner must be closed during this operation.

The heating of the burner is the same as in starting up a blow torch or primus stove: into the pan of the cylinder, under the burner, gasoline is poured and lit. As soon as the burner is hot, the valve is opened and its burning rate is adjusted.

When the coil is heated to a cherry-red color, the valve of the evaporator is opened. If the vapor leaves the outlet pipe in an even jet, without drops of liquid gasoline, the gas generator is considered ready for operation.

The procedure for starting an engine by means of the starting gas generator is as follows:

1) Test the ease with which the crankshaft turns over by hand;

2) open the choke of the carburetor to 1/3 -1/2 of its full opening;

3) open the air ofthe carburetor not less than half of its full capacity. To reduce the starting wear, it is recommended that the starting be made with an empty carburetor float chamber;

4) turn on the ignition;

5) place the lighted gas generator on the running board or fender of the vehicle; insert the exhaust pipe of the gas generator into the air intake pipe of the carburetor;

6) open the valve of the evaporator in such a way that a small quantity of gasoline vapor emerges from the air line of the carburetor;

7) turn over the engine crankshaft by using the crank. On the first explosions in the cylinders, rapidly open the valve of the coil evaporator and adjust the operation of the engine to idling speed;

8) warm up the engine for 3-6 minutes on the fuel vapor from the gas generator, then close the valve of the coil evaporator and continue to work on the fuel supply

from the automobile fuel-supply system.

After completing the starting operation of one or several engines, the valve of the burner and evaporator are closed and the air is released from the gasoline tank by opening the plug of the filler neck.

Assuring Reliable Sparking in Starting Carburetor Engines

The presence of a strong spark between the electrodes of the sparkplugs during the time of starting the engine is not less important than the easy turnover of the crankshaft or good vapor mixture. If the spark from the sparkplug is weak, the engine cannot be started even if it is most carefully adjusted.

No additional devices are needed on the automobile to assure the reliable functioning of the ignition system when starting a cold engine. It depends exclusively on the proper care, adjustment, and setting of the rotor, the distributor, the sparkplugs, on the ignition coil, the high and low tension lines, and the condition of the storage battery.

The special features of the action of the ignition system on the starting of the engine are as follows:

When the crankshaft, even of a hot engine, is turned over by the starter, the voltage in the primary circuit with a 6-volt electrical system drops to 3-4 v, and in a 12-volt system to 8-9 v. The voltage induced in the high-tension circuit is correspondingly reduced. If, however, the storage battery is partly discharged, or if there are current leaks or poor contacts in the high and low tension lines, the voltage will be still lower and the spark will be unable to ignite the fuel mixture. It is therefore necessary that the storage battery is fully charged, that the low and high tension lines have no leaks, and that their connection to the corresponding terminals is entirely reliable.

The ignition coils in GAZ-51, ZIS-150, GAZ-M 20 automobiles with a 12-volt electric system have an additional resistor (variator) which is shorted when the starter is turned on by closing additional contacts located on the starter switch.

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Thus, at the moment of starting the engine, the current flows through the primary winding, by-passing the additional resistor, i.e., it operates as a 6 volt system, while the voltage in the primary circuit amounts to 8-9 v, thus increasing the power of the spark. In the course of the technical inspection of the starter, the instant of closure of the contacts shorting the additional resistor must be checked by means of test bulbs. The contacts must close simultaneously with the switching on of the starter, or a little before it.

The care of the distributor in winter is not different than the usual care: the contacts must be regularly cleaned and the setting must be properly adjusted. The peculiarity of winter conditions is that on varying the temperature, e.g., while the engine is being warmed up or when the cold automobile is placed in a warm garage, small drops of water, producing leakages of current, may condense on all parts, including the distributor, the wiring, and the sparkplugs. For this reason, before turning on the ignition, the distributor, the ignition coil, the wiring and sparkplugs must be inspected, and if moist, they must be wiped dry with a rag.

The condition of the sparkplugs is particularly important in winter. For every engine only sparkplugs of the brand indicated in the factory instructions for the given automobile should be used. The "hot" sparkplugs M 10.2 with a long low insulator cone, designed for GAZ-MM, engines, must not be installed, for example, on the GAZ-51 automobile, where a "colder" sparkplug is required. During the operation of a warmed-up engine, sparkplugs with insufficient heat conduction (hot sparkplugs) will rapidly overheat and cause interruptions in the ignition. On the other hand, the installation in an engine of sparkplugs that are colder than those required leads to the deposition of carbon and oil on the insulator, especially during the starting of a cold engine.

Sparkplugs must be regularly cleaned on a sandblast machine. The large amount of unevaporated gasoline sucked into the cylinders during the starting of the engine covers the walls of the combustion chamber, the cylinders, and the sparkplugs.

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If insulator and electrodes are covered with a layer of carbon, the wetting with gasoline almost always results in a short in the high-tension current "with the body", which interrupts the sparking, and makes the starting of the engine impossible. On the other hand, if the sparkplugs are clean, even if they are wet with gasoline, the engine can always be started.

Correct adjustment of the gap between the electrodes of the sparkplug is very important. The normal gap should be 0.6 - 0.7 mm. This gap should be tested with a feeler gage, and adjusted by bending the side electrode.

If the gaps between the electrodes are too small, droplets of gasoline form more easily between them. The mixture around the sparkplug will be too rich and will be hard to ignite. A mixture that is too rich and contains particles of liquid fuel does not, moreover, burn completely, and gives a large amount of carbon which may fill the gap between the electrodes if the sparking distance is small. As a result, the sparkplugs will operate intermittently.

In a badly worn engine, when much oil gets to the sparkplugs, as well as in the case of "oversuction", many drivers increase the sparking distance, which helps to reduce the amount of carbon deposited on the sparkplugs.

If this method is used, the length of the increased sparking distance must not exceed 2 mm, to avoid damaging of the ignition coil.

Devices for Cranking the Crankshaft

Some automotive companies are making efforts to conserve the the storage batteries by turning over the crankshaft by means of some outside source of energy when starting the engine. A starting battery or a portable starter is used for this purpose.

The starter battery is installed on a special hand truck or on a sled, and is equipped with a set of connecting wires of sufficient length. The cross section of these lead-in cables must not be weaker than that of the wiring connecting the automobile storage battery to the automobile structure and to the starter switch. The

ends of these battery cables must be reliably connected to the automobile structure and to the starter terminals.

The starting battery is usually mounted in a warm casing with openings for the wiring. To start an engine, the battery is wheeled to the automobile and connected into the starter circuit in parallel with the vehicle storage battery.

Portable starters consist of units ordinarily made up of an electric motor which can be plugged into the power line, an automobile gear shift box, and a flexible-drive shaft with a starting rod. The entire setup is mounted on a hand truck. As an example, Fig.28 shows the electric starter designed by Engineer Ye.Lebed'. Some designs of such starters use an internal combustion engine instead of an electric motor.

To start an engine, the mobile starter is wheeled up to the automobile, and the starting rod is inserted into the crankshaft ratchet like a hand crank. The electric motor is switched on and the clutch of the unit is engaged. As soon as the engine gives the first explosions, the starting rod is ejected by the ratchet and goes back to its extreme position. For this purpose, slots are provided on its rear end into which the bushing of the flexible drive shaft fit.

In using mobile starters it must be borne in mind that it is categorically forbidden to crank an engine in which the oil has solidified.

Procedure and Methods of Starting a Carburetor Engine

Various methods of facilitating the starting of a cold engine have been described above. The following conclusions may be drawn from the above data.

The ease of starting an engine, and, consequently, the additional measures that may be necessary, depend primarily on the grade of oil used in the crankcase. If it is winter oil of brand 4, the engine can be started without preheating at temperatures down to -26 to -28°C, and if it is winter oil of brand 6, at temperatures down to -20 to -22°C.

Using AS_p-5 or AS-5 oil, the engine can be started without preheating at tem-

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peratures down to -5 to -8°C. At lower temperatures, the viscosity of these oils increases and may make preheating necessary. When operating on summer oils in winter (e.g., motor oil 10) at outside temperatures of 0°C to -10 or -15°C, the cylin-

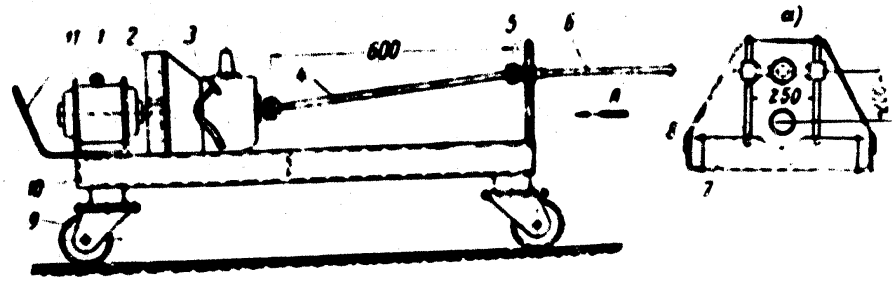

Fig.28 - Electric Starter for Engine Starting

1 - Electric motor 4 KW 1450 rpm AC; 2 - Flywheel of GAZ-M engine with clutch seated on motor shaft; 3 - Gear change box GAZ-AA with flywheel housing; 4 - Flexible drive shaft; 5 - Ball bearings; 6 - Starting rod with pin; 7 - Guide rod; 8 - Movable cross-bar (vertical movement 200 mm); 9 - Rotating wheels; 10 - Base; 11 - Hand lever. a) View along arrow A

der block must be heated with hot water, steam, or some other method, and at still lower temperatures it is advisable, in addition, to heat also the crankcase oil.

In all of the above enumerated cases of engine starting and especially when starting an engine containing winter oil, without preheating, it is advantageous to use devices for improving the fuel mixture: Starter pump AP or starter gas generator PNG-1.

If a liquid that freezes at low temperature is poured into the cooling system of an engine, methods of warming the engine without the necessity of draining the liquid must be selected such as an individual starting preheater, or an electric preheater.

After the preparation of the engine for the starting has been completed, i.e.,

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the easy turning over of the crankshaft has been assured by one of the above methods, the remaining operations differ little from each other and should be performed for a carburetor engine in the following order:

1. Release the clutch completely and leave it in that position by means of the stop installed between the pedal and the seat. The engine must not be started without releasing the clutch, since the gears of the transmission box imbedded in thickened oil hinder the turnover of the crankshaft.

2. Pull the button of the air shutter of the carburetor (suction) completely. The air shutter must be fully closed.

3. Open the choke by pulling out the button of the manual throttle. On the carburetor of the GAZ-51, ZIS-150, "Pobeda", Zis-110, and "Moskvich", these operations are performed automatically since the choke is connected with the air system by rods and levers. It is not necessary to pull out the manual gas button in starting the engines of these automobiles.

4. Completely close the shutters of the radiator or the special cover by pulling the actuating cable.

5. Open the engine hood and pump gasoline with the hand pump into the carburetor to replace the losses due to flooding and evaporation in the float chamber.

6. If there are droplets of water or frost on the sparkplugs and distributor, wipe these dry with a rag.

7. When the engine is started without preheating, the fan must be turned by hand to make sure that the shaft and impeller of the water pump are not frozen. At temperatures below -5 to -10°C, it is very useful to heat the fuel intake pipe to improve the formation of an easily inflammable mixture. The safest method of doing this, so far as fire hazard is concerned, as recommended by the Gor'kiy Automobile Plant, is to pour slowly boiling water, or very hot water, from a pitcher with a pouring lip, a teakettle, or other convenient vessel, on the intake pipe. A total of 1 1/2 - 2 liters of water must be used. To prevent the water from rapidly run-

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ning off, the intake pipe can be wrapped in rags and the hot water poured over these. In the ZIS-5 engine, the water pump must also be preheated, since a small amount of water often remains in it, and the impeller freezes rapidly.

8. Opening the engine hood and the warming jacket, insert the crank and prime the engine by turning over the crankshaft a few times. If the engine has been properly prepared for starting, it will not be difficult to turn over the crankshaft, and the crank will kick slightly. Engines with a downstream carburetor (GAZ-51, ZIS-120, etc.) should be turned over not more than 3-4 times on priming. The choke need not be opened wider while this is being done. With a slightly opened choke slide there will be a high degree of rarefaction produced in the intake pipe, and the gasoline entering through the idling system will be well diffused.

If the starting device AP or the starting gas generator PGG are available, the engine is started as instructed on pages 60 and 61. No priming is necessary.

9. Turn on the ignition and start the engine. To spare the storage battery, it is recommended that in winter the engine should as a rule is cranked. The starter can be used only if the storage battery is in good condition and fully charged, and if the engine is not too new and can be readily turned over by hand at the time of starting. The starter should not be operated longer than 4-5 sec., and the intervals between successive operations should not be shorter than 10-15 sec. If the engine refuses to start after 4-5 attempts, further efforts with the starter should be abandoned and the cause determined.

If the storage battery is out of order or undercharged, or if the engine is still too new, it must not be started with the starter.

Slight opening of the air slide and stronger opening of the choke during starting is unnecessary; it diminishes the quantity of liquid, unatomized gasoline, that is aspirated into the cylinders at the first explosions, flooding the sparkplugs and washing away the lubricant.

10. When the engine starts to run, immediately open the air slide by about

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one third, and then slightly increase the choke opening.

As the engine warms up, gradually increase the air valve opening to full.

11. If the starting is done with an incompletely filled cooling system, close the drain cocks, and, without stopping the engine, pour water into the radiator.

Before leaving the garage, the engine must be warmed up by idling to a coolant temperature of 40-50°C. The warming up must be done with the warming cover on the hood and radiator, and with completely closed shutter or radiator hood and frontal flaps of the warming cover.

At the same time, the readings of the oil pressure gage must be watched and if there is anything wrong the cause must be found.

In practical operation, trouble and poor starting of the engine is most often due to very much enriched working mixture to "oversuction", or to trouble in the ignition system.

If a large amount of liquid unevaporated gasoline has gotten into the engine cylinders, it is not only useless but also harmful to continue starting by the ordinary method. The sparkplugs flooded with gasoline will not give a good spark, and the overrich mixture, even with a good spark, does not ignite, and a weak mixture will even more definitely fail to give an explosion. The liquid gasoline washes the oil on the cylinder walls, pistons and piston rings away, the compression becomes worse, and the wear of the parts will be very great. For this reason, if the engine is "over-aspirated", the unsuccessful attempts to start it must be abandoned and the cylinders must be "blown out".

When the excess gasoline in the cylinders is small, it can be blown out without turning off the ignition, simply by turning over the crankshaft a few times with fully opened air and choke shutters. If the engine still fails to start, then the usual starting operations are repeated.

If a large amount of gasoline has gotten into the cylinders, it is necessary to turn off the ignition, remove all sparkplugs, completely open the air and choke

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shutters, and turn over the crankshaft a few times. To avoid discharging the storage battery, the engine crankshaft must be turned over with the hand crank instead of the starter.

The sparkplugs so removed must be cleaned and dried, but without overheating the upper portion of the insulator. Warm sparkplugs somewhat improve the following starting, since the gasoline will evaporate better around the electrodes.

To restore the compression in each cylinder, a small amount of fuel oil (1/2 tablespoon) must be poured into each cylinder and the crankshaft turned over a few more times.

After screwing the sparkplugs back in to place and connecting them with the leads in the operations for starting the engine are resumed.

The cylinders of an engine that has cooled off during the blowing out (if starting is attempted with warming) must be again heated as before.

Very often, especially if an engine that is not worked in must be started, or if the usual methods of starting are unsuccessful, the methods of starting by towing is used. An engine in good order, if tuned and well prepared, can as a rule be easily started, even without towing.

In practice however there are some cases where the time for leaving the garage is limited and there is no time to correct trouble interfering with easy starting of the engine. In this case recourse must be had to towing, which makes it possible to start the engine rather rapidly.

The proper use of towing accelerates starting and does no particular damage to the engine. But often inexperienced drivers use towing without observing the corresponding rules, which leads to an increased wear on the engine and to failure of parts. If an automobile in whose engine the oil has solidified, is to be towed, and if the crankshaft cannot be easily turned over, the clutch may be "stripped", the connecting rod bent, the transmission and the gears of the oil pump broken, etc. Such cases are observed in practice, and therefore the engine must be started by

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towing only if the following conditions are observed:

1) the engine crankshaft must turn over by means of the hand crank, by one man;

2) the cable, chain, or rope for towing must be sufficiently strong and not less than 4-6 m in length. It is desirable to use a rigid pulling attachment in the form of a wooden or metal yoke 3-4 m long with lugs for attachment on the ends. The cable or towing bar must be firmly attached to the tow hooks of the vehicle to be towed;

3) the direct transmission should be engaged on the towed vehicle. The higher gears (I or II) should not be engaged, since it may damage the clutch. In addition, before the beginning of towing, the brake-shoes and the oil in the transmission units must be inspected for freezing;

4) the towing must be done without interruptions, along a straight section of the road, at a speed of not over 20 km/hour. The clutch must be engaged smoothly on the towed automobile. The use of "suction" and of the choke is the same as in starting with the starter;

5) after the engine has been started, disengage the clutch and place the gear-shift lever into neutral.

The second main source for difficulties in starting an engine is trouble in the ignition system. This occurs mainly as a result of failure of the electrical instruments. The most frequent causes of interruption in the ignition are:

a) an undercharged storage battery;

b) oxidation or poor contact between the connections and terminals of the storage battery;

c) pitting, incorrect setting of the points in the rotor;

d) leakage of high-tension current in the wires or distributer cover (the spark breaks through "to the structure") owing to a cracked or fouled cover;

e) sparkplugs in bad condition or maladjusted.

Starting a Diesel Engine

It is harder to start a Diesel at low temperatures than a carburetor engine. This is due to the fact that the Diesel has no constant source of ignition, and the fuel must ignite on its injection into the cylinder at the end of the compression stroke. For this reason the temperature of the air at the end of the compression must be higher than the self-ignition temperature of the fuel.

A high air temperature at the end of the compression is assured by the fact that Diesels have a high degree of compression, while the power of the starter and storage battery is so selected that the crankshaft can be turned over at a speed sufficient for starting. In summer, the temperature of the air in the cylinder at the end of the compression stroke rises to 400-500°C, which is entirely sufficient for reliable self-ignition of the fuel. In winter, however, in turning over a cold engine, the speed of the crankshaft may be considerably lower than necessary. At the same time, at low speeds, the compressed air in the cylinder will be longer in contact with the cold cylinder walls and will transfer heat to them, and the leaks of air through loose parts of the piston rings will also increase. In addition, the cold air aspirated into the cylinders will not be warmed up on passing through the intake system.

As a result, the air temperature at the end of the compression stroke may be lower than the temperature required for self-ignition of the fuel, and the Diesel will not start.

Consequently, for easy starting of a Diesel, the following must be assured:

1) easy turning of the crankshaft at a speed of not less than 100-150 rpm;

2) reliable ignition of the injected fuel at the end of the compression stroke.

The easy turnover of the Diesel-engine crankshaft is assured by using the winter grades of oil, and by heating the cylinder block and the oil in the crankcase by the same methods used on the carburetor engine.

Heating the block, in addition, produces a rise in temperature of the air in

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the Diesel cylinders.

The reliable ignition of the injected fuel is also assured by using the winter grade of fuel and by preheating the air aspirated into the Diesel. The addition to the suction air of a volatile additive with a low flash point likewise considerably facilitates the starting. Ethyl ether is most often used for this purpose.

On the Diesel YaAZ-204, installed on the automobiles YaAZ-200, MAZ-205 and the buses ZIS-154, an electric torch preheating device (Fig.29) is installed for preheating the suction air. It is mounted on the cover of the inspection port of the fourth cylinder. Its operation is as follows: When the induction coil with a buzzer is turned on, continuous sparking takes place between the electrodes of the sparkplug 1. The kerosene injected through the diffuser (2) is ignited by the spark and forms a torch that heats the air aspirated by the Diesel.

The factory recommends the following procedure for starting a cold YaAZ-204 Diesel at ambient temperatures below 0°C:

1) Heat the cylinder block to the coolant temperature of +50°C and the oil in the crank case to a temperature of +30°C;

2) Turn the crankshaft with a special wrench to ward the hexagonal head of the pulley attachment bolt;

3) Turn on the ignition of the electric torch;

4) About 1-2 minutes after turning on the ignition of the electric torch, press the starter button and the fuel throttle, placing it in the position of maximum supply. The starter must be left on not more than 20 sec, with intervals of 1-2 min between applications. At the same time, during the period of one application of the starter, four or five strokes of the hand pump must be made, smoothly depressing its handle. If the Diesel does not start at the first attempt, repeat these operations after 1-1.5 min;

5) When the Diesel has been started, turn off the ignition of the electric torch and screw the handle of the booster pump to the stop. After starting the

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engine, it is warmed up by idling at a crankshaft speed of about 1000 rpm, until the coolant temperature reaches +50°C. The speed cannot be increased or decreased during the warming-up period. Operation of the Diesel at minimum speed is permissible

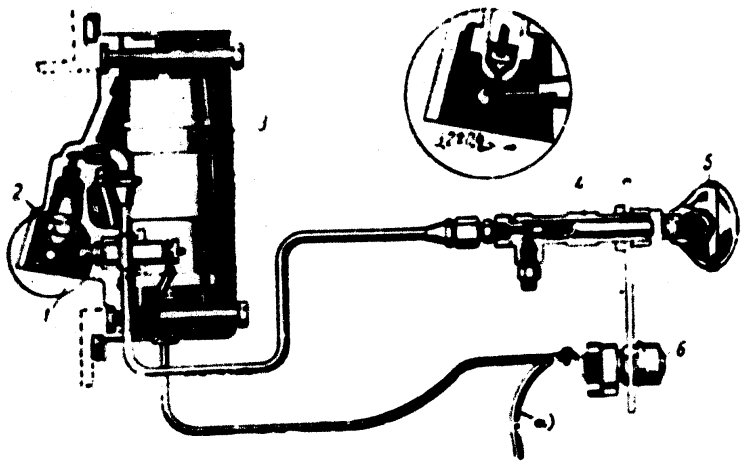

Fig.29 - Electric Torch Preheater for YaAZ-204 Diesel:

1 - Sparkplug; 2 - Diffuser; 3 - Induction coil; 4 - Barrel of booster pump; 5 - Handle of booster pump rod; 6 - Switch. a) From storage battery

only after a coolant temperature of +70°C has been reached.

Before beginning to move, the operation of the control instruments on the instruments board must be checked. The oil pressure at minimum idling speed must not be lower than 0.3 kg/cm^2.

At the Moscow bus stations starting of the Diesels on the ZIS-154 buses is facilitated by addition of ethyl ether to the intake air. This is done only after the crankshaft has been checked for easy turnover. For this, 10-15 drops of ether are dripped into the air filter of the Diesel through a specially drilled opening 5-8 mm in diameter, by means of a funnel. Starting then proceeds by the usual method. The electric torch is not used when starting with ether. Not more than 5 cc ether must be used, to prevent a sharp pressure rise in the cylinder.

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It must be remembered that ether, being a highly inflammable liquid, is a fire hazard. It must be kept in an airtight vessel, observing all rules of fire safety.

If a Diesel must be started by towing or by the aid of portable starters, the same rules apply as in starting carburetor engines by these methods.

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DRIVING AN AUTOMOBILE IN WINTER

Characteristics of Driving an Automobile on Winter Roads

Driving an automobile on winter roads demands special care of the driver and familiarity with special working methods.

On slippery roads, covered with ice or with packed snow, the stopping distance of an automobile on braking is increased two or three times (cf.Table 8); on sudden braking there is the danger of skidding, i.e., loss of control. In this connection, the consequences of careless and reckless driving of inexperienced drivers cause collisions, wrecks, and other road incidents.

Car driving becomes particularly complicated in cities with heavy street traffic. There are also many peculiarities in driving on surburban roads. Falling snow or mist impair the visibility and make the driver's work even more difficult. In addition, the daylight period is considerably shorter in winter than in summer.

Under complicated winter conditions, skillful and careful driving of a car is a prime requisite for safe movement and complete prevention of road incidents and accidents.

It is often necessary to travel over stretches of road where only some of the snow has been removed or which are poorly plowed; sometimes drifted portions of the road must be passed. Traveling conditions on country roads are especially difficult during thaws. At such times, the driver must skillfully use the various appliances and methods of increasing the roadability of the car.

The various methods and devices for driving under such conditions are developed

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only over many years of practice, but various points of advice, based on the experience of expert drivers, may help new drivers to reach more rapidly the level of the masters and become one of the Hundred-Thousander Drivers.

Table 8

Stopping Distance of an Automobile

Speed of Car in km/hour	Distance necessary for stopping automobiles, in m	
	On Highways with Smooth, Dry Surface	On Roads with Wet, Muddy, Slippery Surface
10	4	6
20	10	20
30	18	36
40	30	65
50	40	100
60	60	140

Note. The above-indicated stopping distance of cars constitutes the distance covered by the automobile during the driver's reaction time (that is, the minimum time elapsed between the event requiring brake application to the instant at which the driver depresses the brake pedal), and the time of braking.

City roads and highways are usually plowed and sanded. But not all streets and roads are equally well plowed and sanded; in addition, winter weather is changeable. In the morning the roads may freeze, during the day thaw or wet snow may be encountered, followed by freezing toward evening. As a result, a layer of ice or frozen snow forms on the road surface on which the automobile must travel. Travel over smooth ice is particularly hazardous. In this case, even sanding will not sufficiently increase the traction of the tires, since the sand rolls off the smooth hard surface of the ice. Approximately the same conditions of movement as with

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smooth ice prevail in places where it snows with a light frost, and the snow is then packed down by the wheels. The road in this case is just as slippery and dangerous as with smooth ice.

Movement on smooth ice must start with the choke slightly open, preferably in second gear. It is inadvisable to race the engine, to avoid slipping of the wheels. The least possible reliance must be placed on the brakes. In rapid motion and when suddenly applied, they will not prevent an accident but will only make the situation worse. The brakes must be applied smoothly and without stepping hard on the pedal, and the process of braking should proceed in several stages. The wheels should not be completely braked to the point of "Squeek" since, in this case, the distance traveled with applied brakes will be longer than with gradual braking.

In traveling on a slippery road, it is of prime importance never to turn the steering wheel abruptly, never to increase or reduce engine speed suddenly or, to apply the brakes sharply. This will always lead to skidding.

The distance from a car in front in this case must be twice that on roads with a hard dry surface. Under ordinary conditions, this distance in meters must be equivalent to the traveling speed in km/hour; on a slippery road, the distance is double, i.e., 30 m when traveling at 15 km/hr or 50 m when traveling at 25 km/hr, etc.

It is dangerous to park a car on a slippery road near a truck parked on the shoulder, since the car might slip, due to the lateral tilt of the road.

In driving up- or downhill, the driver must be especially cautious, since it is precisely at these points of a road that accidents in winter are most frequent.

The uphill drive can be started only after the driver is absolutely sure that there is no interference. Downhill driving must be done in low gear, so that the car can be stopped in time. In driving down a steep hill, the engine must be used as a brake, without unclutching. Movement uphill must be started only if the road is free. Driving uphill should be done only at a speed that will make it entirely

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certain that the top can be reached with acceleration and without shifting gears, since gear shifting in uphill runs will lead to slipping of the wheel and to an increase in the danger of skidding. If the road visibility is poor (curves, bends, hills), the speed must be reduced to a minimum, so that the vehicle can be instantly stopped if an obstacle appears.

In spite of the fact that city streets are cleared of snow in winter, ruts will form in some places on trolley lines. As a rule, the driver should avoid driving the automobile along streetcar tracks, not only for safety reasons but also to save his tires (the tracks have hooks that tear the tire tread). If the car slips into a rut on streetcar tracks, it might turn around or skid when the driver tries to get out of it. This often causes accidents.

It is dangerous to park an automobile on a hill if the road is slippery, using only the emergency brake; there are many cases of a braked automobile slipping downhill. If the car must be left on a slope, a chock must be placed under the wheel.

Driving by night on badly lighted streets and on suburban highways demands increased caution, especially at a time of winter when the snow has not yet packed down and the road is wet; a tarred or asphalted road will show up black. In such cases, pedestrians or other obstacles on the road merge with the general darkness, so that the driver must constantly be ready to take the necessary measures.

In stopping on an unlighted street or on a highway, the car must be parked as near the curb or shoulder of the road as possible; other cars must be prevented from running into it by leaving on the tail light, front parking lights, or the dim headlights.

In dry cold weather, the traction of the tire tread on snow-covered roads is better than on roads with soft or wet snow; consequently there is thus no particular danger of skidding in such weather. However, icy stretches of road may be encountered on which ice forms as a result of thaws on the previous day. Remembering this, the driver should be able to spot such places and reduce his speed before-

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hand, avoiding sudden application of the brakes, sharp movements of the steering wheel, etc. Icy and slippery road sections are generally found at city street intersections, due to braking of cars stopping for traffic lights. Such a road surface also occurs near trolley-bus and bus stops. At such spots, the driver must reduce speed and be particularly careful.

When approaching a crossing with a green light, the speed should not be increased, since the lights might change any minute, forcing the driver to apply the brakes suddenly; if the speed had been increased, sudden braking on a slippery road may lead to skidding.

In traveling on a sanded road, especially on hills, the driver must pay attention to the condition of such places. There are cases in which the driver encounters a section of the road that had been sanded a few days before, where the sand, ground into the icy surface, can still be seen but no longer provides traction between tires and road. When snow is falling, the driver must not start on his route without the windshield wiper in perfect working order.

In very cold weather, the front and side windows of the cab and body become covered with ice, which considerably affects the road visibility. All cars on the road are in the same position, so that each driver must drive with special care, and select a stopping place with particular attention.

In cars equipped with a heater (ZIS-110, "Pobeda", ZIS-154), the front window is heated by a jet of warm air directed downward. In cars without a heater, it is suggested, if possible, to install an electric heater on the front window. If there is no heater, the glass can be coated with a special mixture. Salt is added to 0.5 liter of boiling water until it no longer dissolves in the water and settles as crystals; this solution is mixed with one liter of clear glycerol, and the resultant mixture is applied in a thin layer to the inner surface of the glass. This mixture prevents the formation of ice on the glass for 2-3 hours, after which the glass must be wiped off and a new layer of mixture applied.

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In case of extreme necessity, sweating and icing of the cab windows, can be prevented by driving with partly opened side windows; in this case, the temperature of the air in the cab becomes equal to the outside temperature, and the sweating of the windows is reduced.

Methods of Getting over Difficult Sections on Winter Roads

In driving on winter roads and especially on country roads, snow drifts and unplowed sections are frequently encountered. Usually, packed dirt roads have a narrow roadway, and to avoid colliding with traffic in the opposite direction, it is often necessary to drive into the snow.

Driving on country roads during a thaw is particularly difficult, so that the driver must always carry digging tools (an axe or spade), a towing rope, and various other devices for restoring the roadability of the car.

To increase the reliability of operation and the roadability of the car in travel under such conditions, tires with special tread are used, as well as snow chains of various designs.

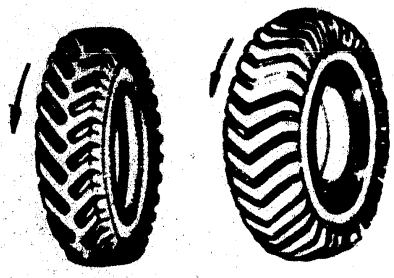

Fig.30 - Tires with Tread Design for Increased Roadability

Figure 30 shows tires with a tread design for higher roadability. Such treads should be mounted on the wheel in such a way that the angle of the tread design is opposite its vertex in the direction of rotation of the wheels, thus preventing snow and mud from filling the tread.

If most of the route in a given trip goes over country roads or poorly plowed roads, it is advisable to use snow chains on the traction wheels.

The type of chains most widely used in practice, for single and double traction wheels are shown in Fig.31. When ordinary forging tools are available, such chains

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can be built in an automobile shop from simple chains with welded links and a bar 8-10 mm thick. The ends of the chain can be directly joined or by means of locks (Fig.32). To prevent the chain from slipping along the surface of the tire when traveling, side segments of the chain must be passed through openings of the disk and attached properly.

In traveling with ordinary snow chains it must be borne in mind that in case of skidding, the wheels will grip the snow more rapidly. Chains should not be used on a hard-surface road, since they increase the wear of the tires and chassis of the car.

Small-link snow chains can also be used in traveling over icy roads, especially on steep slopes. Their use reduces the danger of skidding and slipping.

In traveling through deep snow, gears must not be shifted over the entire length of the snow-covered part of the road, since gear shifting will cause the automobile to lose inertia and the leading wheels to slip. Before entering a snow-covered road, the driver must shift in time to the lowest speed at which he intends to pass the entire snowed-under section.

If the car gets stuck in spite of this, the driver should not attempt to get free by racing the engine. This only makes matters worse, since the leading wheels will penetrate deeper into the snow. The best thing is to back up, speed up and thus pass the dangerous spot in low gear.

In cases where the automobile wheels have sunk deep into the snow, the snow must be scooped out around the front and rear wheels and wooden wedges must be placed underneath the slipping wheels (a piece of board 25-30 cm wide with a planed-off ends), or branches, brushwood, straw, etc.

A useful device for getting a stuck car to run again is the removable shoe designed by engineers O.Dybov and A.Ostrovtsov. Figure 33 shows the arrangement of the shoe and the details of its lock. The shoe is placed on the wheels, passing the connectin link (4) through the opening in the wheel disk and attaching it to a

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second segment of the chain by means of a lock.

Each of the leading wheels is provided with at least two such shoes, according to the number of holes in the wheel disk. When approaching a difficult section of road it is best to attach the shoes at the proper time. However, if the automobile slips in moving without such shoes, an obstacle can be overcome by first placing only one shoe on the slipping wheels and, if this does not help, adding one or two more, and so on.

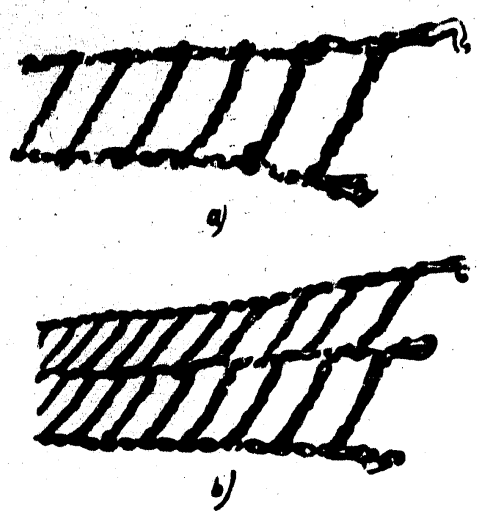

Fig.31 - Snow Chains:
a) Chain for single wheel
b) Chain for double wheel

Fig.32 - Locks for Snow Chains
a) Lock

The track chains produced by the ZIS and GAZ plants (Fig.34) have been used successfully to get through difficult sections. Such chains, if installed in time on the leading wheels of a car, have permitted easy passage over sections of a road with deep loose snow or mud.

Track chains manufactured by a plant can be replaced by the simplified chain shown in Fig.35.

The tracks of the chains are made of iron angles with a rod 20 to 40 mm side

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dimensions, welded on one plane, as shown in Fig.35. The distance between the spot welds is about 100 mm. To the bearing surface of each track a wedge is welded that

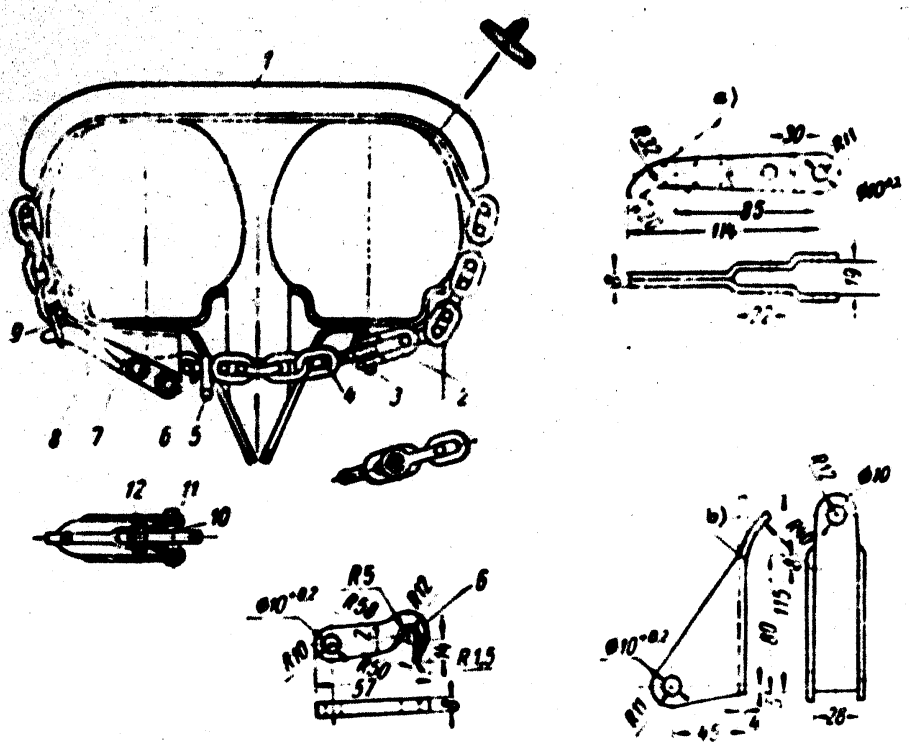

Fig.33 - Removable Shoe

1 - Shoe (Ground-Hook); 2 - Lug for connecting link; 3 - Spindle of connecting link; 4 - Connecting link; 5 - Chain ling; 6 - Hook of lock; 7 - Base of lock; 8 - Lever of lock; 9 - Check ring; 10 - Splint; 11 - Spindle of lever; 12 - Spindle of hook a) Spot welding at indicated surface; b) In straightened condition

prevents it from being displaced to one side. A chain is attached to the wedge of the first track and serves to attach it to the wheel. This chain is brought into the gap between the balloons, is passed through the openings in the wheel disk, wrapped around the balloon, and then drawn through the slot (1) to the opening (2), where it is fastened with a bolt.

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The tracks are spaced at 200 mm and are interconnected by a link chain or a wire 3-4 mm in diameter twisted into two strands. The last track is attached to the

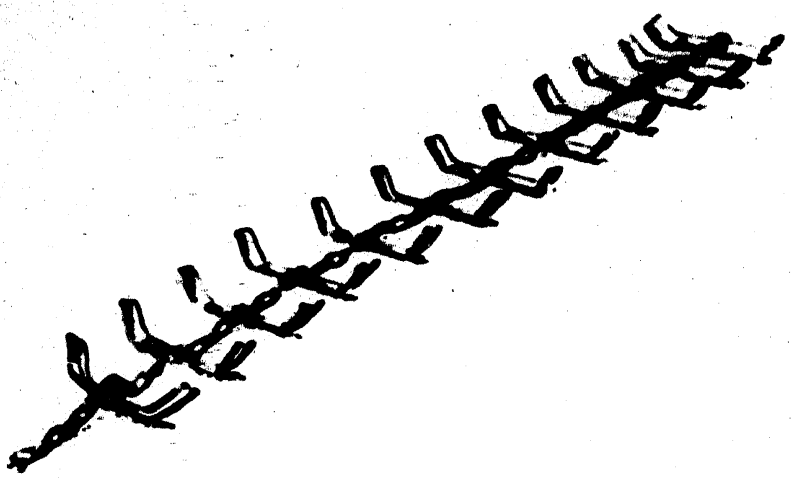

Fig.34 - Track Chain

first one by means of the chain (5) which is fastened by a belt passed to the opening (4). The width of the tracks is selected in accordance with the size of the

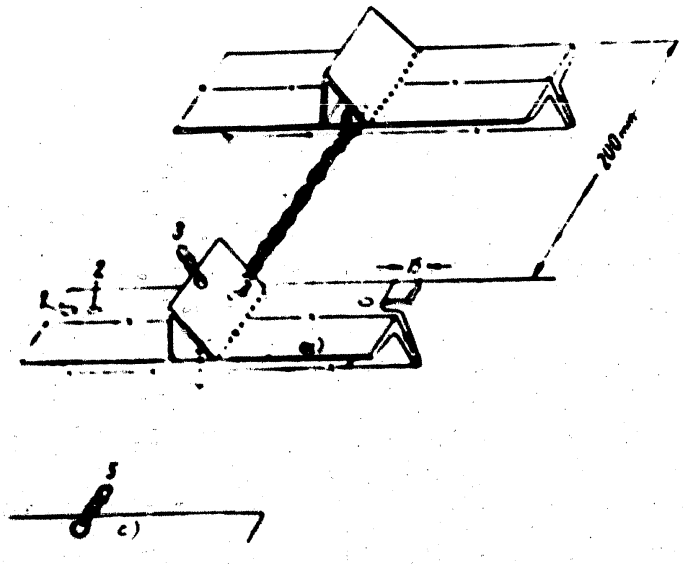

Fig.35 - Chain with Tracks Welded of Angle Irons

a) First track b) 200 mm; c) Last track

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tires in such a way that the edge of the track does not cut the tire tread.

Maintenance of Cars on the Road

The thorough preparation of a car for winter, observance of the rules for filling and lubricating, and rapid starting of the engine in freezing weather are very important measures, without which it is impossible to get good results. However, all these preparatory measures for performing the basic function of motorized carrier service, i.e., fast and inexpensive transportation of freight or passengers at maximum savings in operating expense, are performed during the operating time of the vehicle.

It is therefore necessary to repeat the rules for maintenance of a car on the road, to obtain dependable operation along the route, long runs between overhauls, and savings in fuel and rubber.

Under winter conditions the necessary engine temperature must be maintained by proper use of the protective cover and shutters. The coolant temperature in the water jacket of the engine must be 80-90°C and, in any case, not lower than 75°C.

In adjusting the flaps of the protective cover and the slats of the louvers, for admission of cold air into the space under the hood, it must be remembered that an insufficiently warmed engine will not only increase the wear of parts and the fuel consumption, but the water in the radiator may freeze and, at the same time, become overheated in the engine jacket. It is therefore necessary to start moving only after the coolant in the cooling system has been heated to a temperature of 35-40°C, and the slats of the louvers and the flaps of the protective cover must be opened on the road only after the engine has been heated to the normal operating temperature.

At stops, the louvers and flaps of the protective cover must be completely closed. It is also useful to cover the engine with a tarpaulin. If the water temperature drops to 30°C during a prolonged stop for loading, unloading, or waiting for passengers, the engine should be started up and idled for 4-5 min. Long idling

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is not recommended, since carbon will be deposited on the sparkplugs.

During enforced stops on the road for repairs the water in the radiator must be checked for possible freezing. In very cold weather, the water must be drained.

It seems to most people that draining the water from the cooling system is a very simple operation. However, there are many cases of damage, due to disregarding of this simple point. The water must be drained by opening all drain cocks on the radiator and removing the radiator plug. The driver must not leave the automobile until all the water is drained. If the flow is sluggish, the cocks must be cleaned with a wire.

It is no less important to check the oil pressure in the lubrication system, which, when the engine is heated, should be within the limits indicated in Table 1. The oil temperature should be in the range of 50-70°C.

The driver must constantly and carefully watch the charging current of the generator, check the brakes, steering wheel mechanism, and other parts of the car for proper functioning. It is also very important, especially before resuming travel after a stop, to check the condition of the oil in the transmission unit. If the oil has solidified, it must be reheated before leaving.

With decreasing temperature the elasticity of rubber deteriorates, and at temperatures below -30°C, cracks may appear in the cold tire casings when the car is again started after 20 or 30 min of standing. For this reason, in very cold weather, motion should start smoothly and without jerks. The driver must drive around obstacles in the road, and for the first 10-15 min must drive no faster than 20-25 km/hr.

Fuel saving is of exceptional importance in the work of a Hundred-Thousander Driver. The above rules of winter operation will also result in saving of fuel. Correct adjustment of the car parts, fuel feed, and ignition systems, timely lubrication with the proper grades of oils, warming up the engine and maintaining a high temperature during the entire time of travel as well as prudent and skillful

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driving, are the basic conditions for reducing the fuel consumption. Considerable savings can be obtained by observing the above rules. The achievements of the Hundred-Thousander Driver Ya.I.Titov may serve as an example. Titov, on his patriotic initiative, "operated in winter by summer standards of gasoline consumption" and thus set an example to his followers who realized fuel savings, under winter conditions, amounting to 15 to 30% of the winter standard.

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