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FRICTION TESTS OF A CHRYSLER 1978,225CID ENGINE

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16. Abstract

This document reports tests on a 1978 Chrysler, 225 CID, six-cylinder engine to determine the losses due to friction and accessories. The tests were conducted at the Automotive Research laboratory of the Transportation Systems Center with the engine attached to the dynamometer. The latter is programmable to measure either power output or power absorption. Graphs of the results are presented.

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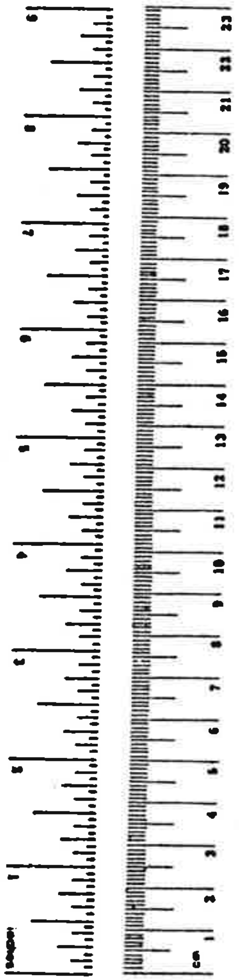
PREFACE

This report presents the test results of friction and accessory losses from a 1978 Chrysler 225 CID engine. This work was performed in the Automotive Research Laboratory at the Transportation Systems Center of the U.S. Department of Transportation. This work satisfies a requirement under the task "Experimental Data on Existing Components" of the Automotive Fuel Economy Research and Analysis Support Program for NHTSA"s Technology Assessment Division, Office of Passenger Vehicle Research. The authors gratefully acknowledge the technical support of Ralph Colello, Dr. Thomas Trella, Russell Zub, and Norman Deserres.

METRIC CONVERSION FACTORS

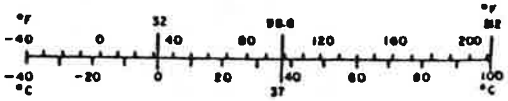
Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1. INTRODUCTION

The work reported details the results of engine dynomometer testing for the frictional and accessory loads of a 1978 Chrysler, 6-cylinder 225 CID engine. The engine was driven from 500 to 4400 RPM at 500 RPM intervals while the motoring torque was measured. Measurements were made at ambient temperatures (~80°F) and fully warmed-up engine temperatures (~185°F) both with and without the fan.

2. EXPERIMENTAL DESIGN

This section briefly reviews the design and highlights the salient features of friction and accessory testing of the Chrysler 225 CID engine.

2.1 ENGINE

The manufacturer's specifications for the Chrysler 225 CID engine are given in Table 1. This mean-tolerance engine was broken-in with the test schedule shown in Table 2. The engine came equipped with an oxidation catalyst and EGR for emissions control. The engine was equipped with a manual transmission flywheel for mounting to the dynamometer.

2.2 TEST CONFIGURATION

The engine was installed in the DOT/TSC, Automotive Research Laboratory test cell No. 2. This cell has a DC programmable dynamometer for power absorption and motoring tests. Figures 1 and 2 show the electronic and fluid-flow configurations for the engine mounted in the cell for testing. For friction tests only speed, torque, temperatures, and pressures were recorded.

Instead of the standard air cleaner, air induction was through a laminar-flow element connected by a 4-inch ID plastic tubing to the carburetor. All engine vents (valve cover, carburetor, charcoal canister) were connected to the air-inlet system. Engine coolant and oil temperatures were maintained at 185°F ± 2°F by external heat-exchangers. The catalytic converter, and the muffler were installed in the exhaust system to duplicate the normal engine back-pressure.

2.2.1 Instrumentation

Real-time measurements of emissions and engine performance were accomplished by the analog instrumentation shown in Table 3.

TABLE 1. ENGINE CHARACTERISTICS

Model Year	1978
Manufacturer	Chrysler Corp.
No. of cylinders	6
Displacement	225 CID (3.7L)
Bore	3.40 inches (86 mm)
Stroke	4.125 inches (105 mm)
Compression ratio	8.4 to 1
Max. Rated HP	109 @ 3600 rpm
Max. Rated Torque	182 @ 2000 rpm
Calibration	49 State, automatic
Transmission type	automatic
Engine weight*	564 lbs (256 kg)

* Includes starter, alternator, fan, manual transmission flywheel, bell housing, wire harness, battery cables, vacuum lines, air inlet system. Does not include radiator, water hoses, exhaust pipes, muffler, engine coolant, oil.

TABLE 2. CHRYSLER 225 CID ENGINE BREAK-IN SCHEDULE

Period (hr)	Speed (rpm)	Torque (lb-ft)
1	1200	64.0
1	1600	94.5
1	2000	108.5
2	2400	122.5
2	2800	133.0
2	3200	136.5
2	3600	138.3(1)
2	4000	WOT (1)
1/2	4400	WOT (2)

(1) Cycle 4 min. at load, 1 min. at 1600 rpm no load
(2) Check wide-open throttle (WOT) friction from 4400 rpm down

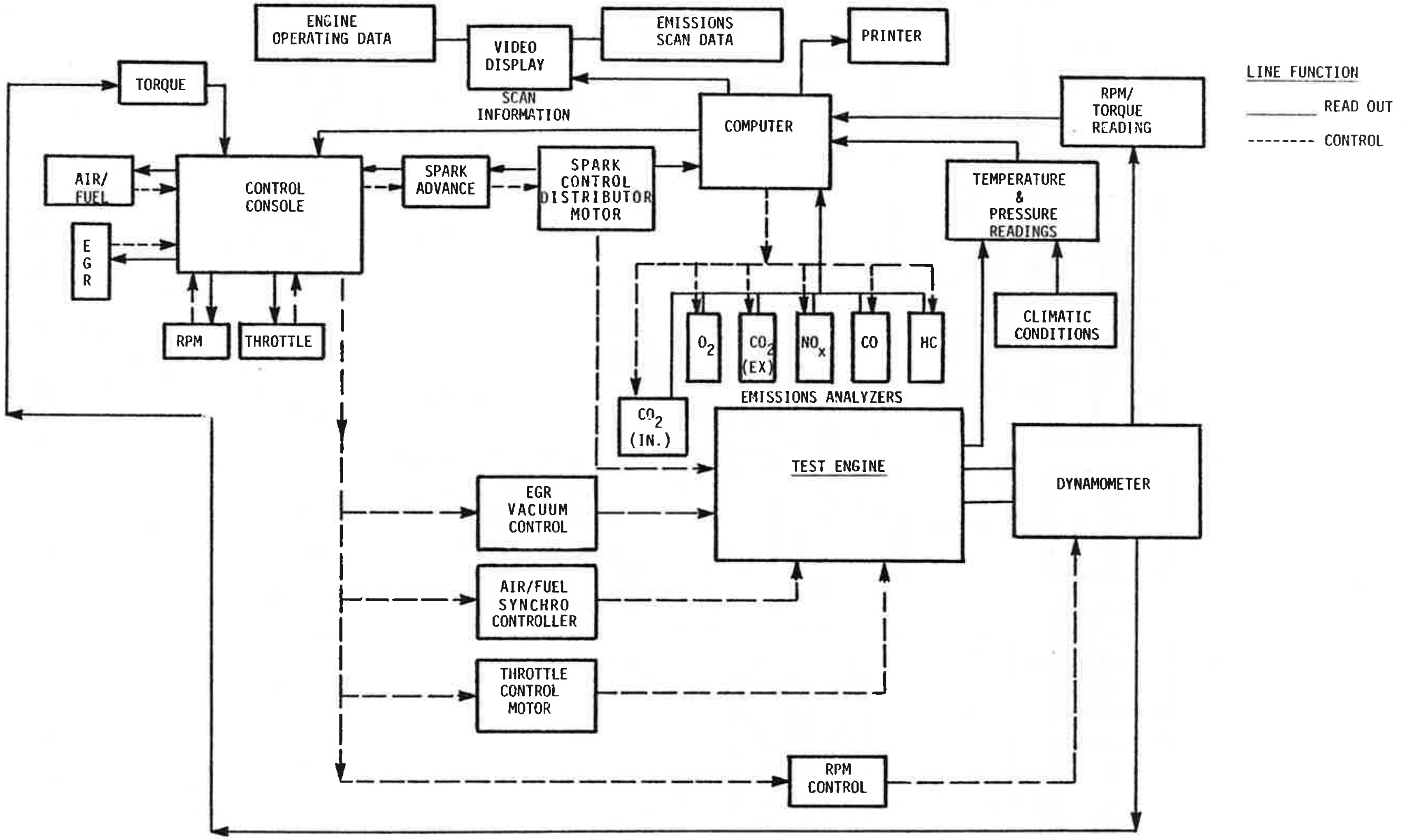

FIGURE 1. ELECTRONIC FLOW DIAGRAM

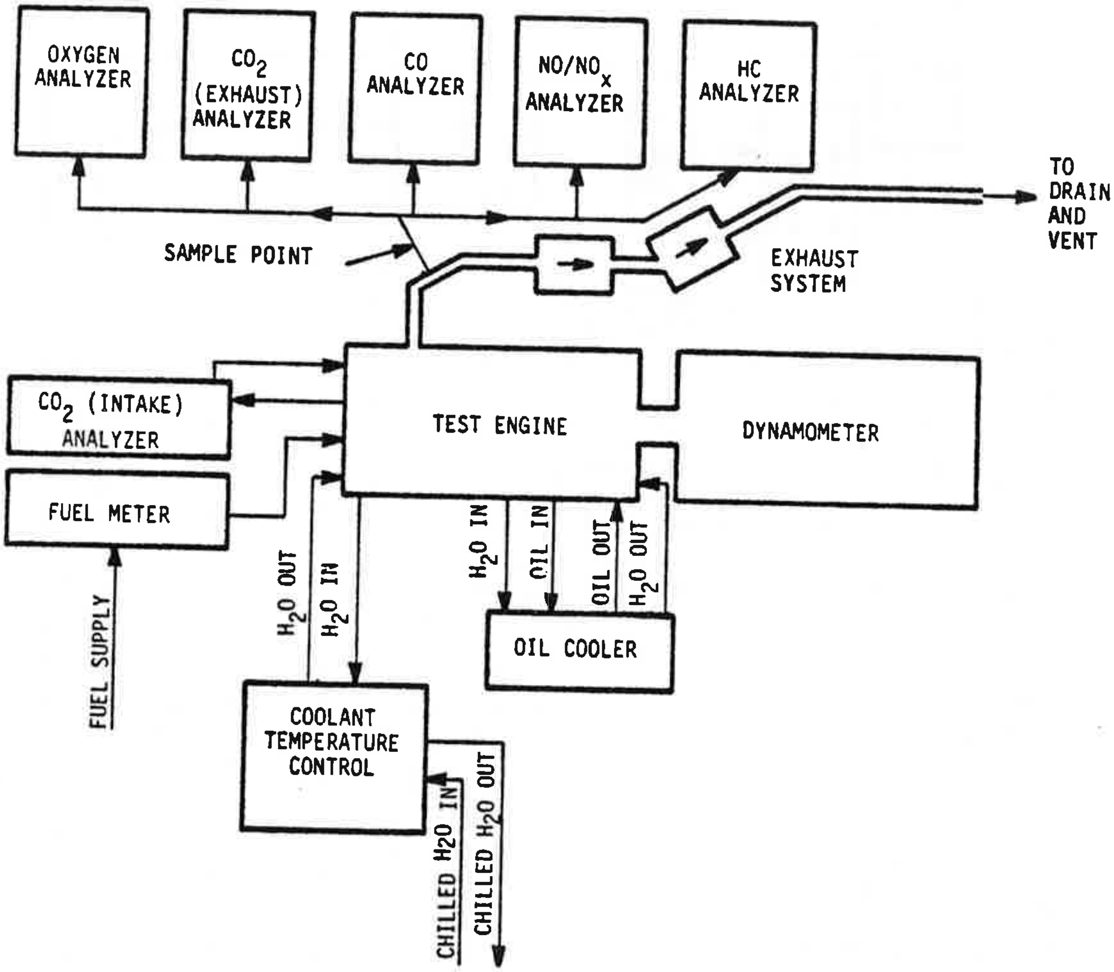

FIGURE 2. CELL NO. 2 TEST ENGINE FLUID FLOW

TABLE 3. ANALOG INSTRUMENTATION

MEASURED VARIABLE	INSTRUMENT TYPE
Oil temp.	OMEGA type K thermocouple; CJ compensator
Ambient temp.	YSI Model 46T6 Tele-thermometer
Inlet air flow	MERRIAM 50MC2-4 Laminar flow element
Inlet air diff. press.	MKS Baratron type 77
Air inlet temp.	OMEGA type K thermocouple; CJ compensator
Fuel inlet temp.	OMEGA type K thermocouple; CJ compensator
Coolant inlet temp.	OMEGA type K thermocouple; CJ compensator
Rel. Humidity	WEATHERMEASURE Model HM111
Exhaust CO	BECKMAN 864 Infrared Analyzer
Exhaust CO_2	BECKMAN 864 Infrared Analyzer
Exhaust HC	BECKMAN 402 Hydrocarbon Analyzer
Exhaust NOx	BECKMAN 951 Chemiluminescent Analyzer
Exhaust O_2	BECKMAN 14330 Paramagnetic Analyzer
Intake CO_2	BECKMAN 864 Infrared Analyzer
Manifold vacuum	TYCO type AB 15 PSI transducer
Coolant exhaust temp.	OMEGA type K thermocouple; CJ compensator
Spark timing	1.8K precision potentiometer
Peak Cylinder Press.	KISTLER 538A/601B1 Piezoelectric
Exhaust temp. AC	OMEGA type K thermocouple; CJ compensator
Exhaust temp. BC	OMEGA type K thermocouple; CJ compensator
Exhaust press. AC	TYCO type AB 6 PSI transducer
Exhaust press. BC	TYCO type AB 6 PSI transducer

2.2.2 Data Acquisition

The data acquisition system was a Hewlett-Packard 21MX mini-computer with a 45kHz A/D converter and multiplexer. Analog signals from the instrumentation shown in Table 3 were routed, along with digital speed and torque signals, to this computer. The data was continuously updated on a video display and line printer. Data was stored on a disc for subsequent reduction.

2.3 FRICTION AND ACCESSORY TEST MATRIX

Engine friction losses were measured by motoring the engine with the DC dynamometer at a constant speed and recording the driving torque. The parasitic losses of various engine accessories (fan, alternator, air pump, etc.), can be determined by repeating the motoring tests with that particular accessory removed.

For these tests the speed and torque were measured while motoring the engine, from 500 rpm to 4400 rpm, at 500 rpm intervals both with and without the fan blades. Tests were performed with the engine at ambient temperature (~85°F) or at fully-warmed-up temperature (~185°F).

3. TEST PROCEDURES

All instrumentation was periodically checked and calibrated. For ambient tests the engine was motored and friction measurements performed prior to any actual engine operation. For the "fully-warmed" tests, the engine was operated at 1600 RPM at about 40 lb-ft torque until fully warmed-up and stabilized. Then fuel was shut off and the engine allowed to run until the small amount of fuel remaining in the carburetor was consumed. At this point, the throttle was opened fully and the engine was motored by the dynamometer. Speed and torque were measured at 500 RPM intervals from 4400 RPM down to 500 RPM. At each speed setting , the torque transients were allowed to stabilize before data was collected, usually about 5 seconds. Speed and torque data were collected by observation of the digital readouts on the operator control console. Data on speed and torque were manually recorded and horsepower calculated. All tests were run with a standard 10W-40 engine oil.

4. TEST RESULTS

The results of the friction and accessory tests with this engine are shown in Figures 3 through 5. Figure 3 shows the total motoring friction horsepower for this engine at ambient and operating temperatures and with the fan blades removed. The engine cold without the fan and the engine hot with the fan gave the same results. Figure 4 shows the friction horsepower difference between a cold and a hot engine. Figure 5 shows the fan losses obtained from the difference between motoring the engine with and without the fan. These results indicate that this engine, when cold, has 17 percent to 19 percent higher frictional losses than when hot. The fan contributes approximately 17 percent of the total frictional losses of this engine when hot.

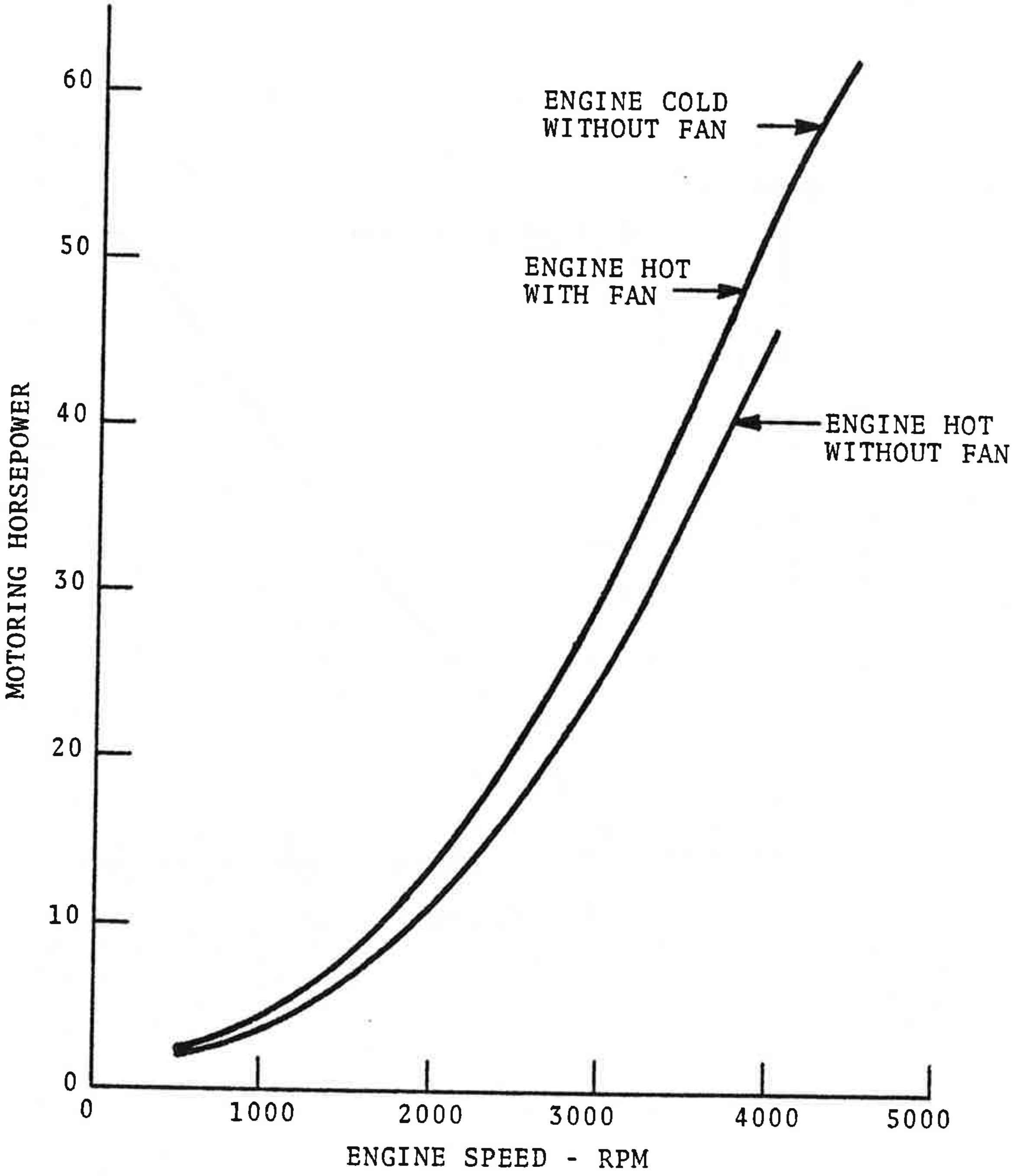

FIGURE 3. ALL FRICTION LOSSES

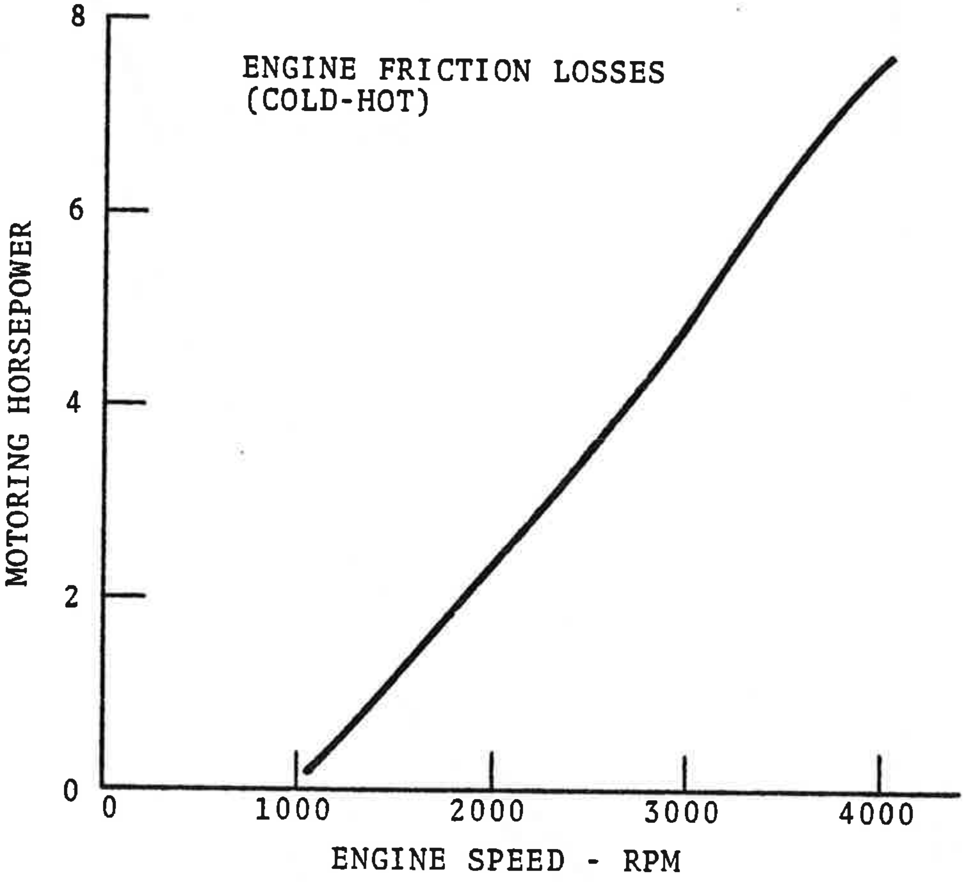

FIGURE 4. FRICTION LOSSES, COLD VS HOT

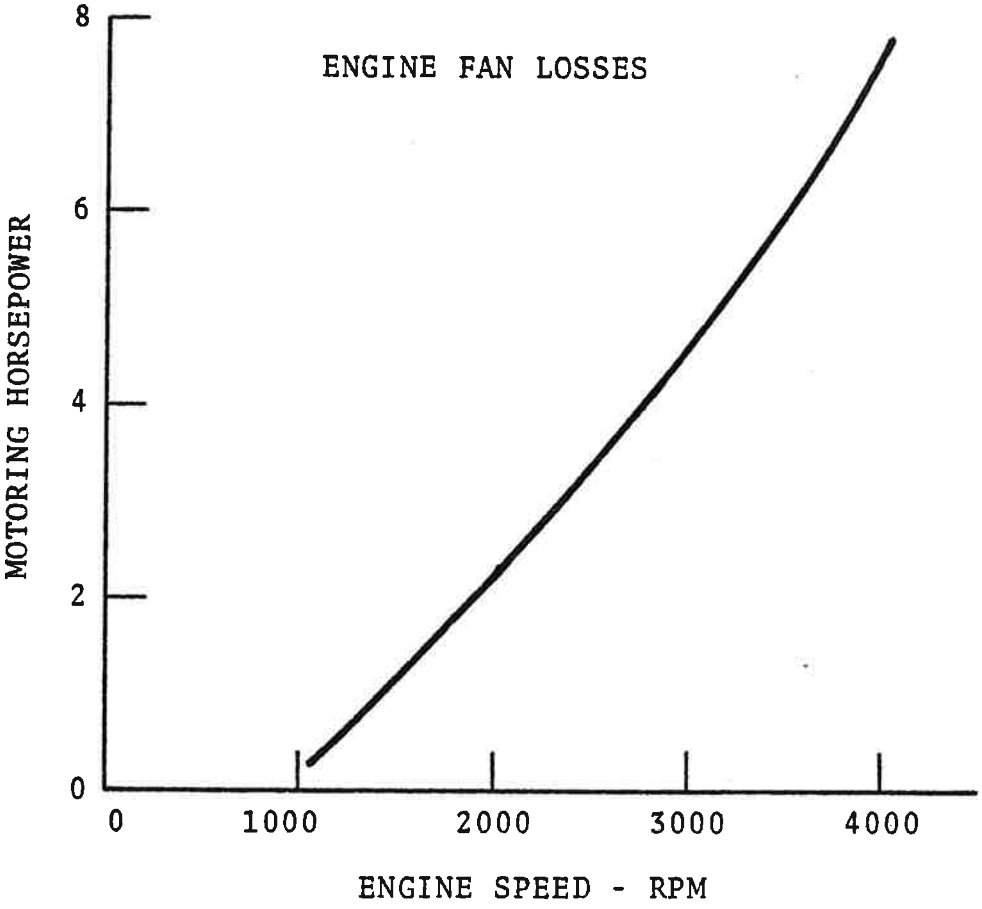

FIGURE 5. FAN FRICTION LOSSES

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