MAINTENANCE MANUAL

AND

PARTS CATALOG

FOR

GENERATOR SET, PORTABLE, DIESEL, SKID-MOUNTED

100 to 106-KW, 127/220-VOLT, 3-PHASE, 60-CYCLE,

OR

230/400-VOLT, 3-PHASE, 50-CYCLE, MURPHY

COVERING PURCHASE ORDERS

C-2744 (Old No.)	23-1577 (New No.)
C-4723 (Old No.)	23-1429 (New No.)
C-6435 (Old No.)	23-1412 (New No.)

For Serial No. See Pages Immediately Following

MANUFACTURED FOR

CORPS OF ENGINEERS

BY

MURPHY DIESEL COMPANY

MILWAUKEE . . . WISCONSIN

PRINTED IN U·S·A

TM 5 - 5052

WAR DEPARTMENT

Washington 25, D. C., 28 March 1944

TM 5-5052, Maintenance Manual and Parts Catalog, Generator Set, Portable, Diesel, Skid-Mounted, 100 to 106-KW, 127/220-Volt, 3-Phase, 60-Cycle, or 230/400-Volt, 3-Phase, 50-Cycle, Murphy, Model ME-650, is published for the information and guidance of all concerned.

A. G. 300.7, 5 April 1944.

By order of the Secretary of War:

G. C. MARSHALL,
Chief of Staff.

Official:

J. A. ULIO,
Major General,
The Adjutant General.

Distribution:

X Armies (10); Corps (10); sv Comds. (10); Depts. (10); Def. Comds. (1); D (2); 1 C 5 (2); Tech. and Sv (2); Arm and Sv Boards (2). I C 5: T/O 5-267, Engr. Base Dep. Co.; 5-377, Engr. Base Equip. Co.

WARNING

SPARE PARTS can be supplied promptly and accurately only if positively identified by correct part number and correct part name.

FURNISH THIS INFORMATION ON ALL REQUISITIONS.

WITHOUT FAIL, on all requisitions, give name of machine, name of manufacturer, model or size, manufacturer's serial number of each machine and subassemblies attached to machine, and components and accessories for which spare parts are required.

List spare parts for only one make or kind of machine on each requisition.

Requisitions must be double spaced to provide room for office notations when necessary.

SPECIFICATION No. 299

Engine No.	Generator No.
10221-B	84532
10267-B	84580
10282-B	84592
10284-B	84550
10303-B	84534
10304-B	84581
10305-B	84552
10306-B	84544
10307-B	84546
10308-B	84541
10315-B	84545
10316-B	84557
10319-B	84587
10330-B	84585
10332-B	84542
10373-B	84547
10374-B	84536
10385-B	84579
10386-B	84576
10398-B	84588
10399-B	84589
10400-B	84597
10402-B	84594
10403-B	84600
10408-B	84568
10412-B	84540
10420-B	84572
10421-B	84559
10427-B	84606
10428-B	84610
10438-B	84595
10439-B	84605
10440-B	84611
10443-B	84609
10452-B	84561
10453-B	84602
10454-B	84563
10456-B	84570
10268-B	84533
10269-B	84535
10270-B	84591
10271-B	84590
10272-B	84582
10281-B	84583
10283-B	84537
10293-B	84554
10294-B	84584
10295-B	84578
10296-B	84548
10317-B	84553
10318-B	84549
10320-B	84538
10329-B	84586
10331-B	84543
10375-B	84539
10376-B	84577
10387-B	84575
10388-B	84598
10389-B	84604
10401-B	84599
10404-B	84593
10405-B	84569
10406-B	84551
10407-B	84565
10413-B	84596
10419-B	84571
10422-B	84555
10424-B	84566
10437-B	84564
10441-B	84562
10442-B	84608
10455-B	84607
10458-B	84601
10460-B	84603

See Page V for list of assemblies which apply to above Engines.

SPECIFICATION No. 299

Page	Quantity of Assem. per Engine	Assembly No.	Description
146	1	MD-7242	Air Cleaner Assembly and Pre-Cleaner Assembly
147	1	MD-6315	Bevel Gear and Pinion Assembly
148, 149	1	MD-6041	Camshaft Housing Assembly
150	6	MD-4315	Connecting Rod Assembly
152, 153	1	MD-6125A	Control Set Assembly
154	1	MD-5092	Control Box Mounting Assembly
155	1	MD-6758	Crankcase Assembly
156	1	MD-4326	Crankcase Breather Assembly
157	1	MD-6768A	Crankshaft Assembly
158, 159	1	MD-3498	Cylinder Head Assembly
160	1	MD-5889	Exhaust Manifold Assembly
161	1	MD-6392	Engine Support Assembly—Front
162	1	MD-7570	Fan Assembly
163	1	MD-4719	Filter Assembly
165	1	MD-4809	Filter Support Assembly
166, 167	1	MD-7580	Filter Tubing Assembly
170	1	MD-5447	Flywheel Housing Assembly
172	1	MD-6575A	Flywheel and Gear Ring Assembly
172	10	MD-885	Flywheel Bolt
173	1	MD-6393	Fuel Supply Pump Assembly
232	1	DR-1106538	Generator
174	1	MD-5091A	Generator Mounting Assembly
175-177	1	MD-6772A	Generator Drive Assembly
178-181	1	MD-5823A	Governor Assembly
180	1	MD-5292	Governor Spring
184	1	MD-7243A	Inlet Manifold Assembly
186	6	MD-6495	Injector Assembly
187	1	MD-3579	Instrument Panel Assembly
189	1	MD-3840	Instrument Panel Mounting Assembly
190	1	MD-6774A	Oil Cooler Assembly
191	1	MD-5337	Oil Pressure Relief Valve Assembly
192	1	MD-6775A	Oil Pump Assembly
193	1	MD-6566	Oil Sump Assembly
194	6	MD-4765	Piston Assembly
195	1	MD-7559	Radiator Assembly
196	1	MD-4894A	Starting Motor Assembly
197	1	MD-6127	Tappet Guide Assembly
198	1	MD-5069B	Tool Kit Assembly
199	6	MD-5952A	Valve Cover Assembly
154	1	DR-5859	Voltage Regulator (Control Box Assembly)
200	1	MD-6777B	Water Pump Assembly
201	1	MD-5221	Wire Assembly
203	1	MD-6316	Worm Assembly
204	1	MD-3020	Worm Oil Line Assembly
214	1	MD-3952	Metallic Gasket Assembly
212	1	MD-6770	Paper Gasket Assembly
205	1	MD-6778	Blower and Mounting Assembly
....	2	....	Battery—Willard R.H.D. 19-6, 12 volts or equivalent
201, 202	1	MD-6373	Battery Cable Assembly
....	1	MD-6111A	Coupling—Thomas 3878S.
207	1	MD-7248	Exhaust Muffler Assembly
208	1	MD-7254A	Fuel Tank Assembly
258-290	1	....	Electric Machinery Manufacturing Co. Generator
210	1	MD-7571	Radiator Guard Assembly
211	1	MD-7749	Skid Assembly
264-265	1	....	Switchboard Panel Assembly
166 etc.	2	MD-4451	Thermometer 1—Jacket Water Temperature 1—Lube Oil Temperature

See Page IV for list of Engines which above assemblies apply to.

SPECIFICATION No. 310

Engine No.	Generator No.	Engine No.	Generator No.	Engine No.	Generator No.
10425-B	85377	10537-B	85388	10598-B	85534
10459-B	85382	10538-B	85522	10605-B	85527
10461-B	85532	10539-B	85374	10606-B	85395
10462-B	85524	10549-B	85523	10607-B	85528
10464-B	85386	10550-B	85385	10608-B	85380
10475-B	85376	10551-B	85392	10609-B	85400
10476-B	85387	10552-B	85525	10610-B	85536
10477-B	85370	10553-B	85530	10611-B	85539
10478-B	85369	10564-B	85415	10612-B	85412
10479-B	85368	10565-B	85399	10613-B	85542
10488-B	85529	10566-B	85394	10614-B	85540
10489-B	85367	10567-B	85401	10620-B	85396
10490-B	85371	10568-B	85402	10621-B	85553
10491-B	85526	10569-B	85551	10622-B	85555
10492-B	85379	10570-B	85544	10623-B	85567
10525-B	85384	10584-B	85411	10624-B	85404
10526-B	85381	10585-B	85537	10625-B	85427
10527-B	85383	10586-B	85533	10626-B	85405
10528-B	85378	10588-B	85566	10627-B	85432
10529-B	85373	10589-B	85541	10628-B	85410
10530-B	85391	10590-B	85548	10629-B	85545
10531-B	85393	10591-B	85547	10635-B	85430
10532-B	85389	10592-B	85543	10636-B	85560
10533-B	85372	10593-B	85549	10637-B	85556
10534-B	85375	10594-B	85398	10638-B	85546
10535-B	85531	10595-B	85535	10640-B	85561
10536-B	85390	10597-B	85397		

See Page VII for list of assemblies which apply to above Engines.

SPECIFICATION No. 310

Page	Quantity of Assem. per Engine	Assembly No.	Description
146	1	MD-7242	Air Cleaner Assembly and Pre-Cleaner Assembly
147	1	MD-6315	Bevel Gear and Pinion Assembly
148, 149	1	MD-6041	Camshaft Housing Assembly
150	6	MD-4315	Connecting Rod Assembly
152, 153	1	MD-6125A	Control Set Assembly
154	1	MD-5092	Control Box Mounting Assembly
155	1	MD-6758	Crankcase Assembly
156	1	MD-4326	Crankcase Breather Assembly
157	1	MD-6768A	Crankshaft Assembly
158, 159	1	MD-3498	Cylinder Head Assembly
160	1	MD-5889	Exhaust Manifold Assembly
161	1	MD-6392	Engine Support Assembly—Front
162	1	MD-7570	Fan Assembly
164	1	MD-4719A	Filter Assembly
165	1	MD-4809	Filter Support Assembly
168	1	MD-7580B	Filter Tubing Assembly
170	1	MD-5447	Flywheel Housing Assembly
172	1	MD-6575A	Flywheel and Gear Ring Assembly
172	10	MD-885	Flywheel Bolt
173	1	MD-6393	Fuel Supply Pump Assembly
232	1	DR-1106538	Generator
174	1	MD-5091A	Generator Mounting Assembly
175-177	1	MD-6772A	Generator Drive Assembly
178-181	1	MD-5823A	Governor Assembly
184	1	MD-7243A	Inlet Manifold Assembly
186	6	MD-6495	Injector Assembly
188	1	MD-7918	Instrument Panel Assembly
190	1	MD-6774A	Oil Cooler Assembly
191	1	MD-5337	Oil Pressure Relief Valve Assembly
192	1	MD-6775A	Oil Pump Assembly
193	1	MD-6566	Oil Sump Assembly
194	6	MD-4765	Piston Assembly
195	1	MD-7559	Radiator Assembly
196	1	MD-4894A	Starting Motor Assembly
197	1	MD-6127	Tappet Guide Assembly
198	1	MD-5069	Tool Kit Assembly
199	6	MD-5952A	Valve Cover Assembly
154	1	DR-5859	Voltage Regulator (Control Box Assembly)
200	1	MD-6777B	Water Pump Assembly
202	1	MD-5221A	Wire Assembly
203	1	MD-6316	Worm Assembly
204	1	MD-3020	Worm Oil Line Assembly
214	1	MD-3952	Metallic Gasket Assembly
212	1	MD-6770	Paper Gasket Assembly
206	1	MD-7906A	Auxiliary Exhaust Pipe Assembly
205	1	MD-6778	Blower and Mounting Assembly
....	2	....	Battery—Willard R.H.D. 19-6, 12 volts or equivalent
201, 202	1	MD-6373	Battery Cable Assembly
....	1	MD-6111A	Coupling—Thomas 3878S.
206	1	MD-7899	Exhaust Muffler Assembly
209	1	MD-7254B	Fuel Tank and Piping Assembly
291-328	1	....	Electric Machinery Manufacturing Co. Generator
215	1	MD-7839A	Lifting Bail Assembly
210	1	MD-7571	Radiator Guard Assembly
211	1	MD-7749	Skid Assembly
166, etc.	2	MD-4451	Thermometer 1—Jacket Water Temperature 1—Lube Oil Temperature

See Page VI for list of Engines which above assemblies apply to.

SPECIFICATION No. 315

Engine No.	Generator No.
10639-B	85417
10641-B	85568
10642-B	85414
10643-B	85562
10644-B	85409
10650-B	85559
10651-B	85431
10652-B	85403
10653-B	85422
10654-B	85418
10655-B	85424
10656-B	85538
10657-B	85421
10658-B	85428
10659-B	85564
10665-B	85407
10666-B	85416
10667-B	85406
10668-B	85413
10669-B	85571
10670-B	85425
10671-B	85574
10672-B	85595
10673-B	85573
10674-B	85554
10680-B	85578
10681-B	85589
10682-B	85550
10683-B	85593
10684-B	85408
10685-B	85423
10686-B	85588
10687-B	85563
10688-B	85594
10689-B	85420
10695-B	85608
10696-B	85592
10697-B	85569
10698-B	85607
10699-B	85557
10700-B	85577
10701-B	85580
10702-B	85552
10703-B	85419
10704-B	85426
10710-B	85572
10711-B	85590
10712-B	85441
10713-B	85581
10714-B	85603
10715-B	85731
10716-B	85429
10717-B	85596
10718-B	85597
10719-B	85599
10725-B	85726
10726-B	85558
10727-B	85618
10728-B	85619
10729-B	85444
10730-B	85433
10740-B	85614
10741-B	85446
10742-B	85613
10743-B	85440
10745-B	85738
10746-B	85610
10747-B	85438
10748-B	85615
10749-B	85732
10750-B	85617
10751-B	85612
10752-B	85436
10753-B	85591
10754-B	85575
10760-B	85733
10761-B	85739
10762-B	85637
10763-B	85745
10764-B	85434
10765-B	85741
10766-B	85435
10767-B	85740
10768-B	85742
10769-B	85583
10770-B	85723
10776-B	85442
10777-B	85582
10778-B	85638
10779-B	85639
10780-B	85586
10781-B	85579
10782-B	85439
10783-B	85737
10784-B	85727
10790-B	85570
10791-B	85616
10792-B	85443
10793-B	85621
10794-B	85736
10795-B	85735
10796-B	85437
10797-B	85611
10798-B	85734
10799-B	85729
10800-B	85587
10801-B	85576
10802-B	85724
10808-B	85602
10809-B	85622
10810-B	85725
10811-B	85598
10812-B	85601
10813-B	85625
10814-B	85604
10815-B	85728
10817-B	85626
10818-B	85445
10819-B	85653
10820-B	85584
10821-B	85627
10827-B	85623
10828-B	85746
10829-B	85644
10830-B	85643
10831-B	85585
10832-B	85730
10833-B	85750
10834-B	85722
10835-B	85605
10841-B	85651
10842-B	85628
10843-B	85565
10844-B	85629
10845-B	85650
10846-B	85609
10847-B	85600
10848-B	85747
10849-B	85606
10850-B	85751
10854-B	85632
10857-B	85757
10858-B	85635
10860-B	85757
10861-B	85630
10862-B	85631
10863-B	85620
10864-B	85749
10865-B	85633
10866-B	85624
10869-B	85636
10870-B	85649
10873-B	85643
10874-B	85641
10877-B	85798
10878-B	85784
10879-B	85674
10880-B	85779
10881-B	85748
10882-B	85759
10883-B	85754
10884-B	85765
10887-B	85654
10888-B	85743
10891-B	85647
10892-B	85782
10894-B	85744
10895-B	85777
10896-B	85760
10897-B	85752
10898-B	85645
10899-B	85758
10900-B	85775
10901-B	85664
10902-B	85640
10905-B	85652
10906-B	85771
10909-B	85753
10910-B	85648
10912-B	85776
10913-B	85791
10916-B	85792
10917-B	85646
10920-B	85673
10921-B	85761
10923-B	85796
10924-B	85790
10925-B	85671
10926-B	85793

See Page X for list of assemblies which apply to above Engines.

SPECIFICATION No. 315—(Cont'd)

Engine No.	Generator No.
10927-B	85755
10928-B	85675
10929-B	85788
10930-B	85756
10931-B	85789
10934-B	85785
10935-B	85668
10938-B	85801
10940-B	85800
10941-B	85797
10942-B	85672
10943-B	85795
10944-B	85772
10945-B	85709
10946-B	85681
10947-B	85678
10948-B	85707
10949-B	85689
10952-B	85685
10953-B	85677
10956-B	85684
10957-B	85680
10959-B	85715
10960-B	85686
10961-B	85763
10962-B	85711
10963-B	85721
10964-B	85712
10965-B	85716
10966-B	85718
10967-B	85714
10972-B	85719
10974-B	85700
10975-B	85762
10976-B	85717
10977-B	85708
10978-B	85701
10979-B	85696
10980-B	85695
10984-B	85683
10985-B	85699
10988-B	85656
10989-B	85768
10990-B	85770
10991-B	85655
10992-B	85766
10993-B	85691
10994-B	85658
10995-B	85693
11001-B	85692
11002-B	85705
11003-B	85764
11004-B	85698
11009-B	85676
11010-B	85720
11017-B	85659
11018-B	85657
11019-B	85767
11020-B	85706
11023-B	85704
11024-B	85703
11027-B	85783
11028-B	85666
11030-B	85710
11031-B	85702
11032-B	85794
11033-B	85694
11034-B	85769
11035-B	85781
11036-B	85713
11037-B	85773
11038-B	85688
11039-B	85669
11040-B	85809
11041-B	85697
11042-B	85780
11043-B	85807
11044-B	85778
11045-B	85805
11046-B	85665
11047-B	85803
11048-B	85810
11049-B	85799
11050-B	85687
11051-B	85661
11054-B	85802
11055-B	85660
11058-B	85774
11059-B	85808
11061-B	85662
11062-B	85811
11063-B	85787
11064-B	85786
11065-B	85815
11066-B	85679
11067-B	85816
11068-B	85813

See Page X for list of assemblies which apply to above Engines.

SPECIFICATION No. 315

Page	Quantity of Assem. per Engine	Assembly No.	Description
146	1	MD-7242	Air Cleaner Assembly and Pre-Cleaner Assembly
147	1	MD-6315	Bevel Gear and Pinion Assembly
148, 149	1	MD-6041	Camshaft Housing Assembly
150	6	MD-4315	Connecting Rod Assembly
152, 153	1	MD-6125A	Control Set Assembly
154	1	MD-5092	Control Box Mounting Assembly
155	1	MD-6758	Crankcase Assembly
156	1	MD-4326	Crankcase Breather Assembly
157	1	MD-6768A	Crankshaft Assembly
158, 159	1	MD-3498	Cylinder Head Assembly
160	1	MD-5889	Exhaust Manifold Assembly
161	1	MD-6392	Engine Support Assembly—Front
162	1	MD-7570	Fan Assembly
164	1	MD-4719A	Filter Assembly
165	1	MD-4809	Filter Support Assembly
168	1	MD-7580B	Filter Tubing Assembly
170	1	MD-5447	Flywheel Housing Assembly
172	1	MD-6575A	Flywheel and Gear Ring Assembly
172	10	MD-885	Flywheel Bolt
173	1	MD-6393	Fuel Supply Pump Assembly
232	1	DR-1106538	Generator
174	1	MD-5091A	Generator Mounting Assembly
175-177	1	MD-6772A	Generator Drive Assembly
182, 183	1	MD-5823B	Governor Assembly
180	1	MD-5292	Governor Spring
184	1	MD-7243A	Inlet Manifold Assembly
186	6	MD-6495	Injector Assembly
188	1	MD-7918	Instrument Panel Assembly
190	1	MD-6774A	Oil Cooler Assembly
191	1	MD-5337	Oil Pressure Relief Valve Assembly
192	1	MD-6775A	Oil Pump Assembly
193	1	MD-6566	Oil Sump Assembly
194	6	MD-4765	Piston Assembly
195	1	MD-7559	Radiator Assembly
196	1	MD-4894A	Starting Motor Assembly
197	1	MD-6127	Tappet Guide Assembly
198	1	MD-5069	Tool Kit Assembly
199	6	MD-5952A	Valve Cover Assembly
154	1	DR-5859	Voltage Regulator (Control Box Assembly)
200	1	MD-6777B	Water Pump Assembly
202	1	MD-5221A	Wire Assembly
203	1	MD-6316	Worm Assembly
204	1	MD-3020	Worm Oil Line Assembly
214	1	MD-3952	Metallic Gasket Assembly
212	1	MD-6770	Paper Gasket Assembly
206	1	MD-7906A	Auxiliary Exhaust Pipe Assembly
205	1	MD-6778	Blower and Mounting Assembly
....	2	....	Battery—Willard W.H.D. 19-6, 12 volts or equivalent
201, 202	1	MD-6373	Battery Cable Assembly
206	1	MD-7899	Exhaust Muffler Assembly
209	1	MD-7254B	Fuel Tank and Piping Assembly
291-328	1	....	Electric Machinery Manufacturing Co. Generator
215	1	MD-7839A	Lifting Bail Assembly
210	1	MD-7571	Radiator Guard Assembly
211	1	MD-7749	Skid Assembly
166, etc.	2	MD-4451	Thermometer 1—Jacket Water Temperature 1—Lube Oil Temperature

See Pages VIII and IX for list of Engines which above assemblies apply to.

SPECIFICATION No. 368

The following engines are identical to those immediately preceding (Specification No. 375 on Page XII) except for the inclusion of Radio Shielding installed on E. M. M. Co. generator and engine wiring assembly. Use MD-5221B wiring assembly (Page 257) instead of MD-5221A wiring assembly. Additional parts for E. M. M. Co. generator are listed on Page 249, items 1 to 5 inclusive.

Engine No.	Generator No.	Engine No.	Generator No.	Engine No.	Generator No.
11223-B	87128	11277-B	87146	11308-B	87164
11222-B	87130	11281-B	87153	11307-B	87147
11232-B	87134	11270-B	87142	11309-B	87127
11100-B	85804	11283-B	87144	11301-B	87169
11236-B	87136	11284-B	87152	11352-B	87187
11233-B	87137	11287-B	87161	11353-B	87182
11237-B	87138	11285-B	87156	11355-B	87189
11221-B	87124	11286-B	87155	11356-B	87191
11239-B	87125	11282-B	87151	11354-B	....
11238-B	87135	11290-B	87158	11357-B	....
11253-B	87129	11288-B	87148	11358-B	....
11241-B	87132	11296-B	87159	11359-B	....
11254-B	87131	11291-B	87160	11360-B	....
11250-B	87126	11289-B	87173	11361-B	....
11249-B	87133	11300-B	87171	11372-B	....
11263-B	87140	11295-B	87165	11373-B	....
11267-B	87149	11304-B	87168	11374-B	....
11262-B	87145	11303-B	87166	11375-B	....
11266-B	87139	11302-B	87172	11376-B	....
11271-B	87141	11305-B	87170	11377-B	....
11276-B	87150	11306-B	87162	11378-B	....

and Engine Numbers 11400 thru 11728 inclusive.

See Page XII for Specifications.

Operation Section Index

GENERAL DESCRIPTION

The Murphy Diesel Generator set consists of a Murphy Diesel Model ME-650 engine connected by a Thomas flexible coupling to an Electric Machinery Manufacturing Co. Generator. The unit is skid mounted and complete with all necessary accessories including fuel tank, tools, spare injectors, and mufflers. The only items needed in addition to those included with the unit are, lubricating oil (see lube section) fuel oil (see fuel section) and coolant (see cooling system section).

The set produces electrical current of the following characteristics:

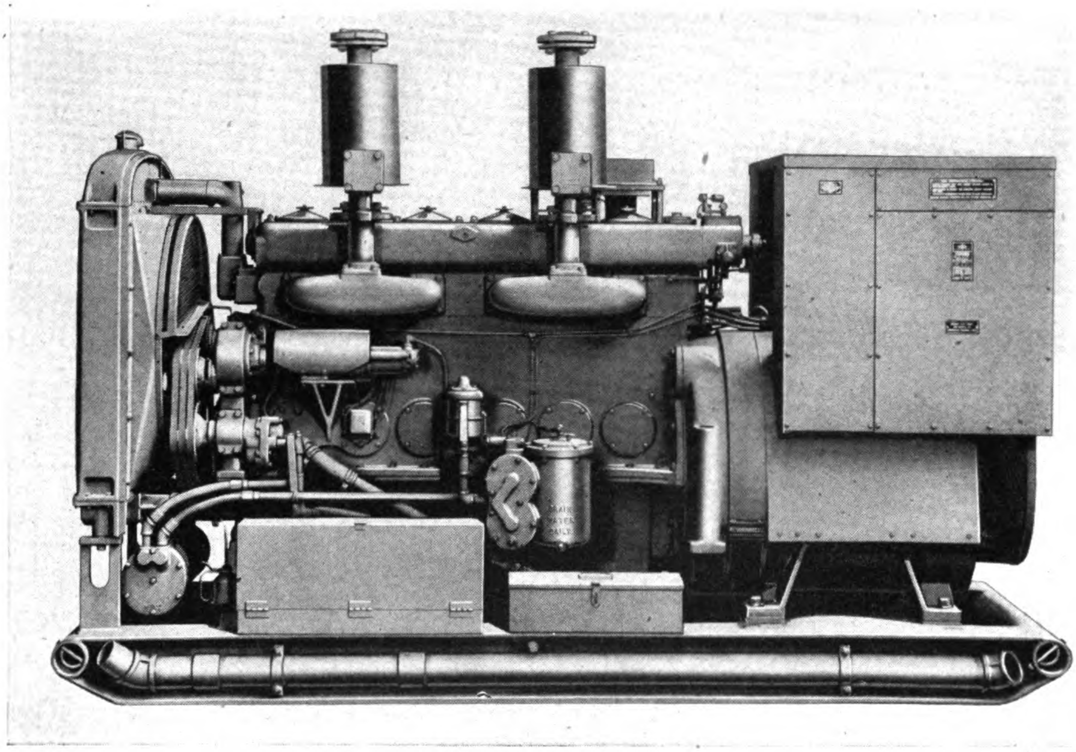
@ 1200 R.P.M. 100 to 106 KW @ 127/220 Volts, 3 Phase, 60 Cycle

@ 1000 R.P.M. 91 to 95 KW @ 400/230 Volts, 3 Phase, 50 Cycle

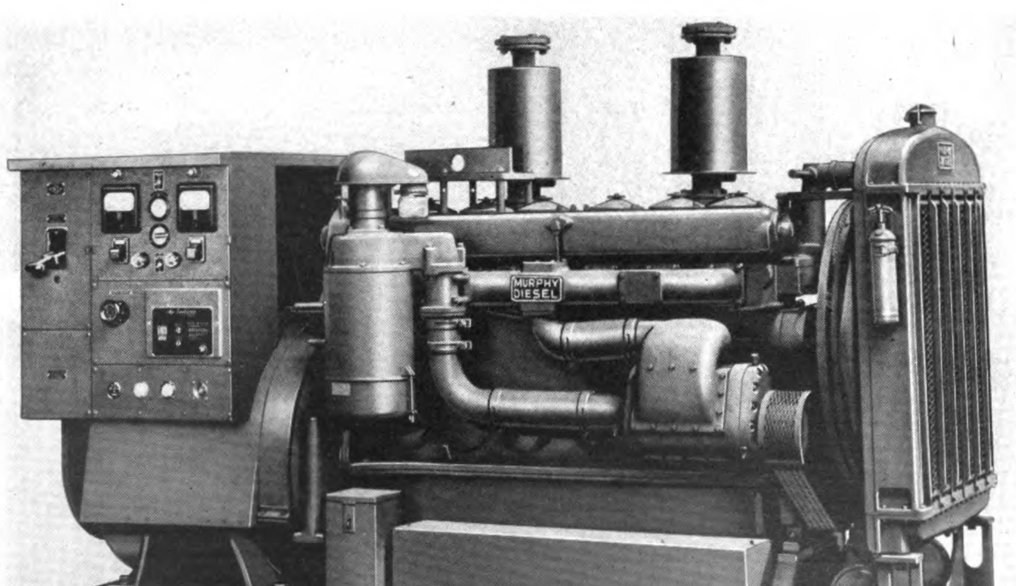
The changes necessary to convert from 50 to 60 cycle current consist of rearrangement of the linkage in the terminal box, changing the breaker trip unit (alternate unit located in terminal box) and a change in position of governor spring pin. These changes are very simple and can normally be made in about 1 hour.

Maintenance Section Index

Parts Section Index



MURPHY DIESEL GENERATOR SET
EXHAUST SIDE



MURPHY DIESEL GENERATOR SET
INTAKE SIDE

OPERATION SECTION

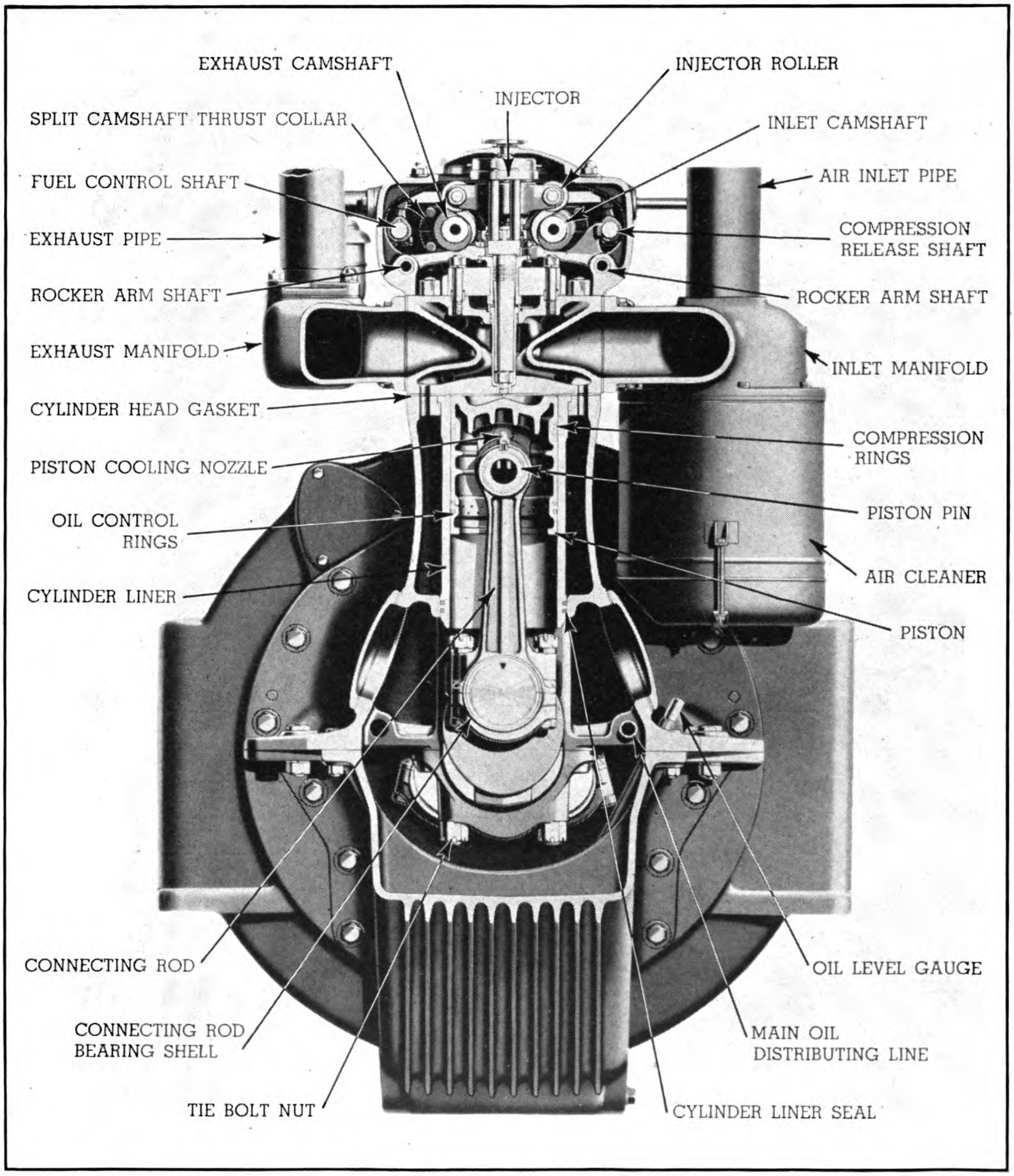


FIG. 1—CROSS SECTION

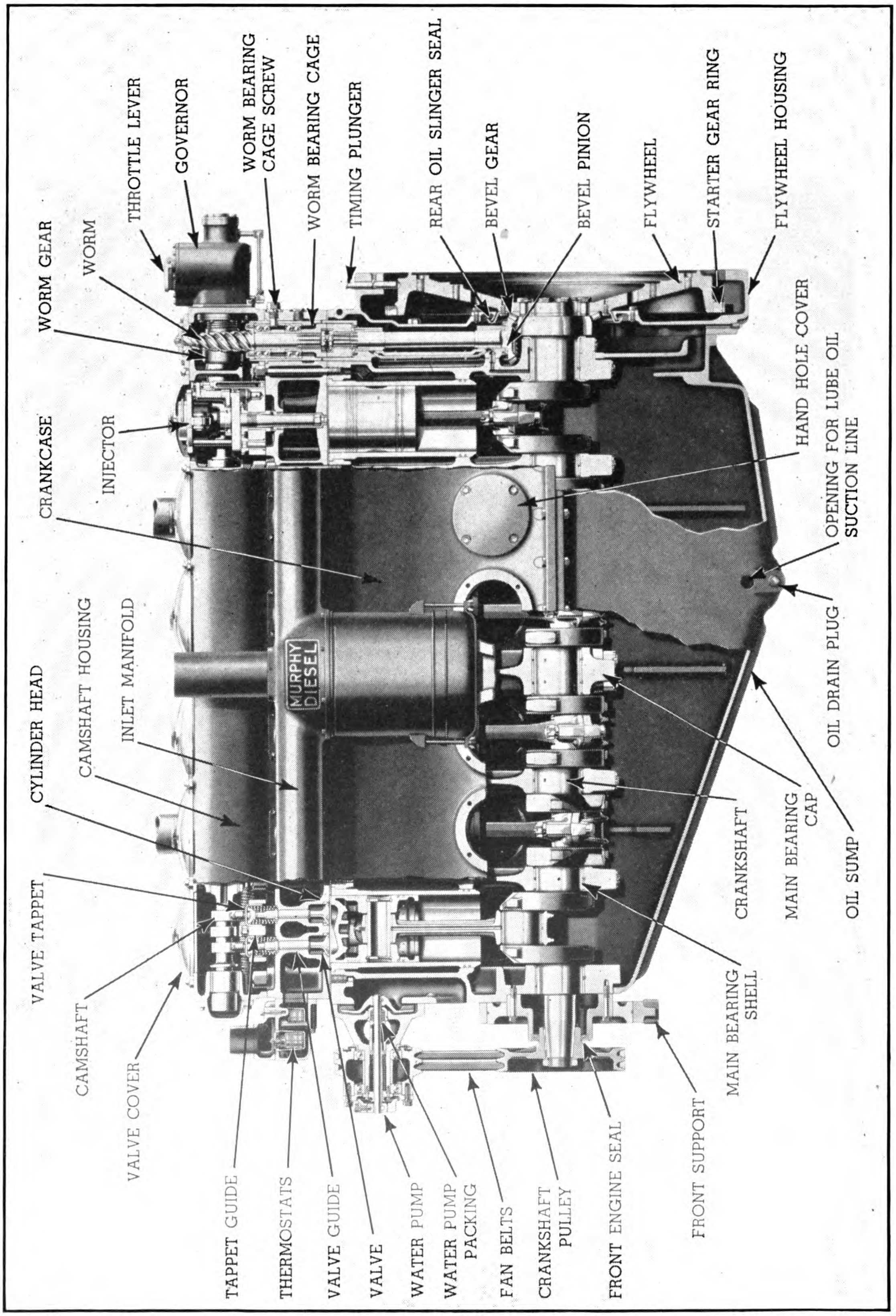


FIG. 2—LONGITUDINAL SECTION

GENERAL ENGINE INFORMATION

The Murphy Diesel engine is of the solid injection, full Diesel type, in which the Diesel fuel is ignited by the heat of compression, without the aid of spark plugs or other external heat.

The engine operates upon the common four stroke cycle principle, the events being as follows:

1. Inlet Stroke
2. Compression Stroke
3. Expansion or Power Stroke
4. Exhaust Stroke

During the inlet stroke, the piston is traveling downward, and draws air only through the open inlet valves and into the engine cylinder. With the valves closed and the piston moving up, the air is compressed to approximately 575 pounds per square inch pressure. Because of the high compression pressure, the air is heated to a temperature of about 1000° Fahrenheit. Ignition takes place near the end of the compression stroke when a very fine spray of fuel is injected into the highly heated air. The heat of combustion creates a pressure, thereby forcing the piston downward on its power stroke. Near the end of the power stroke, the exhaust valves open, and when the piston moves upward on the exhaust stroke, the cylinder is cleared of burnt gas and is ready for the next cycle.

General Description Murphy Diesel Engine

The Diesel fuel is circulated through the injection system by a low pressure supply pump located at the side of the engine, and injected into the combustion chamber, under pressure by a single pump and injection valve above each cylinder. The pump and valve for each cylinder are combined into one campact unit called the injector that may be quickly removed and replaced. The injectors are located in the cylinder head in the exact center of each cylinder and spray the fuel through drilled holes in the nozzle injector tip into a plain, open combustion chamber, formed by the cup-shaped piston head and the flat cylinder head. The Murphy Diesel engine is a true Diesel, and because of the efficient injection system, it requires no precombustion chamber or pre-heating devices. The amount of fuel supplied to each cylinder is regulated with the hydraulic servo governor by rotating the injector plunger back and forth in its cylinder. This rotating action causes a helical groove at the lower end of the plunger to uncover a port in the injector barrel, thus allowing the excess fuel to by-pass back to the supply line.

The two overhead camshafts operate the injectors as well as the intake and exhaust valves. The camshafts are driven from the flywheel end of the engine by a vertical shaft, through bevel gears on the lower end, and worm and gears on the upper end. This construction assures a positive, accurate drive to the injectors. The injector cams on the camshafts raise the injector rollers and tappets, and in so doing, compress the heavy springs in the upper part of each injector. The three springs force the plunger down in the barrel thereby injecting the fuel. This construction provides a safety feature that protects all injector parts in the event a nozzle tip becomes stopped up or a plunger sticks in its barrel. In such cases, the rollers will not follow the cams, and the noise resulting, caused by the cams striking the partially raised rollers, will indicate inoperation of an injector before any damage is done.

GENERAL ENGINE INFORMATION—*(Cont'd)*

The governor that controls the injectors is driven by the rear end of one camshaft. It is of the hydraulic Servo type, and utilizes the lubricating oil pressure as a source of energy. The governor flyball weights control the movement of a piston type oil valve that permits oil pressure to act upon the main governor piston. The oil pressure acting on the governor piston does the actual work of rotating the fuel control shaft to open the injectors, and a compression spring closes them. Utilizing the oil pressure results in a quick acting governor, and provides a particularly desirable safety feature in that a spring closes the injectors stopping the engine if the lubricating oil pressure falls below approximately 20 pounds. This protection provides against burnt out bearings and scored cylinders.

The crankshaft has electrically hardened journals to which are fitted long life, copper-lead, steel-backed precision bearings. The main bearings are 4″ (3.979″ actual) in diameter, and the connecting rod bearings are 3½″ (3.498″ actual) in diameter.

The pistons are accurately machined from special cast iron for long trouble-free life. Pistons run extremely cool, because of oil cooling, thereby largely eliminating ring sticking, a common fault of some Diesel engines.

The lubricating system is of the full force feed type, in which all of the moving parts of the engine including those in the camshaft housing and governor, are flooded in oil. This system employs an adequate oil cooler located at the front end of the engine, which transfers heat from the lubricating oil to the cooling water. This feature provides against excessive lubricating oil temperatures, and insures rapid warming of the oil when operating at low atmospheric temperatures.

The ME series Murphy Diesel engines are started directly on the Diesel cycle by means of a 24-volt electric starting motor. The starting motor control is a lever located on the starter at the rear of the engine. The compression release and speed control are incorporated in a single lever at the rear of the engine. When the engine control lever is in the extreme upper position, the compression of the engine is released for easy cold weather rotation and emergency stops. When the lever is moved downward from the mid-position, it acts as a throttle to control the speed of the engine.

PRELIMINARY PRECAUTIONS

Before attempting to start the engine, check the level of the lubricating oil in the crankcase by means of the oil level gauge found on the side of the engine. The oil level should be up to the top hole in the gauge blade.

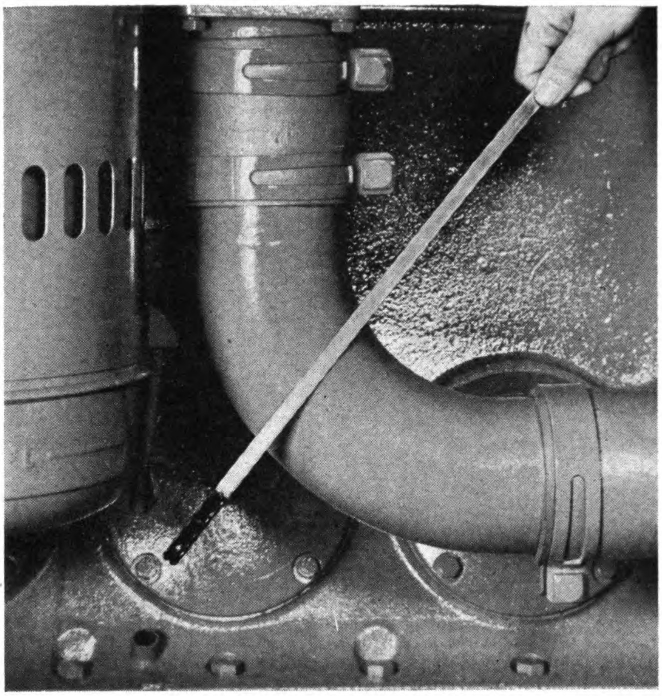


FIG. 3—Checking Oil Level

FIG. 4—Filling Engine with Oil

Filling Engine With Oil

Make sure all injectors are in place in the engine and if oil has to be added, remove one of the injector covers on top of engine and pour the proper grade of lubricating oil through this opening.

PRELIMINARY PRECAUTIONS—*(Cont'd)*

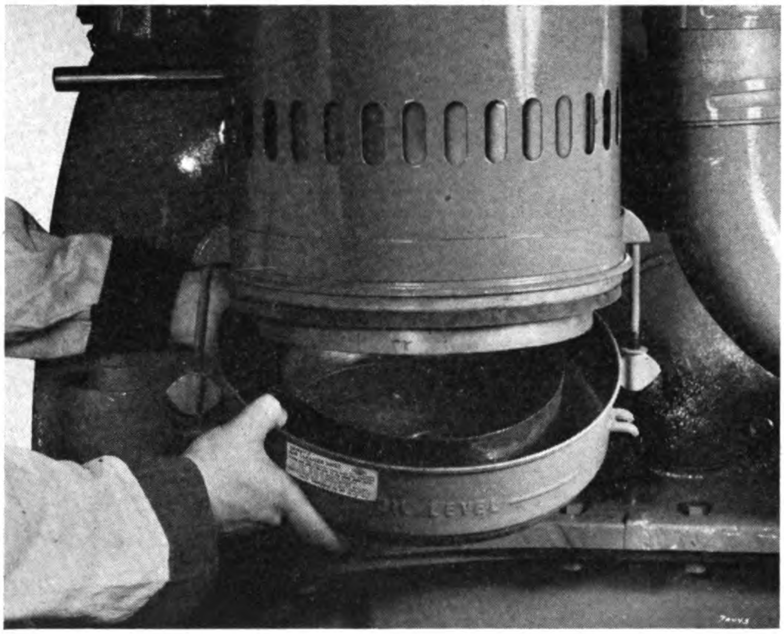


FIG. 5—Removing Air Cleaner Oil Cups

Filling Air Cleaner With Oil

Fill the air cleaner cup to the level mark with plain engine oil being sure to fill both the inner and outer cups. Do not use a special engine oil containing an additive in the air cleaner.

Filling Radiator

The radiator should be filled to within three inches of the top with clean soft water. Rain water should be used, if possible, in any case, the water should be soft and clean. NEVER OPERATE THE ENGINE WITHOUT AN ADEQUATE SUPPLY OF WATER.

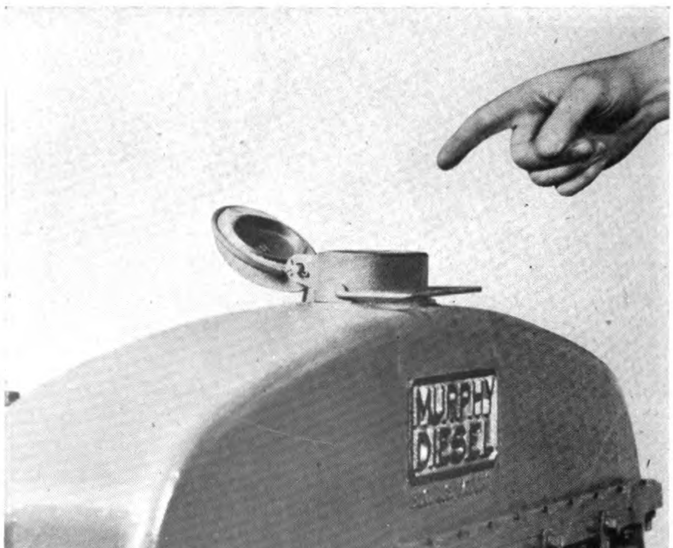


FIG. 6—Radiator Filler Opening

PRELIMINARY PRECAUTIONS—(Cont'd)

Fuel Supply

Check the fuel tank and see that it has an adequate supply of clean fuel.

Timing Plunger

Check the timing plunger on top of the flywheel housing and raise up to release it, if the engine has been locked on top dead center.

STARTING INSTRUCTIONS

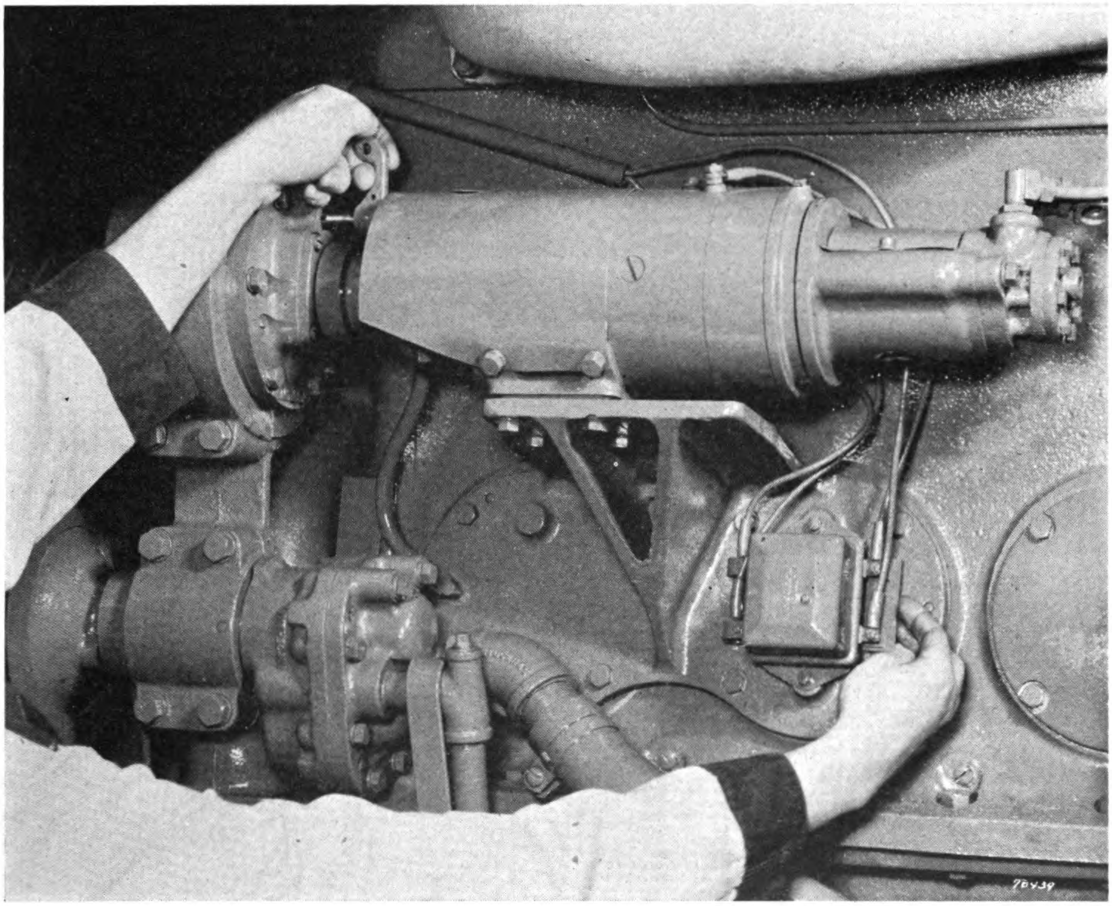


FIG. 7—Priming Engine Fuel System

Priming Engine Fuel System

To prime the engine hold out the lever in the side of the gear housing that drives the generator. Close the switch attached to the voltage regulator which will cause the generator to operate as a motor thereby pumping fuel from the main supply tank through the oil filter, and through all of the injectors. Do not close the switch on the voltage regulator unless the lever is held out. This lever can be locked out by means of a cotter pin inserted through a drilled hole in the shaft provided for this purpose. Maintain the operation of the pump until the fuel sight glass shows full and clear (no air bubbles). Re-engage the generator drive gear by moving the lever before starting the engine. If the lever at the end of the drive housing does not return all the way in when it is released, revolve the generator shaft slightly by turning the coupling.

STARTING INSTRUCTIONS—*(Cont'd)*

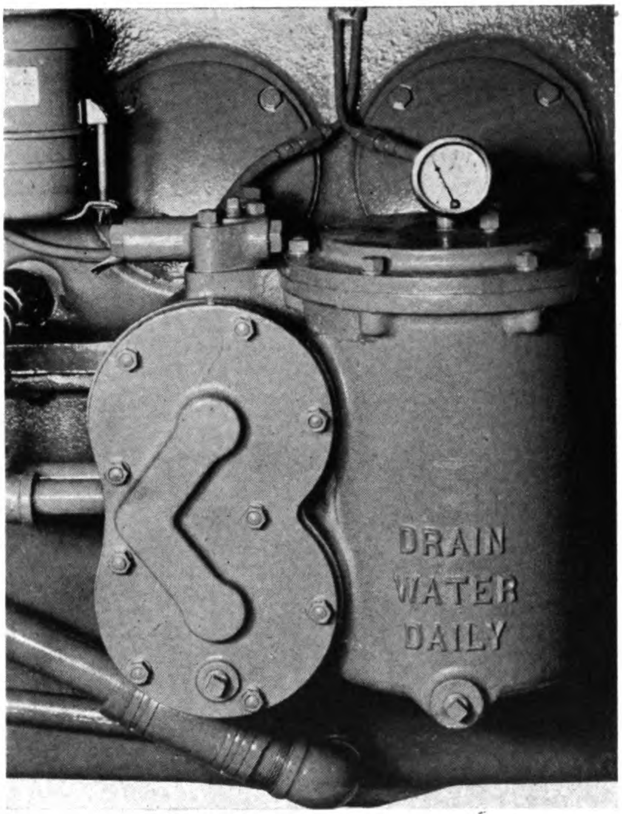


FIG. 8—Lubricating and Fuel Oil Filters

Final Check Before Starting

Disconnect all power lines to eliminate all possible trouble of energizing lines unexpectedly or running into trouble from shorted circuits. On completion of the foregoing, you are ready to start the engine, if you have taken care of the lubrication, cooling, the fuel and the disconnection of the unit from the power lines.

Starting Operation

The control lever which is located in the flywheel end of the engine has three essential positions. When moved from the horizontal position in a downward direction, the engine speed is increased. When placed in the horizontal position, the normal fuel injection is cut off. In the up position, the compression is released which positively prevents the engine from firing.

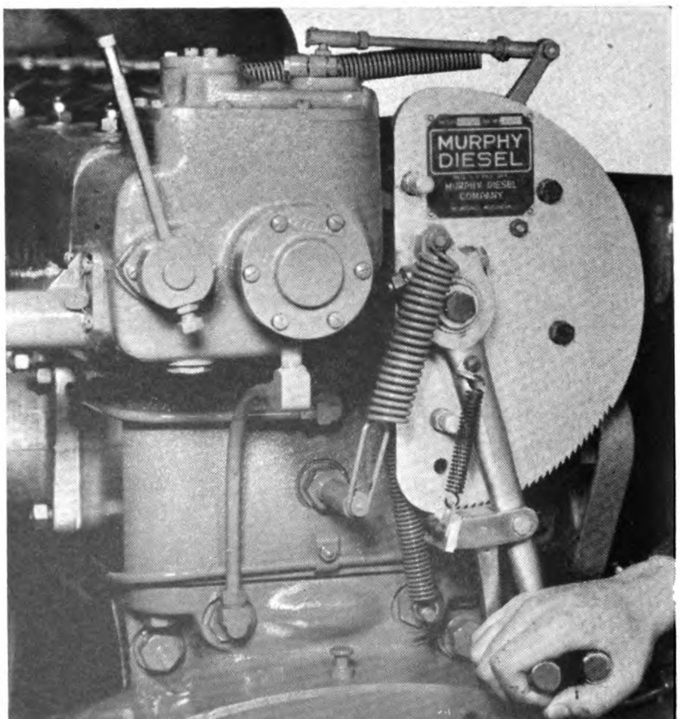


FIG. 9—Full Throttle Position

STARTING INSTRUCTIONS—(Cont'd)

Starting Operation—(Cont'd)

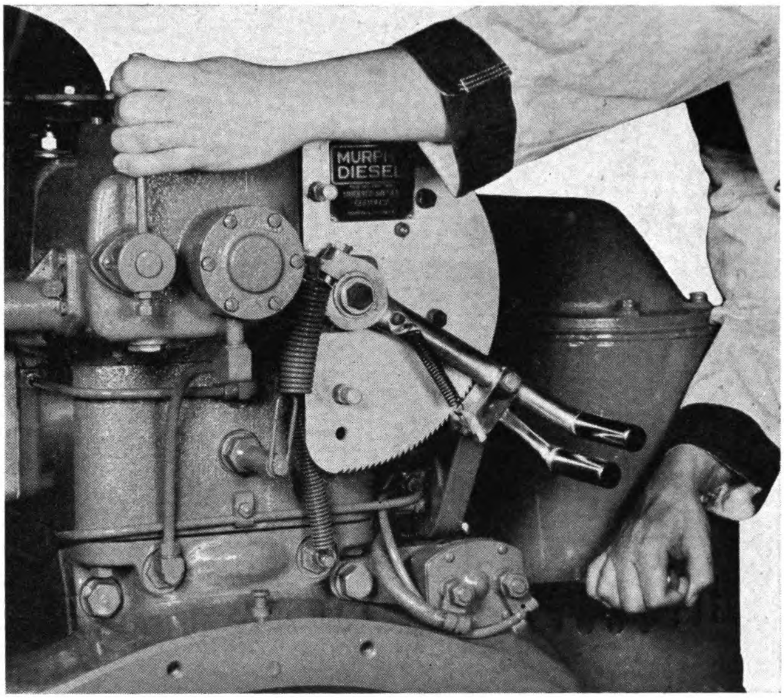


FIG. 10—Starting Throttle Position

Place the control lever about 1/3 or ½ way down on the ratchet which will set the governor lever for a slow speed idle. Insert the 5/16" diameter rod in a hole, in the collar on the rear end of the governor and pull manually holding the injectors open. Rotate the engine with the starter, until the engine starts to fire.

Immediately after the engine starts to fire release the starting motor lever, but, hold the injectors open with the small rod lever to maintain firing until the oil pressure can pick up the load. DO NOT UNDER ANY CONDITIONS KEEP THESE INJECTORS WIDE OPEN AT ANY TIME AS IT WILL CAUSE THE ENGINE TO RUN AWAY WITH SERIOUS RESULTS TO BOTH YOURSELF AND THE ENGINE.

Warm Up Engine

Your engine is now running and it should be allowed to operate at a very moderate speed for several minutes before being put to work. This accomplishes the adjustments which must be made in the engine structure as it warms up to the operating temperature, establishing correct lubrication to all points. It takes time to start the oil from the sump and get the whole system full, and then return the flow to the oil reservoir in the base of the engine. Taking the chill off the oil is also important as cold oil does not flow readily.

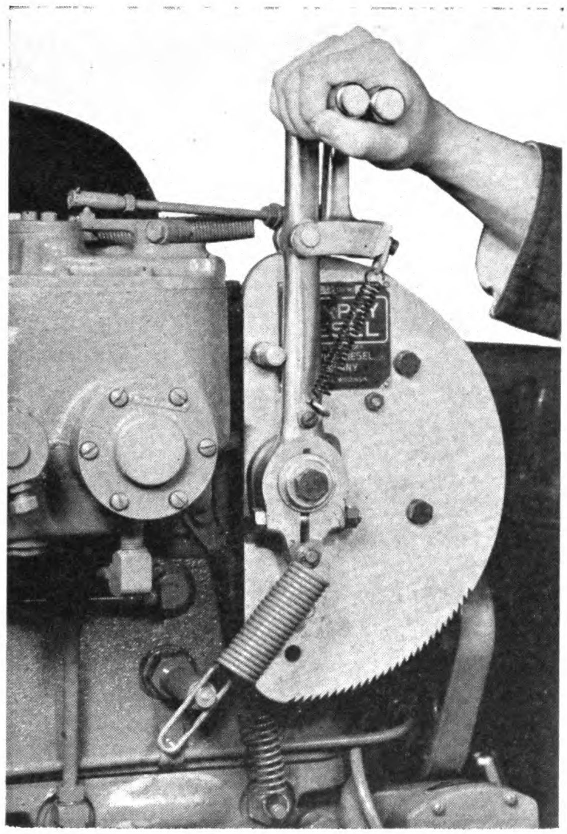


FIG. 11—Compression Release or Emergency Stop Throttle Position

COLD STARTING

When starting at low temperatures, it is helpful to swing the control lever to the up position thereby releasing the compression on the cylinders making the engine easier to turn over. After the engine is rotating, quickly move the control lever down from the up position to the point about half way down on the ratchet and pull the small rod lever open which will permit fuel injection until the oil pressure has been established.

TO STOP THE ENGINE

Move the control lever to the approximate horizontal position which cuts off the fuel to the injectors. If for any reason the control system fails to stop the injection of fuel, an emergency stop may be made by swinging the control lever to the up position. (See Figure 10.) which releases the compression and positively prevents the engine from firing. Never stop the engine instantly from a heavy load. Because of a considerable amount of heat being stored up in the various parts, the load should be removed and the engine allowed to idle for a short period of time at the high governor speed so that the circulation of oil and water will lower the temperature of the parts uniformly, after which the speed of the engine should be reduced to ¼ or ½ allowing a few additional minutes for cooling down. Stopping an engine this way helps to prevent the distortion of parts from excessive heat.

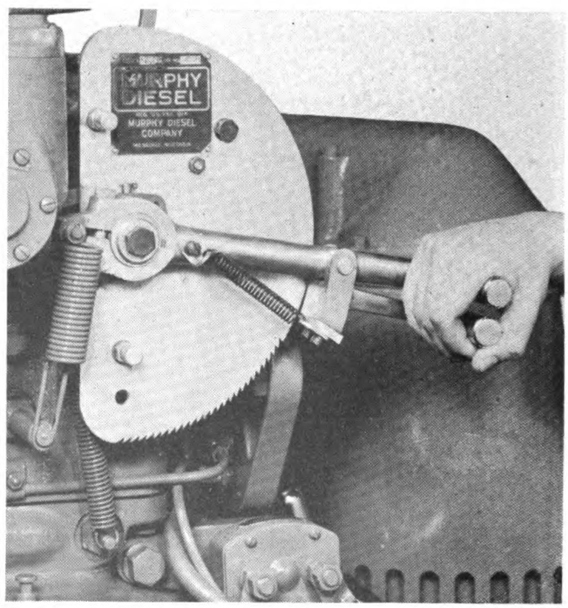


FIG. 12—Stopping Position

ENGINE FAILS TO START

If the engine has good compression, the batteries are well charged, and the injectors are not worn excessively, failure to start is usually caused by lack of fuel. If in doubt about the fuel supply, observe the sight glass gauge and note if fuel is pumped through the engine when the fuel pump is being operated. If there is no fuel coming through check the fuel in the tank, check the fuel filter and check the by-pass valve that returns surplus fuel to the tank. If fuel is not found at any of these points, a new fuel supply pump may be necessary.

Cold Weather Precautions

During exceptionally cold weather, starting may be aided by heating the cooling liquid. (Take care in heating inflammable cooling fluids such as alcohol.) In cold weather, when the cooling fluid is drained, the water pump and thermostats should be thawed out with a torch before the cooling liquid is put in prior to starting. Lubricating oil should be of the correct grade for winter use. If a heavier oil is used it should be drained immediately after shutting down the engine and heated before it is put back into the engine.

Cranking Motor Caution

Cranking should never be attempted for more than 30 seconds continuously without stopping and waiting 2 minutes or longer for the cranking motor to cool.

If the engine does not start at the first or second trial, do not continue cranking. Investigate and find the abnormal condition that prevents the engine from starting.

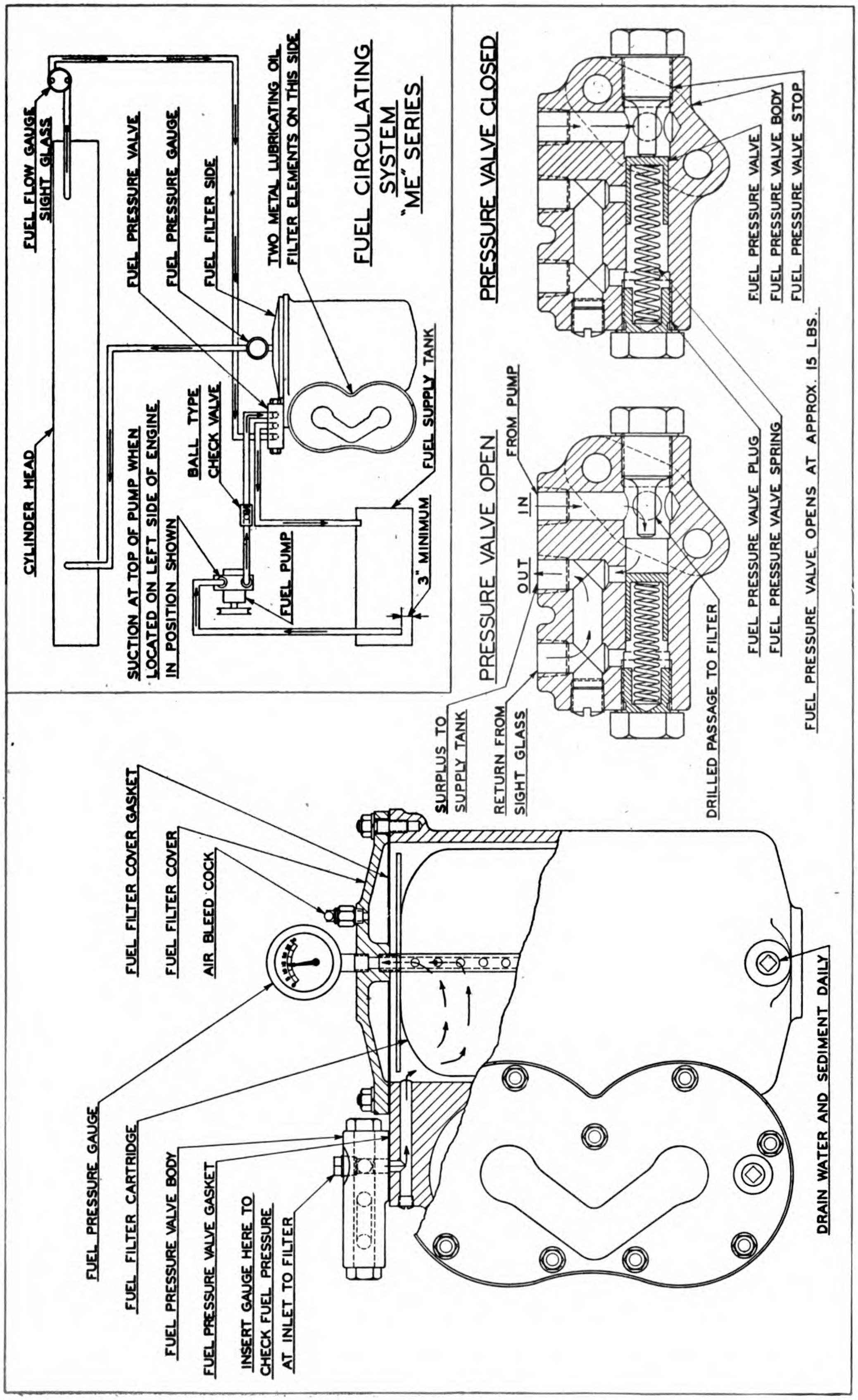


FIG. 13—FUEL SYSTEM DIAGRAM

FUEL SYSTEM

GENERAL DESCRIPTION

The Murphy fuel system differs from that of most Diesel engines in that a high pressure tubing between injector fuel pump and the injector is unnecssary. There is a continuous flow of fuel at from 15 to 20 pounds pressure which is circulated by the fuel transfer pump through the entire fuel system, and around each injector, the surplus returning to the supply tank.

This circulation of fuel keeps the pipes clear of both sediment and air, and, at the same time, tends to maintain a lower working temperature of the injectors. The fuel system consists essentially of:

1. A Fuel circulating system including a transfer pump that is motor driven for priming, together with filters, check valve, and pressure regulating valve to maintain a fuel pressure of about 15 pounds on the injectors.
2. The high pressure fuel pump and the injector nozzle are combined into one unit located at each engine cylinder, which meters, times, and delivers atomized fuel into each combustion chamber.

FUEL TRANSFER PUMP

The fuel transfer pump is located on the rear end of the generator and is driven from the generator shaft through a flexible coupling (See Figure 7).

After establishing a new piping system, that is, after the engine has been moved and the supply system re-piped or drained, it will be necessary to open the cock on the top of the fuel filter cover, and also the bleed cock located on the discharge pipe elbow at the fuel transfer pump before motoring the pump. This will enable the pump to free itself of air without having to force fuel and air through the entire system.

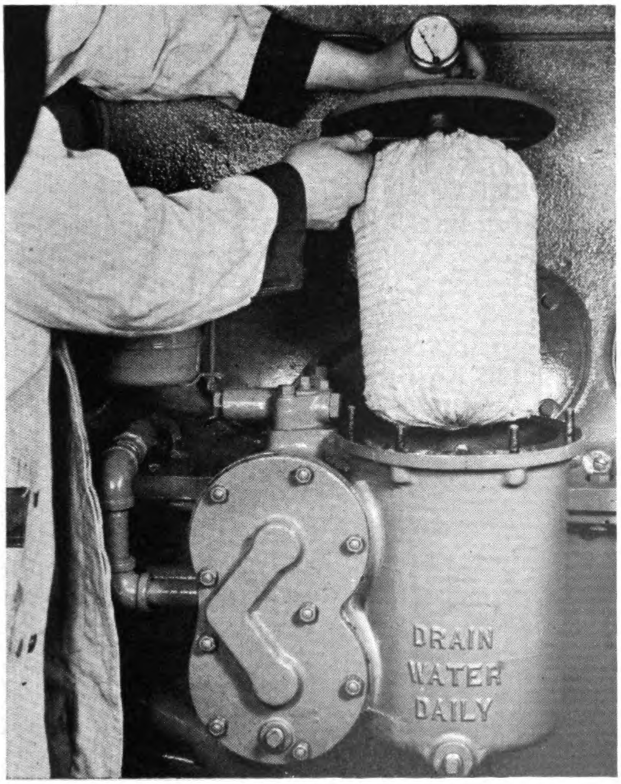


FIG. 14—Installing Fuel Filter Cartridge

Fuel Filter

The fuel oil filter housing and the lube oil filter housing are made a common casting which gives a small amount of preheating to the fuel, resulting in free flow through the injectors. The filter eliminates the dirt from the fuel before it gets into the injectors. In addition, it provides a place for water to settle.

The drain plug on the bottom of the fuel filter should be removed at least every day to drain the water which has accumulated. If the filter element becomes water soaked, it will completely stop the flow of fuel. It is imperative that the water be kept drained out of the system and especially of the filter to protect the injectors from rust corrosion.

FUEL SYSTEM—(Cont'd)

Fuel Filter—(Cont'd)

Fuel pressure of 15 pounds is maintained on this system by the use of a pressure relief valve which is mounted on the filter housing. If dirt and water get into this valve it will rust and stop up. It is well to check this point to be sure it is clean before looking elsewhere for trouble in the fuel system.

When fuel pressure drops to 6 or 8 pounds, it is an indication that the filter element is well saturated with water or filled with dirt and should be replaced. The care in handling of the fuel determines the time between changes of the filter cartridge and the replacement of the injectors. Care in keeping the water completely drained from the fuel filter housing will be of great help in maintaining the fuel system in good condition.

THE PATH OF THE FUEL

Fuel is drawn from the supply tank by the transfer pump and discharged into the fuel pressure relief valve at the connection marked "IN". At the pressure relief valve the stream is divided, part leaving through a drilled passage and going to the fuel filter at about 15 pounds pressure. The surplus fuel is returned to the supply tank through a pipe at the connection marked "OUT". The fuel enters the filter element at the outside of the cotton cartridge, and clean fuel is taken off at the center of the cartridge, and out through the cover where the pressure gauge is connected. From there, the fuel flows through a pipe to the injector system, then through the sight glass gauge on the instrument panel. The return fuel from the sight glass gauge is piped back to the pressure relief valve casting, where it joins the surplus fuel from the transfer pump, piped back to the supply tank. The return line to the supply tank should be large enough to take care of the fuel flow and should never be restricted or stopped off.

Fuel Sight Feed Glass Gauge

This sight feed gauge indicates if the injectors are operating properly. If there is a continuous stream of bubbles coming through the glass gauge, it indicates either that one of the check valves in an injector is not holding properly or that there is a leak in the suction side of the fuel line.

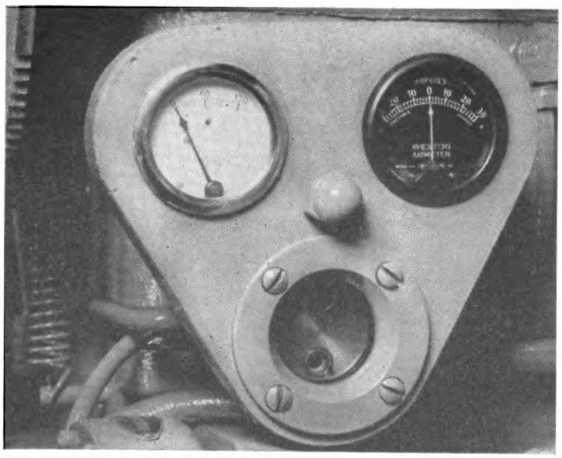


FIG. 15—Instrument Panel

A stream of large bubbles, pulsating thru, indicates compression air blowing back thru an injector, due to a dirty or improperly seating ball on the ball seat in the injector tip. A stream of fine bubbles indicates a leak in the suction side of the fuel transfer pump or defective pump. If it is the fault of the injector check valve the injector will not fire, and the defective injector may be located by lifting one at a time, the latch pin from the injector control rack and moving the latch pin to the wide open position. The one which is not firing properly will show no change in speed or noise while those which are firing properly when held open will increase the speed of the engine and, in addition, make a sharp loud combustion noise.

FUEL SYSTEM—(Cont'd)

Fuel Sight Feed Glass Gauge—(Cont'd)

If the glass gauge is only partly filled with fuel, it is an indication that insufficient fuel is being supplied and the cause must be remedied. Either the fuel filters or the fuel transfer pump may be at fault. When trouble is experienced with the fuel system, always check the operation of the relief valve to be sure that it is not stuck due to the presence of foreign material or corrosion caused by water in the fuel.

FUEL SPECIFICATIONS

Secure a clean, high speed Diesel fuel, marketed by a reputable manufacturer. Care should be exercised in selecting the fuel, as satisfactory performance and the useful life of the engine is greatly affected by the fuel. A variety of troubles with the Diesel engine are directly traceable to poor quality and dirty fuel.

The fuel should be clean, well refined, completely distilled petroleum oil of the following specifications:

1. Viscosity, Minimum ....25 Seconds Sayboldt Universal at 100° Fahrenheit
2. Flash Point, Minimum ......150° Fahrenheit
3. Pour Point ....Must flow freely at lowest temperatures to which it will be exposed.
4. Ignition Quality, Minimum..50 Cetane Number
5. Carbon Residue, Maximum...0.25% by Weight
6. Ash, Maximum ....0.01% by Weight
7. Sediment and Water, Max....0.05% by Weight
8. Sulphur, Maximum ....0.75% by Weight
9. 98% Recovery ....700° Fahrenheit

Care should be exercised at all times in handling the fuel to exclude dirt of all kinds, and any other liquids such as water, gasoline, furnace oil, etc., even in small quantities. Pumps used to handle gasoline should not be used to handle Diesel fuel unless all gasoline that may be left in the pump has been drained or worked out, as a very small quantity of gasoline mixed in with the Diesel fuel can cause a great deal of trouble. In case the pump used to transfer fuel needs priming, it should be primed with clean Diesel fuel of same kind that is being used, and not with any other liquid. Too much care cannot be exercised in the proper handling of Diesel fuel to exclude water and dirt of all kinds. Good strainers should be provided, kept clean, and used when filling with fuel.

INJECTORS

All Murphy injectors of the same size are accurately set for delivery and may be interchanged in the field without unbalancing the engine.

Replacing Injector

To remove an injector turn the engine over until the injector rollers are at the low point of their travel, insert the special square ended "T" wrench through the hole in the top of the injector spring cover and unscrew the retaining nut which holds the injector in place. Turning this nut to the left not only loosens the injector but actually pulls it up a short distance, should it be stuck in the cylinder head by carbon forming on the tip.

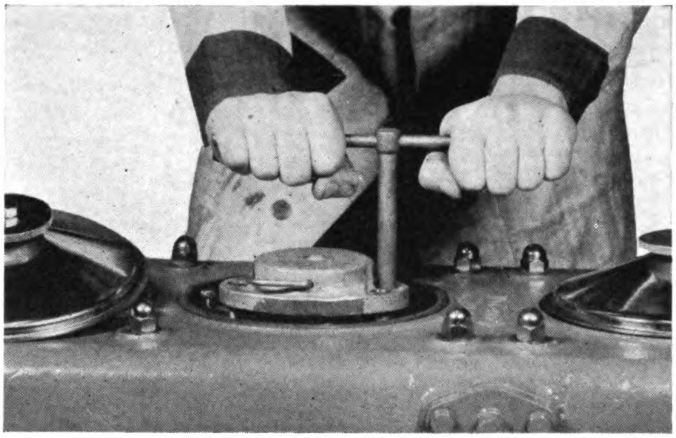


FIG. 16—Injector Removal

Extreme care should be exercised not to bump or damage the small end of the tip, or lower end of the injector, in handling, as it is this portion, which contains the small holes through which the atomized fuel is supplied under pressure to the combustion chamber. These holes are not readily visible to the eye due to their small size. Should the tip be damaged in any way, a new one must be substituted.

Immediately after lifting the injector out of the cylinder head, always look to see if the copper gasket is stuck on the tip. If it has fallen off and remains in the hole of the cylinder head, it must be fished out with a suitable tool made from a small piece of wire.

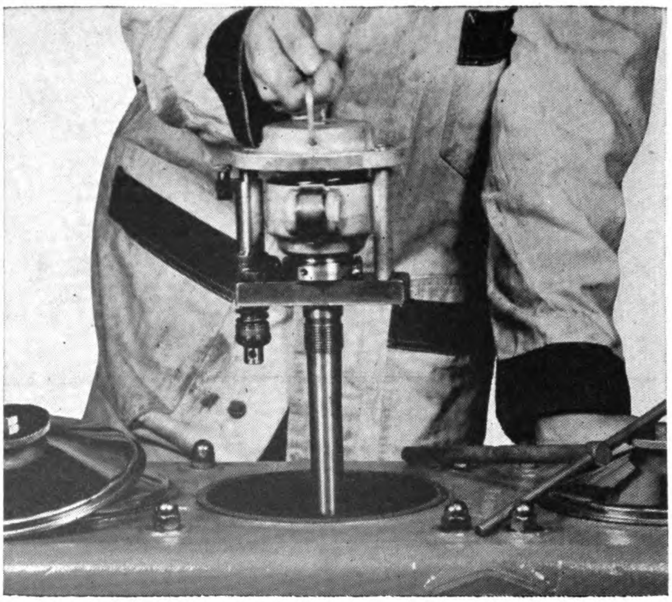


FIG. 17—Lifting Out Injector Assembly

Only One Copper Gasket Should Be Used at This Point

This gasket must be the tip gasket (1/64″ thick) and should not be confused with the thick copper gasket used under the cap nuts on the camshaft housing.

In removing injectors, it is not necessary to disconnect any fuel lines, or control rack connections. The fuel connection, both inlet and outlet, is made by means of a stud on one side of the injector body and the joint is sealed with a synthetic rubber sealing ring, being forced down by a spring against a stop in the valve tappet casting. Also check to see that the synthetic rubber seal ring is not stuck on stem. If it is, free it up so the spring will function and force the seal tight against its seat when the injector is again installed.

INJECTORS—(Cont'd)

WARNING

Never add lubricating oil to the crankcase unless all injectors are properly secured in place, as the oil is likely to fill a cylinder, and damage to a cylinder head, piston, connecting rod or the crankshaft may result when the engine is started.

Replacing Injectors in an Engine

When replacing the injectors in the engine, make sure that there is ONE THIN COPPER GASKET ONLY on the injector tip. Sometimes the injector gasket may stick in the bottom of the hole in the cylinder head when the injector is removed. Fish it out with a wire hook and stick it to the injector tip with a little cup grease. Care should be taken to insure that there is always one gasket, and never more than one on the tip when the injector is replaced. Failure to observe this precaution will impair the engine operation, and may injure the injector. Leaving the copper gasket off the injector tip will destroy the seal between the injector tip and the cylinder head as will a split copper gasket, resulting in the hot gas blowing by, and causing the outside of the injector body and the inside of the hole in the cylinder head to become coated with carbon. This gas leakage is manifested by an excessive amount of gas and smoke escaping from the camshaft housing when the valve cover is removed. Clean the injector body stem and the hole into which it fits, taking particular care to thoroughly clean the gasket seat of the tip, and the seat in the hole. Inspect the synthetic rubber seal ring on the injector fuel connection before installing in the engine, and replace with a new one if damaged or out of shape. A leaking seal ring will allow fuel oil to leak into the crankcase, causing dilution of the lubricating oil.

The operator should change an injector immediately, if any one of them fails to fire. Running the engine with an injector not firing will damage the lower end of the injector. Substitute the spare injector for the one not firing, or clean the ball seat as explained below.

How to Determine Which Cylinder Is Not Firing

With the engine idling slowly, remove all the valve covers from the top of the engine, and one at a time, lift each injector control lever pin out of its slot in the fuel control crossbar, and move it for a short time to the open position toward the inlet manifold. If no change of sound or speed of the engine is observed on moving the control lever pin to the open position, it indicates that the injector is not working. The faulty injector should be removed and replaced with the spare injector, or valve seat cleaned as directed below.

Cleaning Injector Valve Seats

When an injector valve seat is to be cleaned the injector should be mounted tip upward in the special holding fixture provided for that purpose or in a bench vise. Unscrew the injector tip with the special injector tip wrench, then remove the injector valve spring and guide, the valve ball, and the valve seat. Fill the tip with gasoline and press the thumb over the opening to force the gasoline out through the spray holes. If all holes are open, set the tip aside for reassembly. If some holes are plugged, clean the tip, as explained under "Cleaning Injector Tips."

INJECTORS—*(Cont'd)*

Cleaning Injector Valve Seats—*(Cont'd)*

Wash the spring guide, ball and seat carefully in clean gasoline or fuel oil. Small particles of dirt or metal that are lodged on the injector valve seat, where the small ball seats, must be very carefully removed. As these particles are very small, and cannot be seen without a magnifying glass, the valve seat is very apt to be considered clean when it is not. Very carefully wash the valve seat in CLEAN gasoline or fuel oil and remove the tiny particles of metal by rotating a clean piece of paper in the valve seat. A match or small soft pine stick, if clean, may also be found useful to dislodge particles. Before reassembly, the seat should be checked to see that the valve is tight. This is done by placing the valve ball on the valve seat and sucking on the opposite end to check for tightness and proper seating. If the valve still leaks, wash the valve seat and ball again, and repeat the cleaning process. Use a shallow pan or container partly filled with clean fuel oil when washing and cleaning injector parts. Clean your hands and do not use waste or rags with lint, when handling parts.

Replace the valve seat and ball in the injector, first making certain that all surfaces of the valve seat, as well as the end of the injector body where the valve seat rests are perfectly clean. Assemble the valve spring and guide and place on top of the ball. Then carefully enter the spring into the hole in the injector tip and screw down by hand. If the tip does not screw down nearly all the way by hand remove it and make sure that all parts are in their proper locations. About one-half turn with the special injector wrench is required to tighten the injector tip. In the event that the injector tip resists screwing down to its proper place, it is an indication that the spring and guide are not entered into the hole in the injector tip in which case the tip should be removed and the spring and guide straightened up, and another assembly trial made.

If the injector still fails to fire when replaced in the engine, repeat the cleaning process. If the valve continues to leak, try a new ball.

In reassembling the cleaned parts, great care must be exercised to keep them absolutely clean. A tiny particle of dirt in the injector may cause the injector to misfire. If the filtering equipment is kept in proper condition and dirt is kept out of the injectors when handling, little trouble will be experienced.

If Injector Knocks

If an injector knocks sharply, it is probably a sign of one or more holes stopped up in the injector tip. The knocking injector is located by operating each injector independently as explained under the paragraph "How to Determine Which Cylinder is Not Firing." The stopped-up injector will quit knocking when the control lever pin is out of the slot and in the OFF position. If cleaning or replacing the tip assembly does not remedy the difficulty, return the injector to the factory for overhauling.

The injectors carry a symbol "A," "SD," and "D" which indicates plunger sizes. The tips carry these same symbol letters indicating the exact units on which they are to be used. Never mix the injectors with different symbol markings or get a tip on an injector with a different symbol than for which it is marked. Mixing these will cause a sharp injector knock and extreme irregularity in the operation of the engine.

INJECTORS—*(Cont'd)*

Cleaning Injector Tips

Mount the injector with the tip upward in the special holding fixture and remove the tip from the injector with the injector tip wrench.

The injector tip has several small spray holes equally spaced around the tip. Clean these holes by using a piece of music wire, placed in the small wire chuck, found in the handle of the injector tip wrench. Use only wire furnished by the Manufacturer. Use .007" diameter wire to clean tips marked 6-008 SD or 5-008-A, and .009" diameter wire for tips marked 6-010-D. Use a rotary motion without force, and always keep the end of the wire straight and in line with the hole. The central hole on the inside of the tip may be cleaned, if necessary, with the special flat 1/16 inch drill which is furnished in the kit. After the tip has been carefully cleaned, it should be washed in gasoline and checked with gasoline by pressing the thumb over the end to see if all spray holes are open.

Repairing Injectors

DO NOT ATTEMPT TO DISASSEMBLE A MURPHY DIESEL FUEL INJECTOR other than to clean valve seat and nozzle tip. These injectors have no adjustments, and if, for any reason, an injector does not function properly, and the nozzle tip and valve are clean and in good shape, THE ENTIRE ASSEMBLY SHOULD BE RETURNED FOR OVERHAUL AND TEST. Without special facilities, it is impossible to disassemble and overhaul an injector in the field, and it should never be attempted. Use the spare injector, and send the disabled injector back for reworking. If the engine shows a slight consistent loss of power after long continued periods of operation, it may be an indication of injector wear, which may be remedied by returning all the injectors for overhaul.

COLD WEATHER PRECAUTIONS:

At temperatures below freezing, care must be used to prevent great damage resulting from freezing in the cooling system. A reliable antifreeze solution should be used in the cooling system during freezing temperatures in place of water. This is desirable on account of the possibility that the engine will not be properly drained and the necessity of thawing the water pump and thermostats.

When draining an engine, be sure to drain the oil cooler under the radiator which is the lowest point in the system; also remove the drain plugs in the side of the cylinder block on the flywheel end to eliminate any possibility of freezing trapped water causing cracks.

Low engine operating temperature is conducive to the formation of sludge in the engine and lubricating oil system. In cold weather, cover a part of the radiator to maintain the water temperature sufficiently high which will keep the lube oil temperature at 150°F. or above. This practice will greatly reduce the formation of sludge and the condensation of vapor to water in the engine. Small amounts of water in a low temperature lubricating system form an abnormal amount of sludge, stopping filters, and small lubricating oil passages.

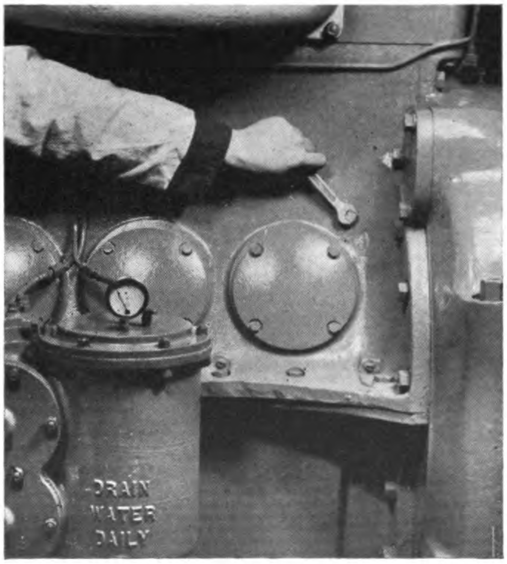


FIG. 18—Water Drain Plug in Block (There is another drain plug in same position on opposite side of engine.)

In cold weather operation, make it a practice to warm up the engine so that the water and the oil are up to temperature before putting the engine to work. In severely cold weather, it may be necessary to drain the oil after shutting down, and heating the oil before pouring it into the engine just before starting. With a very cold engine, it is advantageous to fill the cooling system with very hot water to aid in starting.

See lubrication, oil recommendations and specifications for low temperature operation.

COOLING SYSTEM

Radiator and Thermostats

The radiator is mounted at the front of the engine, and is connected to the engine with rubber hoses.

The temperature of the cooling water in the engine jackets is regulated by three thermostats, located in a housing at the front end of the cylinder head. When the engine is cold, these thermostats remain closed, and cause the engine water to circulate through the water jackets only. When the engine warms up, the thermostats open, and the water circulates through the radiator and engine. To drain the cooling system, remove the pipe plug at the center of the bottom of the oil cooler.

Care of the Radiator

The radiator should be kept filled at all times to within three inches of the top with soft, clean water. The use of hard water, strong in minerals, will eventually build up lime deposits in the water jackets, making proper cooling of the engine impossible. Hot spots will form under the scale, and eventually a cracked cylinder head may result. Water strong in alkali will eat or corrode parts of the engine and radiator. Do not pour dirty ditch water into the engine cooling system as it is a sure way to cause expensive repairs.

If the air spaces between the radiator cooling fins become stopped up with oil and dirt, use a mixture of 40% carbon tetrachloride (Pyrene Fire Extinguisher Fluid) and 60% gasoline, for cleaning. Use a squirt gun to force the solution through the fin spaces; then wait a few minutes for the dirt to loosen. Continue cleaning until the spaces between the fins and tubes are clean. If a blower type fan is used, some of the solution may be poured into the path of the revolving fan blades when the engine is running on governor idle speed. The air blast will force the solution through the radiator, and help remove oil and dirt. Do not employ this method of cleaning if a suction fan is used, as the solution will be blown back on the operator and the engine.

WARNING:

If, for any reason whatsover, the engine has been allowed to boil the water or to run dry, or become overheated in any way, stop it immediately, and leave it cool for one-half to three-quarters of an hour. Failure to wait until the engine has cooled sufficiently before filling with water can have disastrous results. THE ADDITION OF WATER TO AN OVER-HEATED ENGINE IS ONE OF THE SUREST KNOWN METHODS OF CRACKING A CYLINDER HEAD. After the engine is thoroughly cold, fill the cooling system, check the oil, and try turning the engine over by hand. If no damage has been done, the engine can be put back to work.

WATER PUMP AND FAN

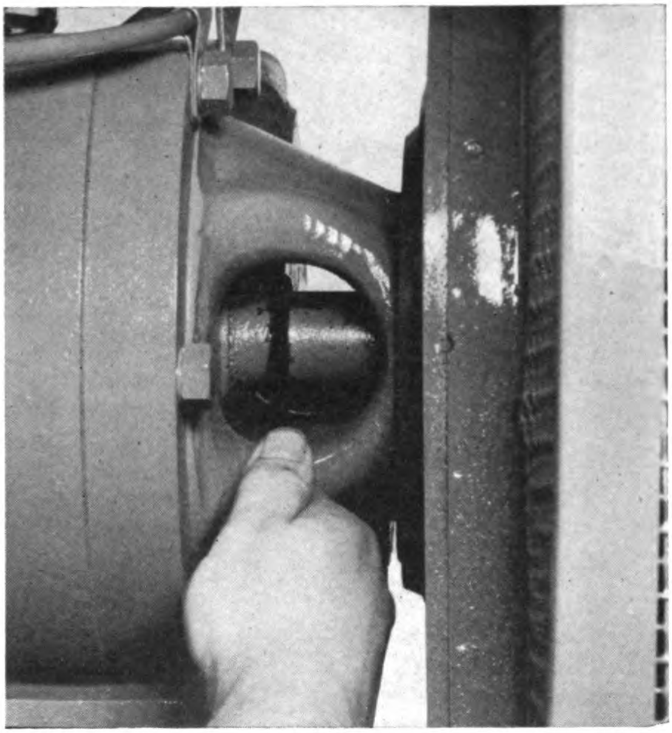


FIG. 19—Adjusting Water Pump Packing

The water pump and fan are combined into one assembly, located at the front of the crankcase. The water pump packing is composed of asbestos and lead split rings, which can be replaced by backing off the packing gland nut with a spanner wrench, removing the old packing and replacing with new packing. Tighten the packing nut just enough to stop the leak; then back off slightly. A very small amount of leakage is desirable to lubricate the shaft packing.

The fan bearings should be greased every 500 operating hours. Remove the pipe plug from the bottom of the center fan belt groove and insert the grease fitting furnished in the tool kit. Use a good quality medium ball bearing grease. See Lubricating Guide.

FAN BELTS

A set of three matched fan belts form a 4 point drive to operate the fan and water pump assembly, the generator, and the lube pump from the crankshaft sheave. These belts should only be used in matched sets.

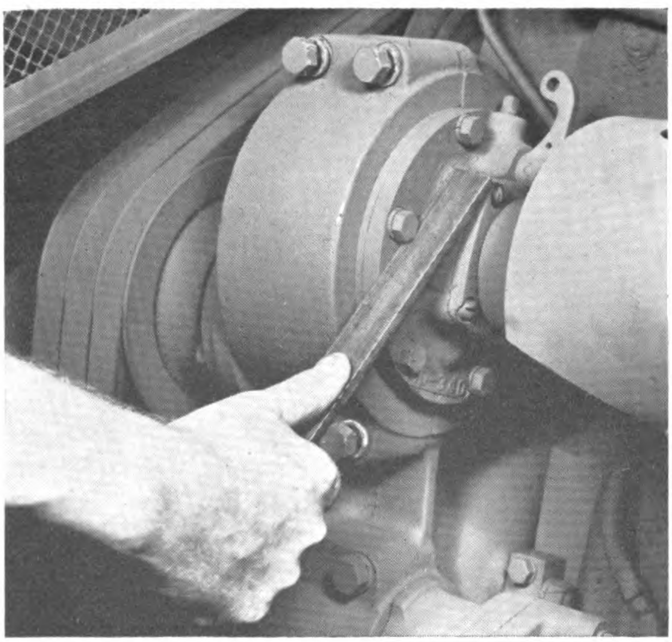


FIG. 20—Adjusting Fan Belt Tension

To tighten the fan belts, first loosen the four cap screws holding the generator drive housing cap onto its bracket; then rotate the generator drive housing until the fan belts have the correct tension. Push the generator drive assembly toward the rear of the engine before tightening the capscrews to keep the housing in place and the V-belt sheaves in line.

Before attempting to replace the fan belts, turn the generator drive assembly so that the sheaves are as close to the engine as possible. Do not pry the new belts over the sheaves with a bar as they will be damaged.

AIR CLEANERS

Care of Air Cleaners

The Murphy Diesel engine is equipped with a built-in, oil-washed air cleaner to provide the greatest degree of protection from abrasive dirt entering the engine. It is of the utmost importance that this unit be maintained in proper operating condition at all times.

Examine the oil cup at the bottom of the air cleaner regularly. If the air is dusty, clean the cup daily, or as necessary, and refill both the inner and outer cups to the oil level mark. Do not use compounded oils in the air cleaner as they may cause foam. Use a straight mineral oil SAE No. 30 in summer, SAE No. 20 or No. 10 in winter. The breather air cleaner on the exhaust side of the engine must be kept filled with oil to the level mark, and cleaned when necessary.

The pre-cleaner is to take out the larger particles of dust, thereby lightening the load on the regular cleaner. Remove the glass jar and empty the dirt which collects whenever it is noticeable. This can be done with the unit in operation.

Washing Cleaner

When the air cleaner cup is removed, the screen in the air cleaner should be examined. If it is dirty, the entire cleaner should be unbolted from the inlet manifold, and thoroughly washed in Diesel fuel or solvent. Clean the cup daily and refill both the inner and outer cup to the oil level mark. If air is dusty, clean oftener, as necessary. When replacing the air cleaner body, make sure that both the inner and outer gaskets are in good condition and that there are no air leaks, as even small leaks can admit quantities of dirt and do damage in a short period of time.

In cold weather an oil with light enough body should be used in the air cleaner to enable the oil to circulate up into the filtering element and wash it so it shows a bright color. Too heavy an oil will clog up the element and will reduce the amount of air delivered to the engine, causing excessive smoke in the exhaust and loss of power. Lubricating oil may be diluted with Diesel fuel to obtain the correct viscosity or body if the oil used does not wash the screens clean.

Extreme caution must be exercised after washing out the cleaner, to allow screens to dry as liquid or fumes may be drawn into the engine with the air supply in a completely uncontrolled manner and may cause serious damage.

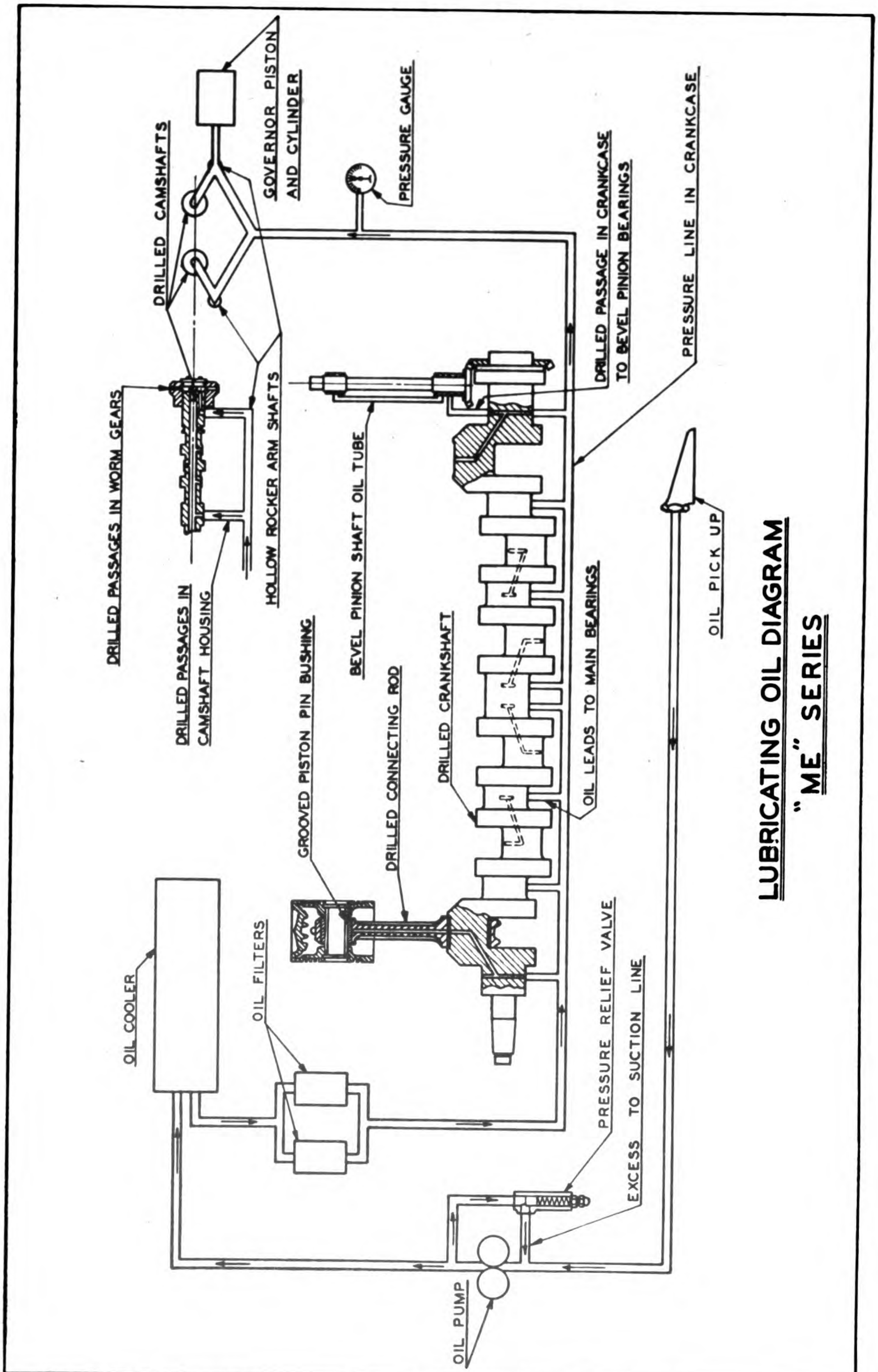

DRILLED CAMSHAFTS
GOVERNOR PISTON AND CYLINDER
PRESSURE GAUGE
DRILLED PASSAGE IN CRANKCASE TO BEVEL PINION BEARINGS
PRESSURE LINE IN CRANKCASE
DRILLED PASSAGES IN WORM GEARS
DRILLED PASSAGES IN CAMSHAFT HOUSING
HOLLOW ROCKER ARM SHAFTS
BEVEL PINION SHAFT OIL TUBE
GROOVED PISTON PIN BUSHING
DRILLED CONNECTING ROD
DRILLED CRANKSHAFT
OIL LEADS TO MAIN BEARINGS
OIL PICK UP
LUBRICATING OIL DIAGRAM
"ME" SERIES
OIL COOLER
OIL FILTERS
PRESSURE RELIEF VALVE
EXCESS TO SUCTION LINE
OIL PUMP

FIG. 21

LUBRICATION SYSTEM

The Murphy Diesel engine is thoroughly lubricated by a full force feed pressure lubrication system. The oil pump on the outside of the engine draws from the fitting in the bottom of the sump. The discharge from the pump is divided by the oil pressure relief valve. A sufficient part of the pump

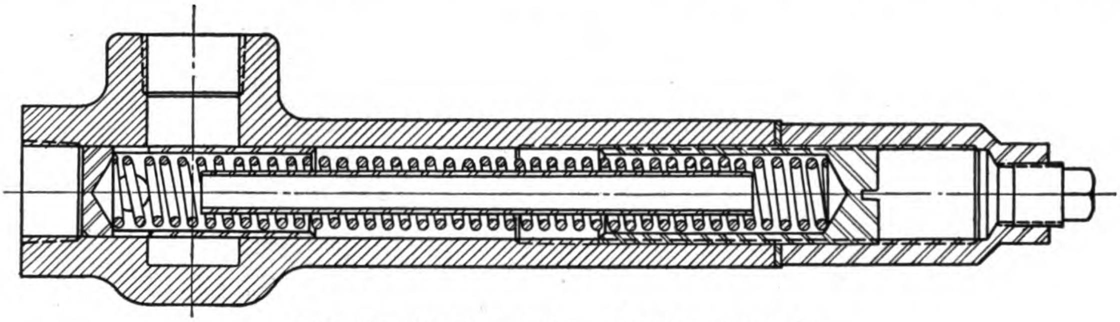


FIG. 22—Sectional View of Oil Relief Valve

delivery being diverted from the normal lubrication circuit back to the pump inlet to maintain the desired pressure on the lubrication system. The oil from the pump is carried through a double pass oil cooler mounted on the lower tank of the radiator. After cooling, the oil is carried to the oil filters where it passes through an edge type metal filter of .003 opening before entering the internal piping system of the engine proper. The oil filters are two duplex filters and the lubricant can pass through any one of these elements in going from the oil to the internal oiling system.

Practically all parts of the engine are lubricated by the pressure circuits shown in this diagram.

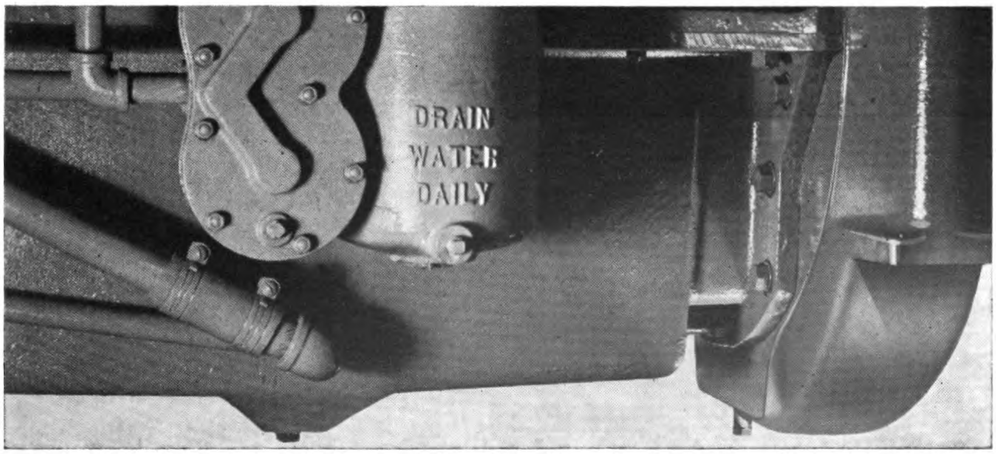


FIG. 23—Oil Drain Plugs (one under sump, one under flywheel housing)

Draining Oil Sump

The crankcase where the main oil supply is carried should be drained after each 64 hours of operation. In dusty or dirty conditions it is very wise to change the oil more often. The draining of the crankcase is accomplished by removing the pipe plug at the bottom of the oil sump. The

LUBRICATION SYSTEM—(Cont'd)

Draining Oil Sump—(Cont'd)

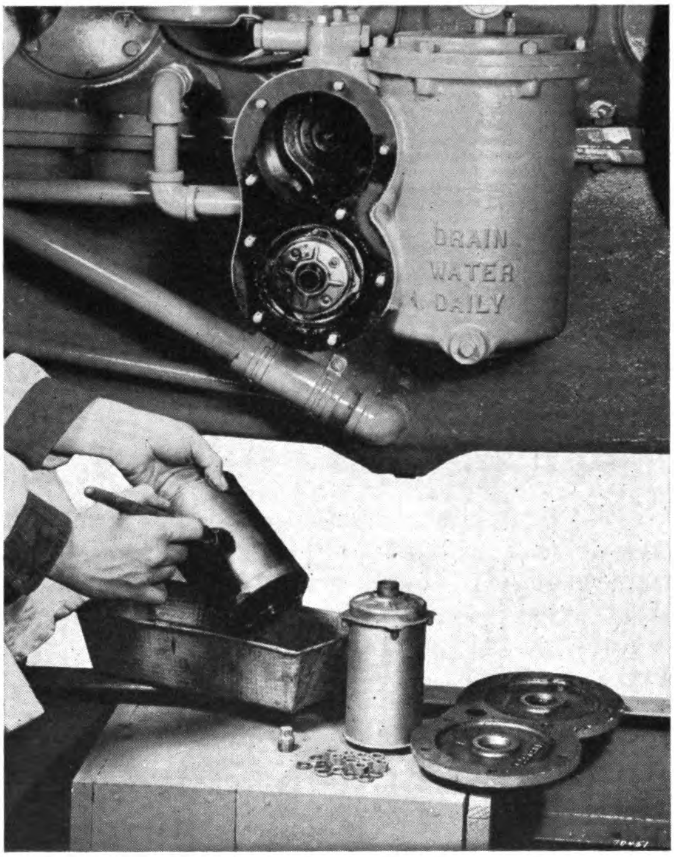


FIG. 24—Cleaning Lubricating Oil Filters

lubricating oil filter housing should be opened up, drained and the lube oil filter elements should be washed in solvent or fuel oil to remove all sediment.

The oil cooler at the bottom of the radiator should have the pipe plug removed to eliminate the dirty oil which remains there when the engine is drained. The plug on the bottom of the flywheel housing should also be removed to drain the dirty oil which accumulates in this vent trap (See Figure 23).

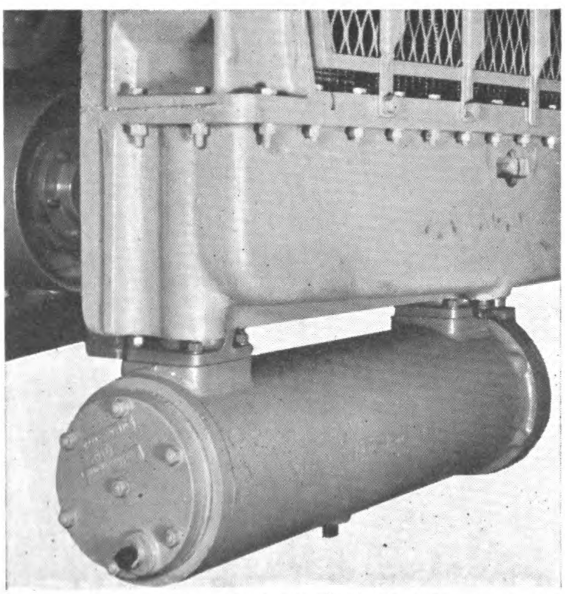


FIG. 25—Water and Oil Drain Plugs (One water drain under radiator, one under oil cooler. Oil drain at end of cooler.)

LUBRICATION SYSTEM—*(Cont'd)*

Draining Oil Sump—*(Cont'd)*

After allowing these various parts to drain, replace the drain plugs which have been removed from the oil sump, the oil cooler and flywheel housing. Reassemble the lube oil filter elements on the cover and insert in the filter housing. Fill the crankcase by pouring oil through any of the covers at the top of the engine (See Figure 4).

CAUTION:

Be sure to clean thoroughly, the openings and covers removed to prevent dirt from entering the engine. Be very sure that all injectors are in place and tightened down before pouring oil in through any of the injector covers.

CAUTION:

If through any oversight or any other reason, lubricating oil or fuel is permitted to run down into the cylinders due to the injector not being properly in place, it must be removed with a squirt gun before the engine is started or disastrous results will occur. The engine normally carries about 8 gallons of oil which will show a level up to the high point marked with a drilled hole on the bayonet gauge.

Note:

Immediately after shutting down an engine you will find that the oil sump level is quite low. This apparent reading is caused by well over half of the oil supply in the engine, in normal operation, being in circulating system at some point between its start from and return to the oil sump. Do not check oil level with the idea of adding, until the engine has been shut down for at least 15 minutes.

FLUSHING THE ENGINE

If the inside of the engine becomes very dirty for any reason after draining pour in 5 gallons of flushing oil or OE10 (Oil Engine SAE 10) and run the engine for 5 minutes which will wash out any loose material. Then drain at all of the points previously indicated, and refill with oil of proper grade. Under some conditions it might be necessary to repeat the operation of flushing. If the engine condition is really bad, there is no option but tearing down and actually scrapping and washing out the various parts.

LUBRICATION SYSTEM—*(Cont'd)*

LUBRICATING OIL FILTERS

Clean the oil filters every time the oil is drained and at any additional times when the oil pressure at the instrument panel drops to 30 pounds at rated speeds.

The filters should be removed from the filter housing and washed off in either clean gasoline or fuel oil, using a soft brush for this purpose (See Figure 23). Try to take the material off the filter rather than in any way forcing the material into the slots which are only .003″ wide and possibly permanently plugging the elements. Should the filters be so plugged as to restrict the flow of oil and reduce the pressure maintained on the gauge, they must be replaced with new elements.

Oil Pressure Adjustment

The oil pressure adjustment should only be made with clean oil in the system, clean filters, and the oil temperature at the normal operating level. See "Oil Pressure Adjustment."

PLACES TO OIL OR GREASE WHICH ARE NOT TAKEN CARE OF BY THE PRESSURE LUBRICATING SYSTEM

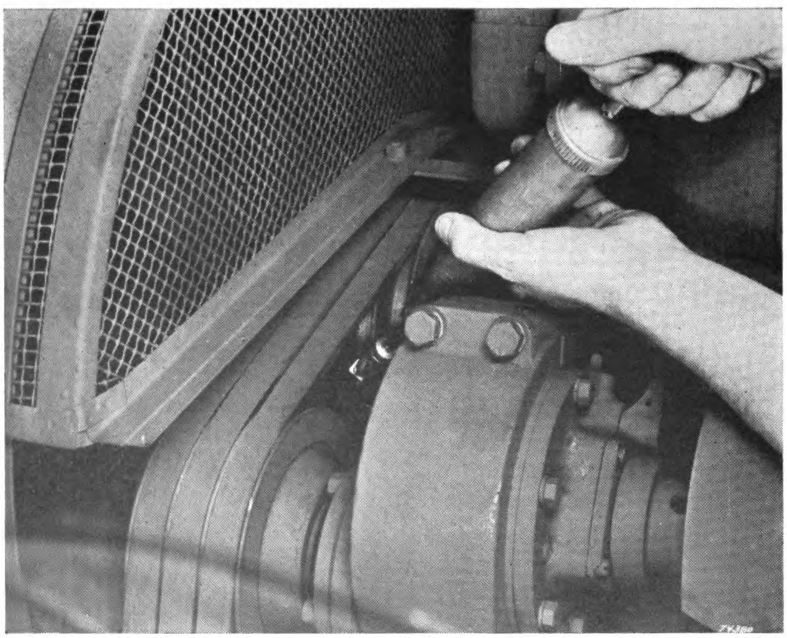


FIG. 26—Lubricating Fan Bearings

Fan Pulley

Every 512 hours remove the 1/8″ pipe plug at the bottom of the center "V" groove for the fan belts. Install grease fitting and lubricate with WB-2 (Grease General Purpose #2). After greasing remove the fitting and replace the pipe plug, tightening to eliminate the grease being thrown out.

LUBRICATION SYSTEM—(Cont'd)

PLACES TO OIL OR GREASE WHICH ARE NOT TAKEN CARE OF BY THE PRESSURE LUBRICATION SYSTEM—(Cont'd)

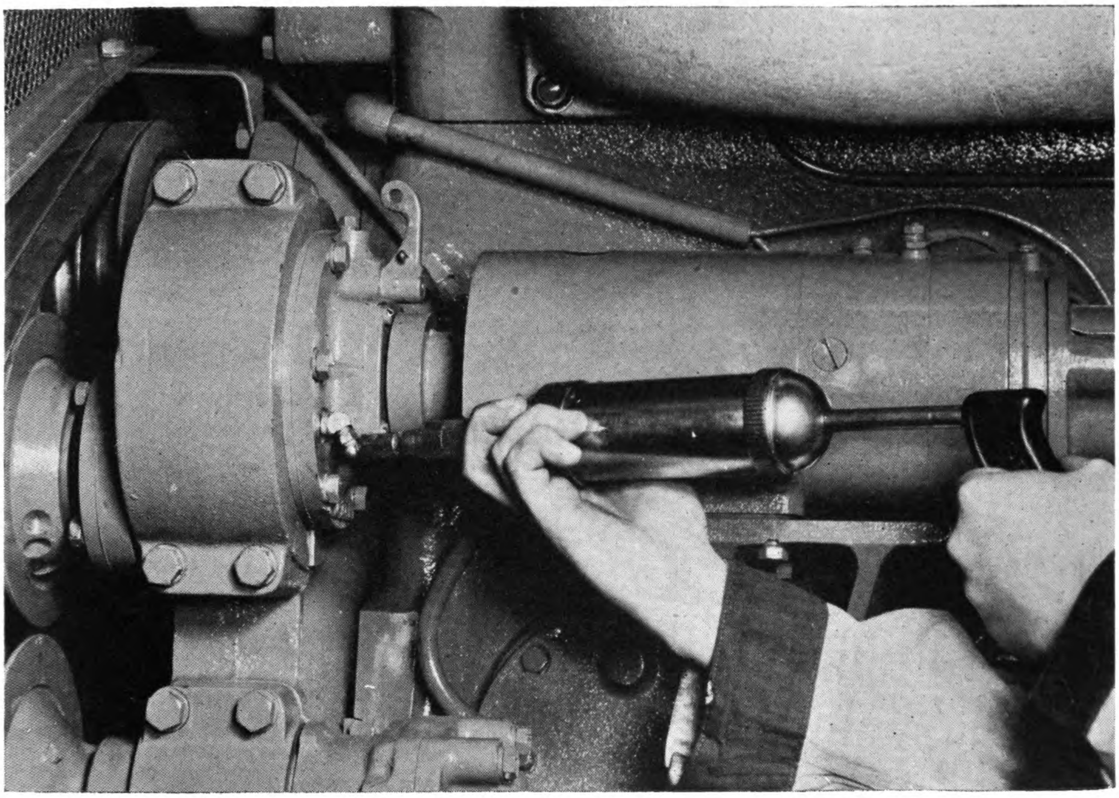


FIG. 27—Lubricating Generator Drive Assembly (grease lubricated type only)

Generator Drive Gear

Every 512 hours lubricate the generator drive gears with WB-2 (Grease General Purpose #2). The special fitting provided at this point prevents any over lubrication. The insertion of lubricant should cease as soon as lubricant starts to appear through the relief opening provided.

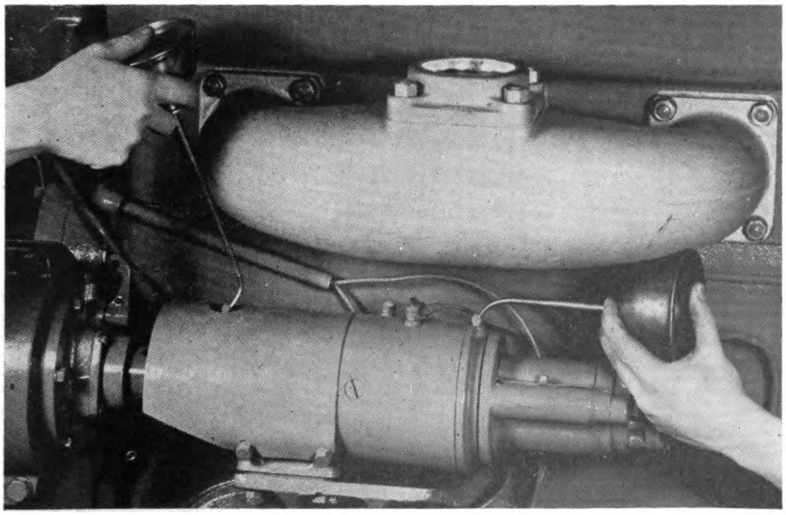


FIG. 28—Oiling Generator

Oiling Generator

The **generator** has an oil cup on each bearing which should be supplied a few drops of OE-10 (Oil Engine SAE 10) every 64 hours of operation.

LUBRICATION SYSTEM—(Cont'd)

PLACES TO OIL OR GREASE WHICH ARE NOT TAKEN CARE OF BY THE PRESSURE LUBRICATION SYSTEM—(Cont'd)

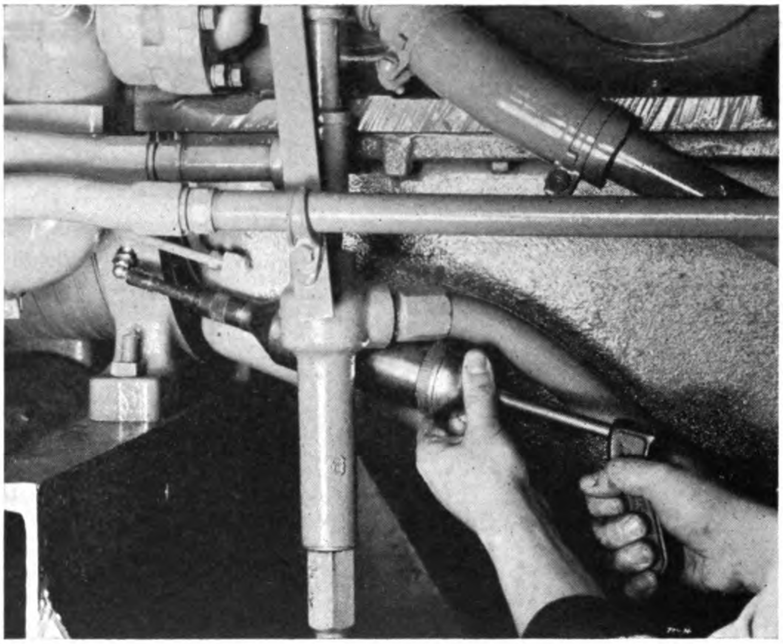


FIG. 29—Lubricating Trunnion

Support Trunnion

Every 1024 hours remove the pipe plug in the side of the front engine support trunnion and add a small amount of grease by means of a pressure gun. The purpose of this is to be sure that the trunnion does not rust in, as there is practically no relative movement between the trunnion bracket and the trunnion on the crankcase.

The only additional points on this engine to be lubricated are on the accessories.

Oiling Cranking Motor

The starting motor has 2 oil cups which must receive a few drops of OE-10 (Oil Engine SAE 10) every 512 hours of operation.

Every 1024 hours remove starter and lubricate outboard bearing thru oil cups. Use OE-10 (Oil Engine SAE 10).

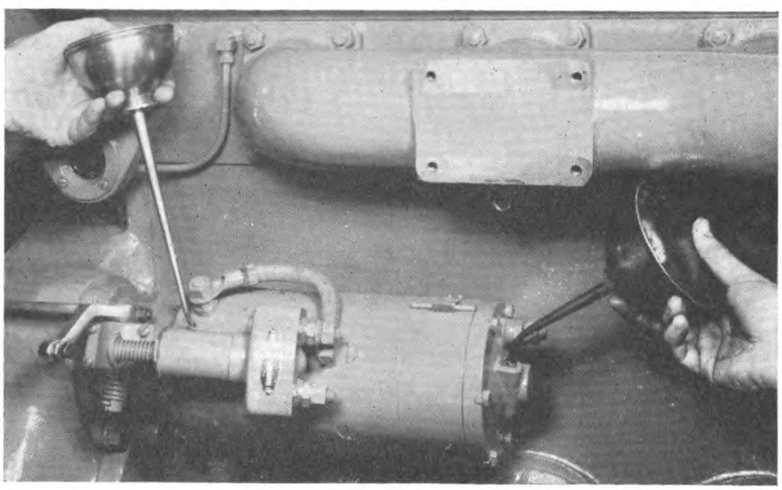


FIG. 30—Oiling Starting Motor (A third oil cup is located inside flywheel housing.)

LUBRICATION SYSTEM—(Cont'd)

SUPERCHARGER LUBRICATION

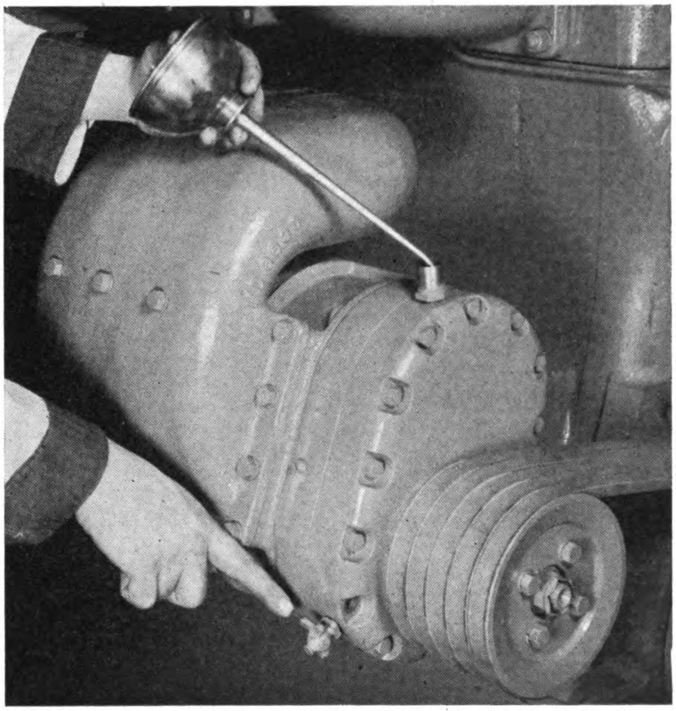


FIG. 31—Filling Oil Reservoir on Blower

Every 32 hours check the oil level in the gear compartment at the front of the blower. The oil level should be up to the pet cock located at the side of the housing a few inches from the bottom. Add oil by removing the breather plug at the top of the housing and fill until oil flows from the oil level cock.

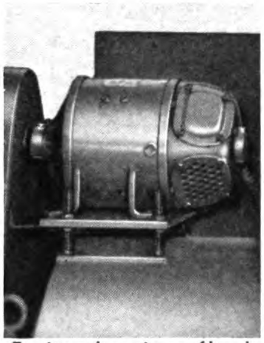
Use the same grade of oil as in the engine.

Every 128 hours remove the 2 covers over the bearings at rear end of Blower. Handpack approximately 2/3 full with WB-2 (Grease General Purpose #2). Replace covers securely.

LUBRICATING OIL SPECIFICATIONS

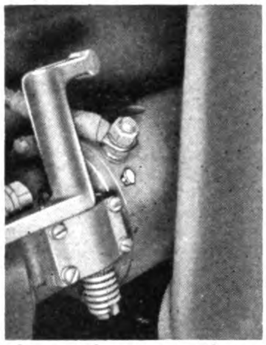
If other than Standard Army lubricants are used make certain that the oil used is non corrosive. The Murphy Diesel engine has copper lead bearings which will be ruined if **corrosive oils** are used.

Use Army oils as follows: above + 32° F. OE-30 (Oil Engine SAE 30); + 30° F. to 0° F. OE-10 (Oil Engine SAE 10).

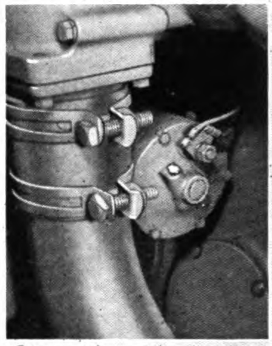


Exciter bearings, flush and refill every 1024 hours. Use WB-2.

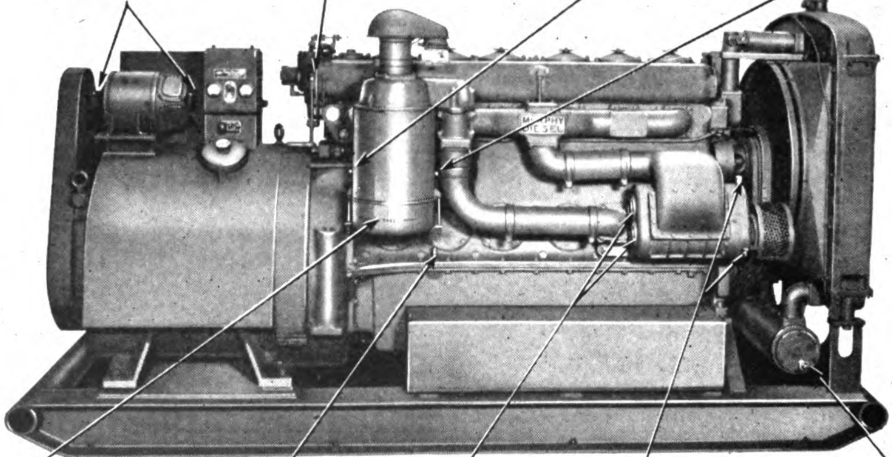
Control lever, oil every 128 hours. Use OE-10.

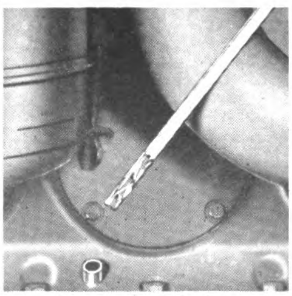


Starter bearings, oil every 512 hrs. Use OE-10.

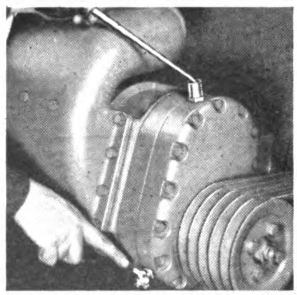


Starter bearings, oil every 512 hrs. Use OE-10.

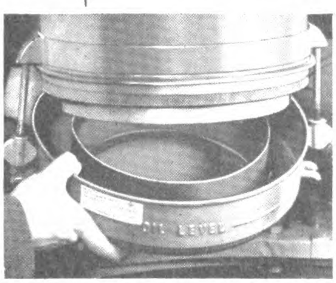




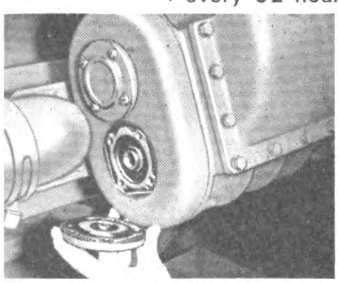
Oil level gauge. Check every 8 hours, keep level at top hole.



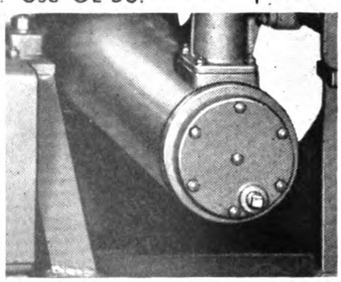
Blower bearings drive end. Check and refill as necessary every 32 hours. Use OE-30.



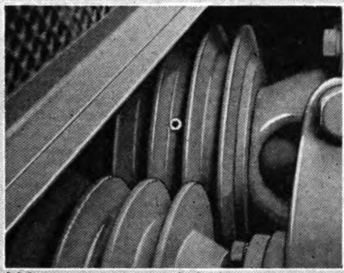
Air Cleaner, empty and refill every 64 hours. Use OE-30.



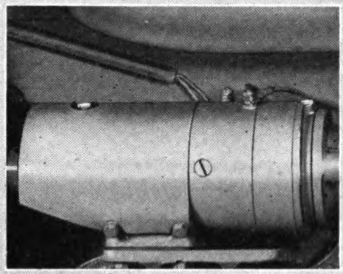
Blower bearings rear. Handpack 2-3 full every 128 hours. Use WB-2. Flush and refill every 1028 hours.



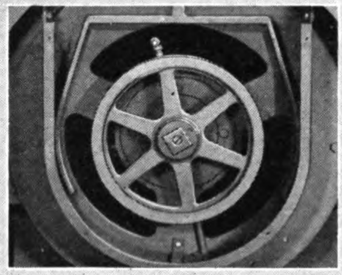
Drain every 64 hours when draining sump.



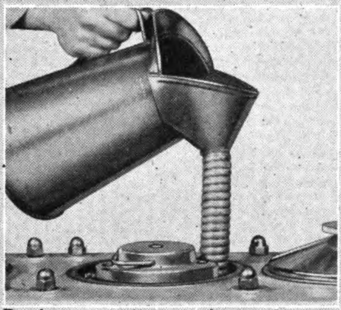
Water Pump, lubricate every 512 hours. Use WB-2.



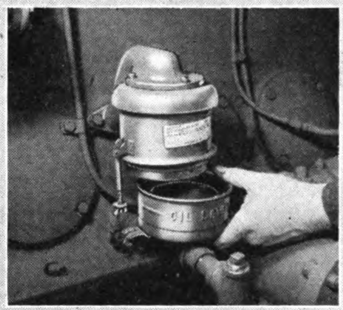
Battery Charging Generator—oil every 64 hours. Use OE-10.



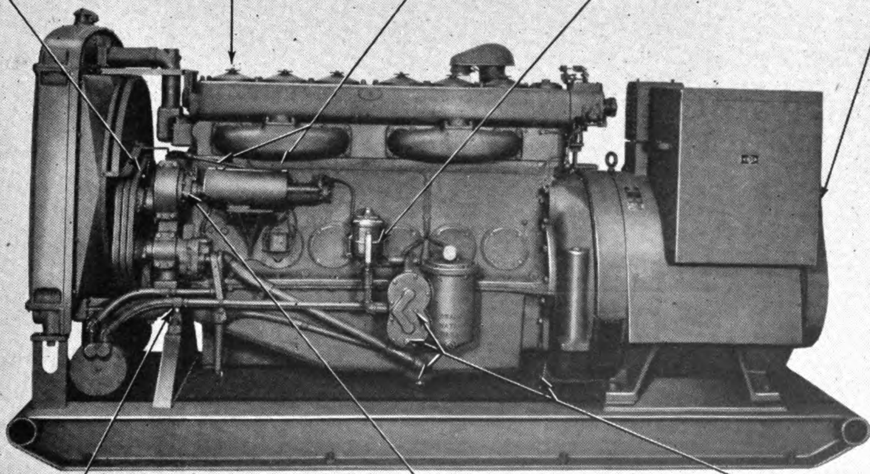
Generator Bearing — flush and refill every 1024 hours. Use WB-2.

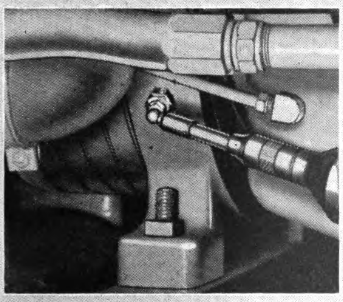


Drain at points indicated and refill through cover every 64 hours. Use OE-30 above 32° F. OE-10 below 32° F.

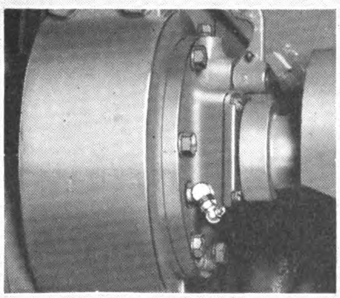


Breather Air Cleaner, empty and refill every 64 hours.

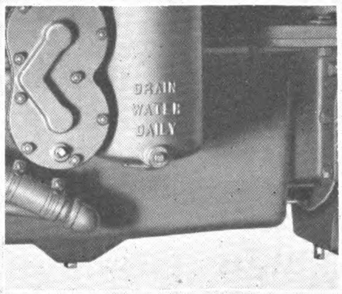




Trunnion, lubricate every 1024 hours. Use WB-2.



Generator Drive, oiled by drain from Cylinder Head.



Drain lube oil—remove cover to clean filter every 64 hours.

SUPERCHARGING BLOWER

Supercharged engines are equipped with a blower which is driven through belts from the front crankshaft pulley. The purpose of a supercharger is to force more air into the combustion chamber than can be drawn in on the regular suction stroke of the piston. This additional air will allow more fuel to burn, thereby giving more power.

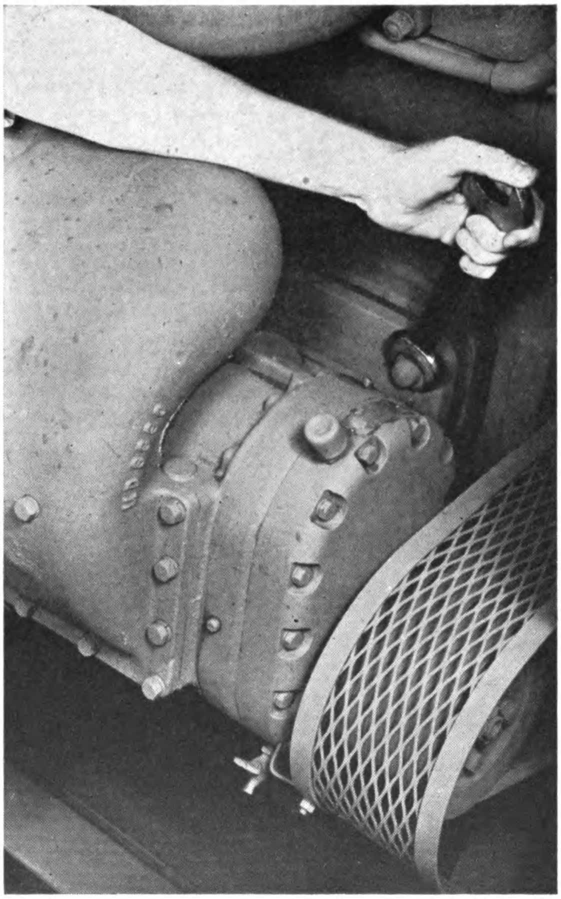


FIG. 32—Adjusting Blower Belt Tension

Blower Belts

Keep the belts adjusted to the correct tension to prevent slippage. Loosen the outer nuts on the studs supporting the supercharger on the side of the crankcase, then, turn out the nuts between the charger mounting plate and the crankcase and it will be forced out to the new position. Caution must be exercised to adjust outwardly, uniformly, on the four nuts. After which, the retaining nuts on the outside should be locked into place.

These five belts are in matched sets which should not be broken. When servicing, be sure to replace all belts, thereby keeping them properly matched.

Piping to Air Cleaner

Always keep the air piping connections and hoses air tight to prevent uncleaned air from entering the engine. The engine and supercharger will be seriously damaged if dirty air is sucked through loose fittings without going through the air cleaner.

OPERATING TROUBLE CHART

Engine Fails to Start

1. No fuel in circulating system.

   See fuel sight glass. Operate fuel pump by motoring generator to fill injection system with fuel.

   Check fuel filter, (See "Fuel Oil Filter Section").

   Check fuel supply in tank.

   Check fuel relief valve located on filter housing, to make sure valve is not held open or relief valve spring broken. An open relief valve will allow all the fuel to return to the tank and none will flow through the engine.

   If the fuel tank is equipped with a pickup strainer or foot valve, inspect for dirt or stoppage.
2. Weak batteries.
3. Read Section "If the Engine Fails to Start."

Engine Starts but Will Not Run With Control Lever in Operating Position

1. No lubricating oil pressure.

   Check pressure gauge. Pressure must be above 25 pounds to correctly operate governor and open injectors.

   Check oil in crankcase.

   Clean lubricating oil filters (See "Lubricating Oil Filters" Section.

   Also check fuel pressure. Notice if generator drive has been put back in mesh. Engine may not be turning the pump.

Engine Suddenly Loses Power or Stops

1. Lubricating oil pressure, low, preventing proper governor action.

   Check lubricating oil pressure.

   Clean lubricating oil filters.

   Check oil pressure relief valve. Dirt or other foreign matter may be holding valve open, preventing pressure from coming up for proper governor operation.
2. Fuel filters dirty or no fuel.

   Check tank, fuel sight glass, and clean all fuel filters. Prime system by motoring fuel pump with generator. With engine running at full speed with clean filters, note if gauge at top of filter housing shows pressure of 8 to 15 pounds.
3. Air leak in fuel suction line as shown by a steady stream of small bubbles in fuel sight glass gauge.
4. Fuel relief valve held open.

   Make sure valve slides freely in valve body and that spring is in good condition. Clean all parts of valve thoroughly.

Engine Gradually Loses Power Over a Period of Time

1. Worn injectors after long length of service.

   Obtain reconditioned injectors or return old injectors for repairs.

   Check condition of filters and specifications of fuel if injectors have worn out prematurely. Also make sure dirt does not enter fuel due to careless handling.

OPERATING TROUBLE CHART—*(Cont'd)*

2. Sticking piston rings as evidenced by excessive blow-by of gases at crankcase breather. (Check injectors to make sure blow-by is not from leaking injector tip gasket.)

   Free up or replace rings. Check lubrication oil and fuel oil specifications. (See "Pistons and Rings" Section.)

Engine Misfires

1. Dirt under ball valve seat of one or more injectors, as shown by a large amount of bubbles coming through fuel sight gauge in pulsations.
   Locate injector causing trouble, clean out seat, or replace with spare. (See "How to Determine Which Cylinder is Not Firing" and "Cleaning Injector Valve Seats," Section.)
2. Injector valve spring in injector tip not working properly.
   Make sure spring fits freely on injector valve guide and is of the correct length.

Engine Knocks Sharply

1. Dirt in injector tip. One or more holes plugged.
   Locate injector causing trouble, clean tip or replace with spare (See "Cleaning Injector Tips" Section.)
2. Gasoline in fuel. Extreme care must be used to see that no gasoline is put in fuel tank as a very small percentage will cause a sharp knock.

Fuel Oil in Crankcase, Dilution

1. Injector rubber seal ring leaking (or missing).
   Replace with new synthetic rubber ring if required. Make sure springs and spring seat located above rubber seal ring are free and will hold rubber seal in place when injector is installed in engine.
2. Tubing and fuel connections in camshaft housing leaking. (See "Testing for Fuel Leaks of Connections and Tubing on Cylinder Head" Section.)
3. Injector Tip not pulled up tight. Injector tip must be tight to insure that no fuel oil leakage occurs at ground joint flange of valve seat as fuel could leak past threads inside injector tip and travel outside of injector body into lube oil returning to crankcase.
4. Defective Injector.
   Exchange spare injector with each injector in engine. Try new tip assembly on injector causing trouble or return to factory for test and repairs.

   CAUTION: Never operate engine when dilution is building up in crankcase. Thinning of oil in crankcase will ruin the engine in a short time.

Excessive Fumes at Crankcase Breather

1. Leaking injector tip gasket.

   Replace with new gasket.

2. Sticking piston rings.

   See "Pistons and Rings" Section. Piston rings will positively not stick if proper oil is used.

LIMITED STORAGE

(30 days or less)

Start engine and run till approximate operating temperature is reached (150° or higher). Shut down, drain lubricating oil and fuel filters (see lube and fuel sections), and clean filters. Fill crankcase with OE-10. Prime fuel system. Start engine and operate for 5 minutes to allow fresh lubricating oil to reach all working parts. Then shut down engine and disconnect generator from line by removing leads at terminal box.

Check batteries and if not fully charged, recharge. Clean terminals and coat with USA-282.

Drain cooling system, take plugs removed from drain openings and wire together, tie to throttle lever with tag. "Before operating this unit replace plugs and fill cooling system." Another tag to be tied to radiator cap with same wording. Seal openings to muffler and air cleaner, and cover entire unit with a weatherproof covering.

DEAD STORAGE

For instructions regarding Dead Storage refer to T M5-9715 "Instructions for preparation of Corps of Engineers Equipment for Storage," issued by Engineer Field Maintenance Office, P. O. Box 1679, Columbus, Ohio.

SHIPMENT BY TROOPS

When shipping unit the following precautions are necessary to insure no damage will be done to Generator set.

If unit has been in operation, remove mufflers, and fuel lines, and cover or plug all openings to engine, fuel lines and both ends of muffler. Box fuel tank, fuel lines, and mufflers securely.

The Generator set is equipped with a lifter assembly which when not in use is bolted to front of skid.

If hoisting equipment capable of lifting the unit (10,058 pounds net) is available attach the lifter bail by bolting to the six camshaft housing studs at the rear (Generator) end of the camshaft housing. This furnishes a point at the approximate center of unit by which it can be hoisted to the trailer or car.

Unit should be placed in center of trailer or car and blocks 4x4 inches or larger should be securely fastened to the floor on both ends and sides of unit by means of bolts or lag screws to keep unit from shifting while trailer or car is in motion. Because the center of gravity of these units is very low it is not usually necessary to fasten them down. If it is desired to

SHIPMENT BY TROOPS—(Cont'd)

fasten the unit (crated) down, do so by running one or more cables over the top and securing firmly. If unit is not crated **do not attempt** to tie down as the unit will be damaged. Instead use lag screws or bolts to secure to vehicle. There are holes drilled in the skid for this purpose.

Place box containing fuel tank, mufflers, and fuel lines **on same vehicle or car** that unit is being shipped on and fasten down securely. This is best done by securing 2 skids to box and bolting skids to vehicle.

EXPORT SHIPMENT

For export shipping instructions refer to TB5-5052-1 "Preparation for Export." Issued by Engineer Field Maintenance Office, P. O. Box 1679, Columbus, Ohio.

MAINTENANCE SECTION

GENERAL NOTES

Cleanliness

Always clean all dirt and grease from the outside of the engine before removing any parts. Try to keep all bolts, nuts and other parts from the various assemblies in separate containers. This will be a great help when ready to assemble the engine. Clean all parts and wash thoroughly in gasoline before replacing. When an engine is opened up cover it with heavy paper or other covering to keep out the dirt.

Gaskets

Whenever any parts of the engine are removed, before replacing them make sure that the gaskets under these parts are clean and in good condition. A reasonable amount of care on this point will assure an oil-tight engine, and more important, will prevent the entry of dirt into the engine.

In general gaskets should be replaced dry and will require no cement or sealing agent. When gaskets must remain attached to a certain part, such as the handhole covers, use gasket shellac on that one side only. Only a few special cases will be found in the following instructions where a sealing compound is advisable.

Tightening Nuts

When assembling, care should be used to tighten the retaining nuts evenly and uniformly, and to set all the nuts up firmly. If this is done carefully the gaskets will have a much better chance of performing their function of sealing joints. This is particularly important in the case of the cylinder head nuts, which must hold the cylinder head gasket tightly enough to seal the gas pressure in the cylinders.

The cap nuts, and lifter connections, on top of the camshaft housing must also be tight, as they perform two tasks. In addition to retaining the camshaft housing, they must seal the lubricating oil which otherwise would flow up through the stud holes and out from under the nuts. The copper washers under these nuts must be in good condition.

Tools

Owing to the extensive use of alloy steels in the nuts, studs, and other parts of the Murphy Diesel engine, ordinary wrenches may not be found equal to the task of properly disassembling, adjusting and tightening these parts. For this reason a tool kit of high quality tools which are suited to this task, has been provided for every important operation. Use these tools rather than other tools which may be available. Battered nuts and injured parts will be prevented, and there will be much less chance for an injury to the operator.

See Operating Trouble Chart for Assistance in Diagnosing Trouble

COOLING SYSTEM

The Murphy Diesel engine is cooled by a radiator on which is mounted an oil cooler. Most water contains material which eventually forms scale on the water passages of the cooling system and silt which settles to the bottom of the water jackets. These deposits make proper cooling impossible as they prevent proper heat dissipation. Periodically, and always when doing major overhaul work, the entire water circulating system must be cleaned out by the use of any of the commonly known solvents, such as oakite, sal soda, or sani-flush. CAUTION—Care must be used to be sure that any chemicals be flushed out of the system before putting the engine back into service.

The oil cooler should be flushed out carefully as part of this system, although, if the cooling water portion becomes filled up or clogged, it can be taken apart, that is, the core removed at which time it can be washed off with a brush and blown out with air. It is occasionally necessary to clean out the inside of the copper tubes forming the core to remove any sludge or dirt from the oil which may have accumulated in them. A coating of foreign material on either the inside or outside of these tubes will greatly reduce the cooling capacity and raise the operating temperatures of the water and the oil.

Removing Radiator

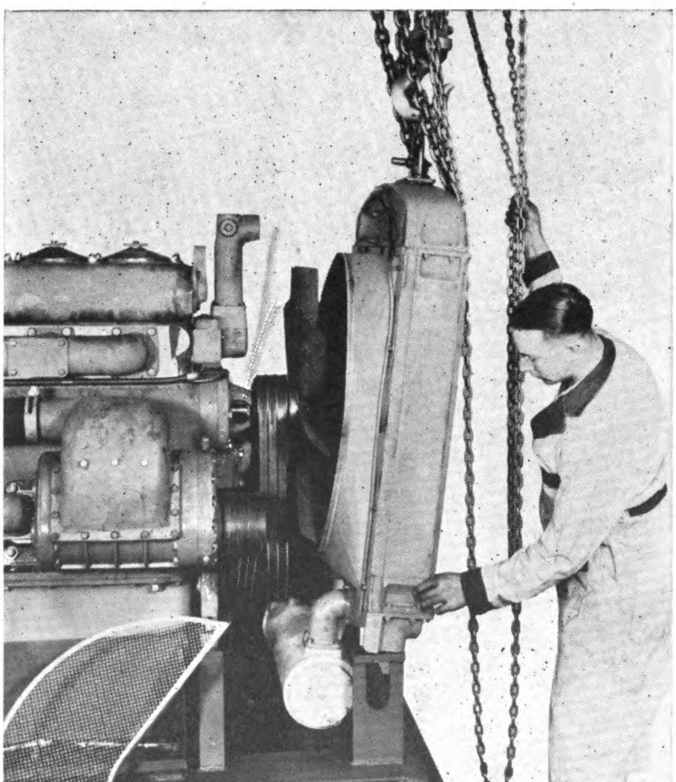


FIG. 33—Installing Radiator and Oil Cooler as a Unit

1. Drain cooling system by removing pipe plug at the center of the bottom of the oil cooler. (See Figure 25.)
2. Detach fan guard screen from sheet metal fan shroud and remove any braces supporting radiator.
3. Loosen up and lower radiator hoses, remove capscrews holding radiator onto base, uncouple the two oil lines from oil cooler, and move radiator and oil cooler ahead. Or the oil cooler may be detached from the radiator leaving it connected through the two oil lines and through the lower water connection hose. When handled in this manner the oil cooler must be suitably supported before loosening the mounting screws.

COOLING SYSTEM—*(Cont'd)*

Fan Belts

Three fan belts form a four point drive to operate the fan and water pump assembly, also the generator and oil pump.

To tighten the fan belts, first loosen the four nuts holding the generator drive housing onto its bracket, then rotate the housing until the fan belts have the correct tension. Push the generator drive assembly toward the rear of the engine when tightening belts to keep the housing in place and prevent it from slipping forward. (See Operating Instructions Figure 20).

To replace the fan belts loosen the belt adjustment, then work the belts over the fan blades and remove. These belts are in matched sets. When replacing always replace the complete set.

Water Pump and Fan

The water pump and fan are combined into one assembly, located at the front of the crankcase. The water pump packing is composed of asbestos and lead split rings, which can be replaced by backing off the packing gland, removing the old packing and replacing with new packing. Tighten the packing nut just enough to stop the leak, then back off slightly. A very small amount of leakage is desirable to lubricate the shaft packing.

The fan bearings should be greased every 500 operating hours. Remove the pipe plug from the bottom of the center fan belt grooves and insert the grease fitting furnished in the tool kit. Use a good quality medium ball bearing grease.

Removing and Dismantling Water Pump and Fan

1. To remove the water pump assembly from the engine, first move radiator ahead as previously explained. Remove the fan belts, take off six capscrews holding the water pump on the engine and lift off. Remove fan before attempting to remove water pump.

2. To remove the pump runner and shaft, take out six capscrews holding the fan blades onto the fan pulley. Remove the fan, take out the dog-point capscrew that drives the water pump and then remove the bearing plate that is also held on with the six capscrews which hold the fan in place. Remove the lock screw from the pump shaft collar and remove the collar and Woodruff key. Loosen the water pump packing nut and remove the shaft and runner. If one end of the shaft is found to be worn excessively by the packing, the shaft may be turned end for end, thereby doubling the life of the shaft.

3. To replace the water pump packing nut and gland, take out shaft and runner and loosen up the packing nut as far as it will go. Then tap out the cup-shaped packing gland, after which the packing may be screwed forward and removed. Inspect the small leather seal in the packing nut which is used to keep dirt from the fan bearings, and replace if necessary.

4. To inspect or re-pack the fan bearings, remove the fan pulley, the bearing plate and the shaft collar as explained above. Then remove the nuts from the inner circle of small studs and remove the bearing retainer, leaving the long tube attached. Remove the belt pulley, together with bearings and bearing spacer. When reassembling bearings re-pack with 1¼ pounds of best quality ball bearing grease.

COOLING SYSTEM—(Cont'd)

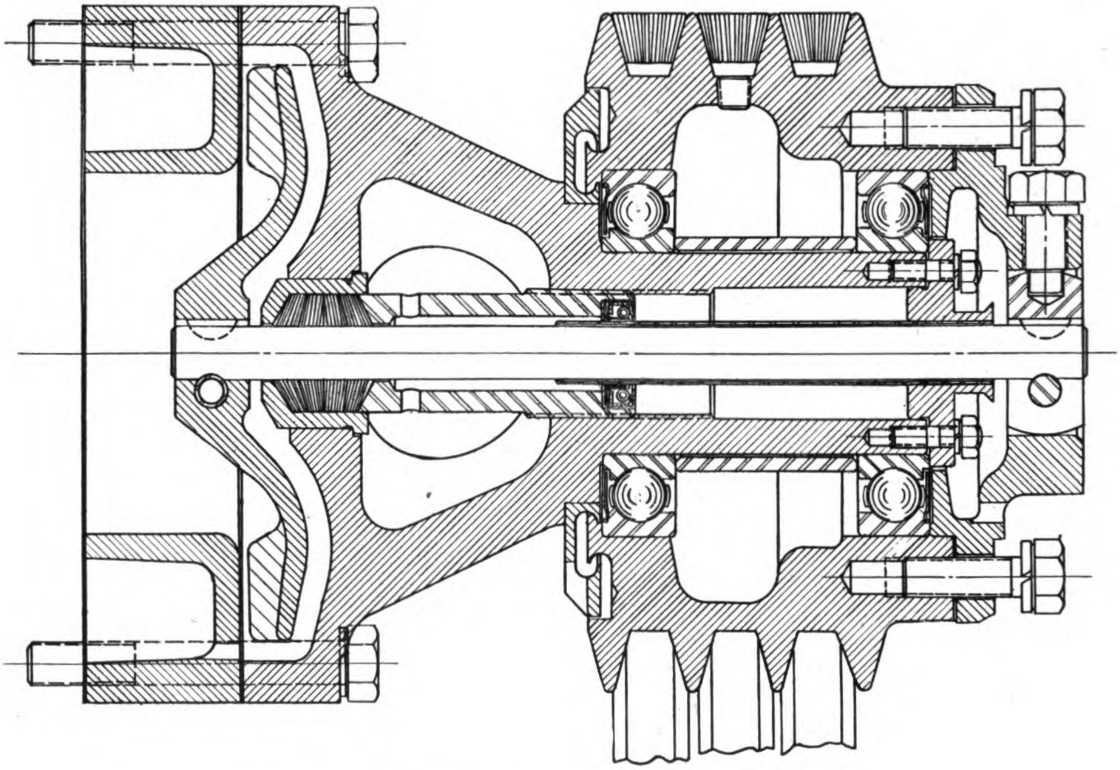


FIG. 34—Cross Section of Water Pump

Removing and Dismantling Water Pump and Fan — (Cont'd)

5. The bearings supporting the water pump pulley are of the shielded type on one side, this is done to permit the lubricant within the pulley to reach the bearings and races. When reassembling, be sure that the shields are to the outside in both bearings and that the open side of these bearings face each other.

Thermostats

The flow of water from the cylinder head to the radiator is sharply reduced when the engine is cold by three thermostats, located in a housing at the front end of the cylinder head. These remain closed when the engine is cold and cause the engine water to circulate thru the engine water jackets only. When the engine warms up the thermostats open and the water then circulates through the radiator. These thermostat units will require no attention unless damaged by overheating in which case they should be replaced by new units.

INJECTORS

The fuel injectors are located directly above each cylinder and can be seen by removing the valve covers on top of the engine. If the engine is operating satisfactorily, the injectors need no cleaning and should not be disturbed.

Removing Injectors from Engine

Turn the engine over until the injector rollers are at the low point of their travel. Insert the square-ended "T" injector wrench through the hole in the top of the injector spring cover, and unscrew the retaining nut which holds the injectors in place. There are no throttle connections to break, and the fuel connections are made by a plunger that fits into a packing gland. After the retaining nut is loosened, the injector can be lifted straight up, out of the engine by the bail handle provided for that purpose. Care should be taken not to bump the tip or lower end while handling the injector. If the tip is damaged in any way, a new one should be substituted. When the injector is lifted out of the hole in the cylinder head, inspect the tip to see if the copper gasket remained on the tip or stayed in the hole. There should be only one thin copper gasket used.

WARNING

Never add lubricating oil to the crankcase unless all injectors are properly secured in place, as the oil is likely to fill a cylinder, and damage to a cylinder head, piston, connecting rod or crankshaft may result when the engine is started.

Replacing Injector in Engine

When replacing the injectors in the engine, make sure that there is ONE THIN COPPER GASKET ONLY on the injector tip. Sometimes the injector gasket may stick in the bottom of the hole in the cylinder head when the injector is removed. Fish it out with a wire hook and stick it to the injector tip with a little cup grease. Care should be taken to insure that there is always one gasket, and never more than one on the tip when the injector is replaced. Failure to observe this precaution will impair the engine operation, and may injure the injector. Leaving the copper gasket off the injector tip will destroy the seal between the injector tip and the cylinder head as will a split copper gasket, resulting in the hot gas blowing by, and causing the outside of the injector body and the inside of the hole in the cylinder head to become coated with carbon. This gas leakage is manifested by an excessive amount of gas and smoke escaping from the camshaft housing when the valve cover is removed. Clean the injector body stem and the hole into which it fits, taking particular care to thoroughly clean the gasket seat of the tip, and the seat in the hole. Inspect the synthetic rubber seal ring on the injector fuel connection before installing in the engine, and replace with a new one if damaged or out of shape. A leaking seal ring will allow fuel oil to leak into the crankcase, causing dilution of the lubricating oil. (See "Testing for Fuel Leaks of Injector Connections and Tubing on Cylinder Head.")

When replacing an injector in the engine, draw down firmly, but not with an excessive force to seat the injector on its gasket.

Before replacing the valve cover, MAKE SURE THAT THE INJECTOR CONTROL LEVER PIN IS CORRECTLY LOCATED IN THE SLOT IN THE FUEL CONTROL CROSS BAR.

INJECTORS—(Cont'd)

Re-Assembly

Replace the valve seat and ball in the injector, first making certain that all surfaces of the valve seat, as well as the end of the injector body where the valve seat rests, are perfectly clean. Assemble the valve spring and guide and place on top of the ball. Then carefully enter the spring into the hole in the injector tip and screw down by hand. If the tip does not screw down nearly all the way by hand, remove it and make sure that all parts are in their proper locations. About one-half turn with the special injector wrench is required to tighten the injector tip. In the event that the injector tip resists screwing down to its proper place, it is an indication that the spring and guide are not entered into the hole in the injector tip, in which case the tip should be removed and the spring and guide straightened up, and another assembly trial made.

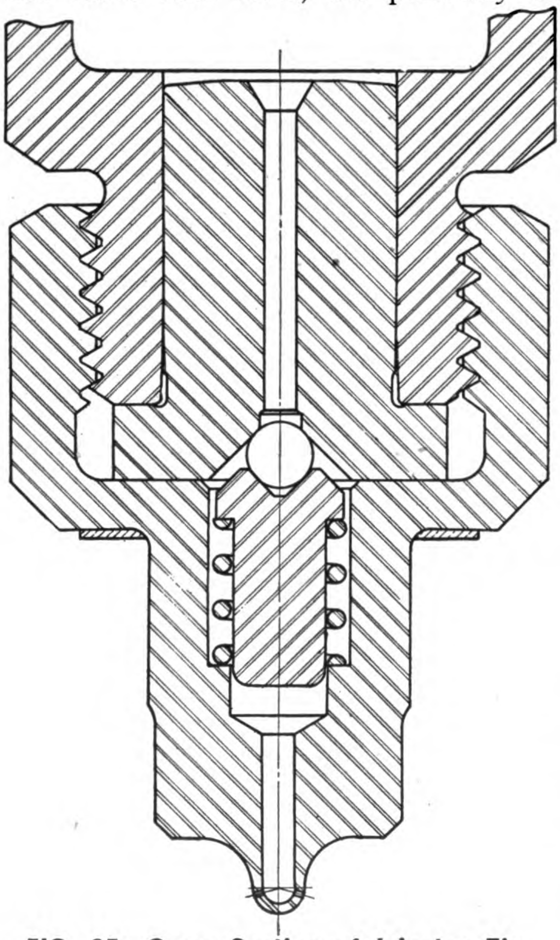


FIG. 35—Cross Section of Injector Tip and Check Valve

If the injector tip still fails to fire when replaced in the engine, repeat the cleaning process. If the valve continues to leak try a new ball, and if leakage still occurs, lap the injector valve seat as explained under "Lapping Injector Valves."

In reassembling the cleaned parts, great care must be exercised to keep them absolutely clean. A tiny particle of dirt in the injector may cause the injector to misfire. If the filtering equipment is kept in proper condition and dirt is kept out of the injectors when handling, little trouble will be experienced.

Cleaning Injector Seats

The necessity for cleaning valve seats is shown by groups of air bubbles appearing at regular intervals in the sight feed glass. These bubbles are caused by the compression pressure leaking back through this ball check valve and into the fuel system and thereby preventing the pump from filling with fuel.

When an injector valve seat is to be cleaned the injector should be mounted tip upward in the special holding fixture provided for that purpose or in a bench vise. Unscrew the injector tip with the special injector tip wrench, then remove the injector valve spring and guide, the valve ball, and the valve seat. Fill the tip with gasoline and press the thumb over the opening to force the gasoline out through the spray holes. If all holes are open, set the tip aside for reassembly. If some holes are plugged, clean the tip as explained under "Cleaning Injector Tips." Another very accurate way of checking the injector tip holes is to pass illuminating gas through the

INJECTORS—(Cont'd)

Cleaning Injector Seats—(Cont'd)

tip and allow it to burn. If the holes are clean and undamaged, the length of flame will be uniform and evenly spaced around a circle.

Wash the spring guide, ball and seat carefully in clean gasoline or fuel oil. Small particles of dirt or metal that are lodged on the injector valve seat, where the small ball seats, must be very carefully removed. As these particles are very small, and cannot be seen without a magnifying glass, the valve seat is very apt to be considered clean when it is not. Very carefully wash the valve seat in CLEAN gasoline or fuel oil and remove the small foreign particles by rotating a clean piece of paper in the valve seat. A match or small soft pine stick, if clean, may also be found useful to dislodge particles. Before reassembling, the seat should be checked to see that the valve is tight. This is done by placing the valve ball on the valve seat and sucking on the opposite end to check for tightness and proper seating. If the valve still leaks wash the valve seat and ball again, and repeat the cleaning process. If the valve seat and ball cannot be made tight, see "Lapping Injector Valve."

If Injector Knocks

If an injector knocks sharply, it is probably a sign of one or more holes stopped up in the injector tip. The knocking injector is located by operating each injector independently as explained under the paragraph "How to Determine Which Cylinder is Not Firing." The stopped up injector will quit knocking when the control lever pin is out of the slot and in the off position. If cleaning the tip does not remedy the difficulty, return the injector to the Murphy Diesel Factory for overhauling.

Cleaning Injector Tips

Mount the injector with the tip upward in the special holding fixture and remove the tip from the injector with the injector tip wrench.

The injector has several small spray holes equally spaced around the tip. Clean these holes by using a piece of music wire, placed in the small wire chuck, found in the handle of the injector tip wrench. Use only wire furnished by the Manufacturer, or piano wire of correct size. Use .009" diameter wire for tips marked 6-010-D. Use a rotary motion without force, and always keep the end of the wire straight and in line with the hole. The central hole on the inside of the tip may be cleaned, if necessary, with the special 1/16 inch drill which is furnished in the kit. After the tip has been carefully cleaned, it should be washed in gasoline and checked with gasoline by pressing the thumb over the end to see if all the spray holes are open.

Tips marked 5-008-A are to be used in injectors stamped "A" on head.

Tips marked 6-008-SD only in injectors stamped "SD" on head.

Tips marked 6-010-D only in injectors stamped "D" on head.

The ME-650 generating sets use only the "D" size injector, the tips for which are marked 6-010-D. The other two sizes of injectors, namely the "A" and the "SD" together with the tips as listed, are other sizes which are used in other models of engines. The different size injectors must never be mixed in an engine, and only the large "D" size should be used on these generating sets.

INJECTORS—*(Cont'd)*

Lapping Injector Valves

To lap in an injector valve, the special tool furnished in the tool kit should be used. This tool is an injector valve ball soldered to a steel taper shank which fits the open end of the small wire chuck. Use a small amount of very fine lapping compound furnished for this purpose in the tool kit. NEVER USE GRINDING COMPOUND. (In an emergency, use rouge.) Hold the ball lapping tool very lightly against the seat on which some of the fine lapping compound has been applied, and rotate the tool in all possible directions while holding it at various angles with the seat. It is important that the force be light, and the motion irregular to avoid the formation of rings. After a short time of this light lapping, wash the parts very carefully in gasoline and try the seat with a new ball to see if a tight seal is made. Repeat the process as required until a gas tight valve is obtained, always using great care to wash the parts and blow out the hole before trying the seat for tightness.

Injector Valve Balls

Whenever replacing injector balls, be sure to use only those furnished by the manufacturer as they are the nearest to the perfect shape of any obtainable and are decidedly different from commercial ones. Ordinary balls are not truly spherical and trouble will be experienced in securing a leak-proof valve seat if their use is attempted.

Injector Valve Springs

The compression of the small injector valve springs determines the pressure at which the injector valve will open, and consequently should be of the proper length and in good condition to insure proper engine performance. Compare the length of the springs in other injectors working properly, and if found to be shorter, the spring should be replaced with a new one. Make sure the springs fit free without binding on the spring guides.

The final check on the fuel connection should be made before returning the injector to service as to the condition of the synthetic rubber sealing ring, being sure that it is in good condition, shows no cuts, or that it has not lost its shape or life. The sealing spring must be in good condition as it must exert sufficient pressure against the spring seat of the sealing ring to maintain a fuel tight connection. It is often desirable to soak the rubber sealing ring in warm oil for a few minutes before assembling.

Repairing Injectors

DO NOT ATTEMPT TO DISASSEMBLE A MURPHY DIESEL FUEL INJECTOR other than to clean valve seat and nozzle tip. These injectors have no adjustments, and if, for any reason, an injector does not function properly, and the nozzle tip and valve are clean and in good shape, THE ENTIRE ASSEMBLY SHOULD BE SENT IN TO THE FACTORY FOR OVERHAUL AND TEST. Without special facilities, it is impossible to disassemble and overhaul an injector in the field, and it should never be attempted. Use the spare injector, and send in the disabled injector to the factory for reworking. If the engine shows a slight consistent loss of power after long continued periods of operation, it may be an indication of injector wear, which may be remedied by returning all the injectors to the factory to be overhauled and new parts supplied where necessary.

INJECTORS—*(Cont'd)*

Testing for Fuel Leaks of Injector Connections and Tubing on Cylinder Head

If any of the connections or tubing of the injector system on top of the cylinder head have been broken or disturbed, or if the crankcase lubricating oil appears to be diluting or thinning out the fuel oil, the following procedure should be used to determine if there are leaks of fuel and to locate the leak:

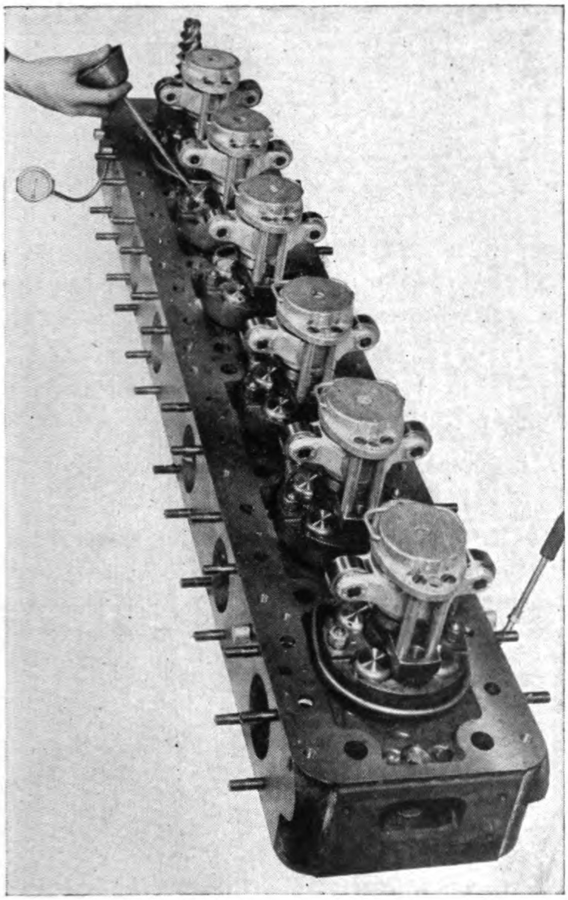


FIG. 36—Testing Fuel Lines for Leakage

Disconnect the inlet and outlet fuel lines from the cylinder head. Apply air pressure at one opening with tire pump and suitable valve fitting made from an automobile tire valve soldered to a tubing connection, and blow fuel out of system. Attach pressure gauge to open end of system and apply 50 pounds air pressure. Apply oil with squirt can to all the following points:

1. Copper tubing and the connections to the round tappet guide body.
2. Around gasket of stand pipe, fastened to tappet guide body.
3. At the end of injector body where two small holes have been plugged.
4. At the point where the fuel connection pin passes through the body.
5. Around the rubber injector seal ring where leaks are most likely to be found.
6. Around small capscrew at side of injector body.

Leaks will usually be found around tip. This can not be seen but can be heard. Then change to spare injector and return faulty one for repairs.

By listening at the valve cover holes, a hissing sound of escaping air may sometimes be heard, which may help to locate the leak.

To do a thoroughly complete job of testing, it is necessary to remove the camshaft housing in order to make accessible all possible points that may be leaking, and make the necessary repairs. All injectors should be in place and pulled down tightly at the time of making the test.

When the intake and exhaust valves are taken out, it is necessary to remove from the cylinder head the round tappet guide which necessitates breaking all fuel connections on top of the cylinder head. The above test must always be made after the round tappet guides have been installed, and all fuel connections made.

STARTING SYSTEM

The ME series Murphy Diesel engines are equipped with 24 volt electric equipment for direct starting on the Diesel cycle. See Wiring Diagram (Figure 37).

Starting Motor

The starting motor is of the positive engagement type and is operated by a lever attached to the starter. If the engine does not start immediately always wait for it to stop turning before trying to engage the starter again. This will prevent damaging the starter and flywheel ring gear.

The oil cups should be oiled with only a few drops of light oil every 500 hours of engine operation.

Generator

The generator is mounted at the side of the engine and is driven by the fan belts through a drive assembly which also acts as an eccentric for tightening the fan belts.

The oil cups at both ends of the generator should be oiled with only a few drops of light oil every 100 hours of engine operation.

If the commutator should become dirty it should be cleaned with fine sandpaper.

To remove the generator, take out three bolts from the flexible generator drive coupling, detach the wiring, and remove the capscrews which hold the generator on its bracket. Disconnect fuel lines to fuel pump mounted on end at generator. Always line up the coupling accurately when replacing the generator.

Generator Control Box

The control box to regulate the generator charging rate and prevent overcharging the batteries is located on the side of the engine.

The control box, used with third brush generators, contains a voltage regulator and generator cut-out. The voltage regulator prevents overcharging the batteries and the cut-out prevents battery current from backing up into the generator when the engine is not running.

A switch made from copper strips is attached to the underside of each regulator, to short the terminals when it is desired to reverse the current flow and allow the generator to act as a motor to operate the fuel pump for priming purposes.

Batteries

The 24 volt system uses two heavy duty 12 volt batteries. Willard RHD-19-6 or equivalent should be used.

Keep the batteries well charged at all times to insure good starting. This is especially true in winter as a partially discharged battery will freeze in extremely cold weather.

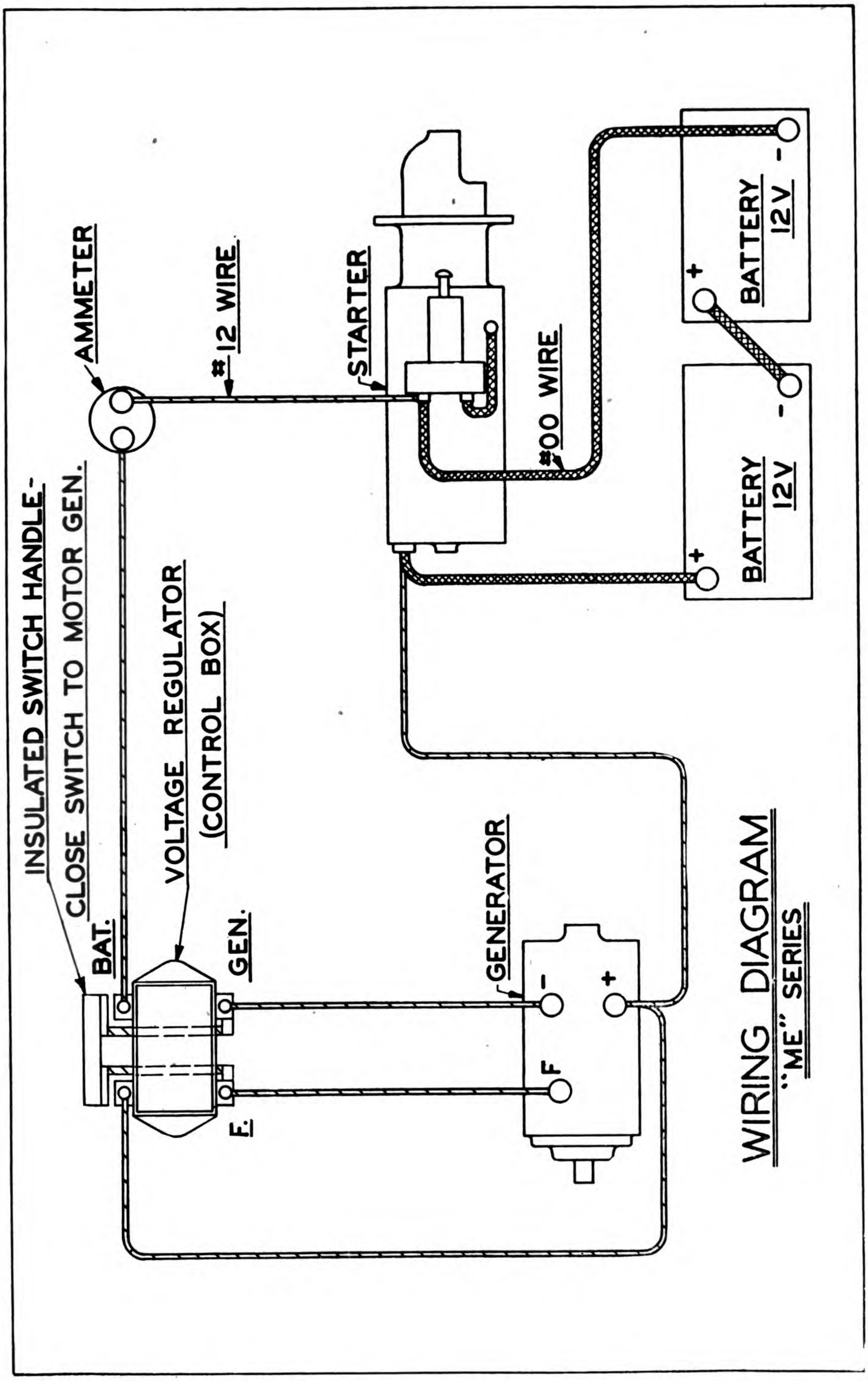


FIG. 37—Wiring Diagram for Third Brush Generator Using Small Control Box

GENERATOR DRIVE ASSEMBLY

General

The generator drive assembly forms an adjustment for the fan belts, and also drives the generator. The shaft driving the generator is located in the exact center of the housing, and the shaft connected to the generator drive pulley is offset. These two shafts have gears attached inside the housing, which are in mesh. When the housing is rotated the eccentric construction causes the belts to be tightened without affecting the position of the generator. A lever on the side of the housing throws the gears out of mesh when motoring the generator to drive the fuel pump.

A small stream of oil flows by gravity to the generator drive housing from the engine proper. Surplus oil is led back to the crankcase.

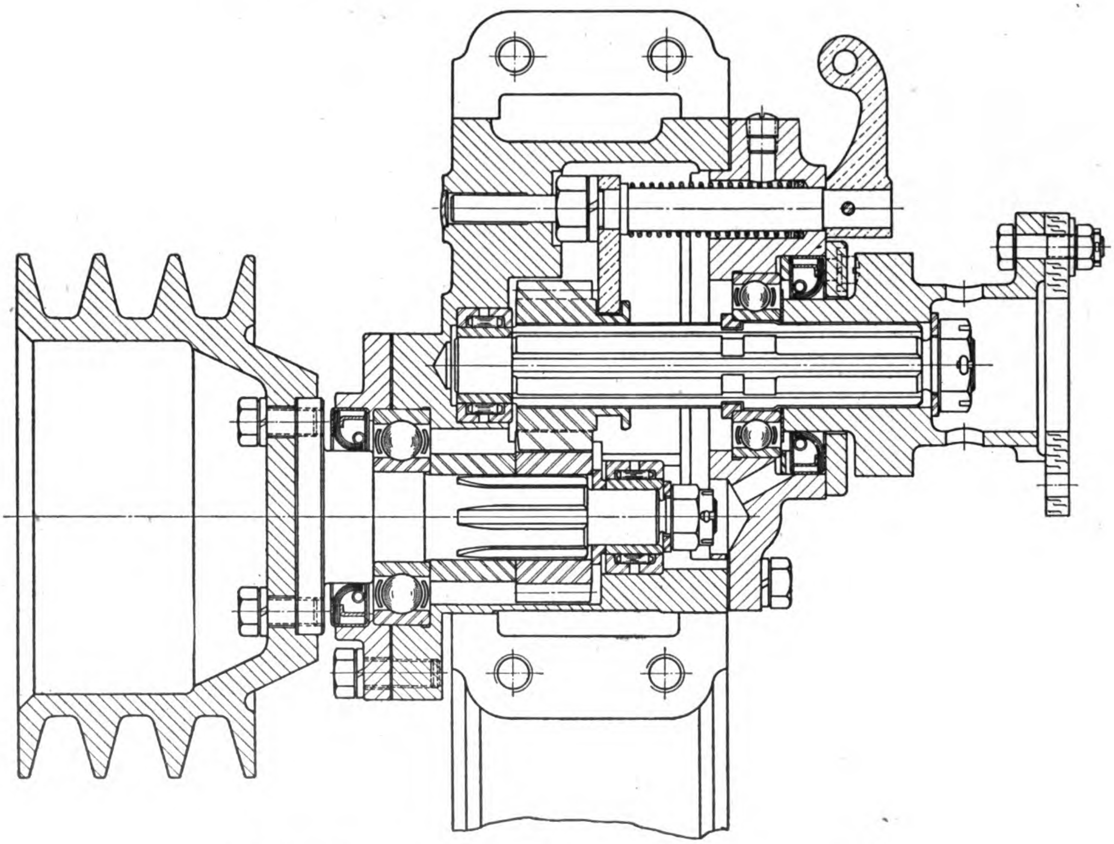


FIG. 38—Cross Section of Generator Drive Assembly

Dismantling Generator Drive

1. Remove entire unit from engine by removing four screws from mounting cap; disconnect flexible coupling.

2. To inspect upper countershaft, oil seal, and bearings; first remove six ⅜″ capscrews from end nearest generator and take off bearing cage and assembled parts. Take off nut on end of shaft and remove splined coupling flange. Push on end of shaft from which coupling flange was removed to

GENERATOR DRIVE ASSEMBLY—*(Cont'd)*

Dismantling Generator Drive—*(Cont'd)*

allow removal of the two split bearing retainers. Remove nut holding shifting fork in place and remove fork. Pull out shaft. To remove gear from shaft first remove inner bearing race that is pressed onto end of shaft and then remove gear. To inspect bearing and oil seal on countershaft, remove four ¼″ screws from small cover plate, then tap on outer race of bearing to remove bearing and seal. To remove needle bearing from housing, take out lower drive shaft assembly as explained in (3) and force out bearings using the two holes provided in the housing for this purpose. Reverse above procedure when replacing parts. When replacing ball bearings and leather seal, be sure to insert large bearing retainer washer between the bearing and seal, with the notched side of the washer facing the bearing and lining up with the drilled hole in the casting. Also place the thin slinger washer next to the bearing before inserting the seal. When replacing the splined coupling on shaft use non-hardening Permatex No. 2 or similar compound to prevent oil leaking out along the splines.

3. To inspect lower drive shaft, seal, and bearings first remove wire from circle of capscrews holding drive pulley in place and remove pulley. Take out the four ⅜″ capscrews from bearing cover and tap on end of shaft on which nut is fastened, to remove shaft and assembled parts. Remove nut from end of shaft, then remove small washer, inner race for roller bearing, larger washer, gear and spacer. Tap out shaft, then remove bearing from inside of cover and leather seal from outside of cover. When replacing leather type seals be sure to install with the sealing edge of the leather ring pointing toward the inside of the housing. Reverse above procedure when replacing parts.

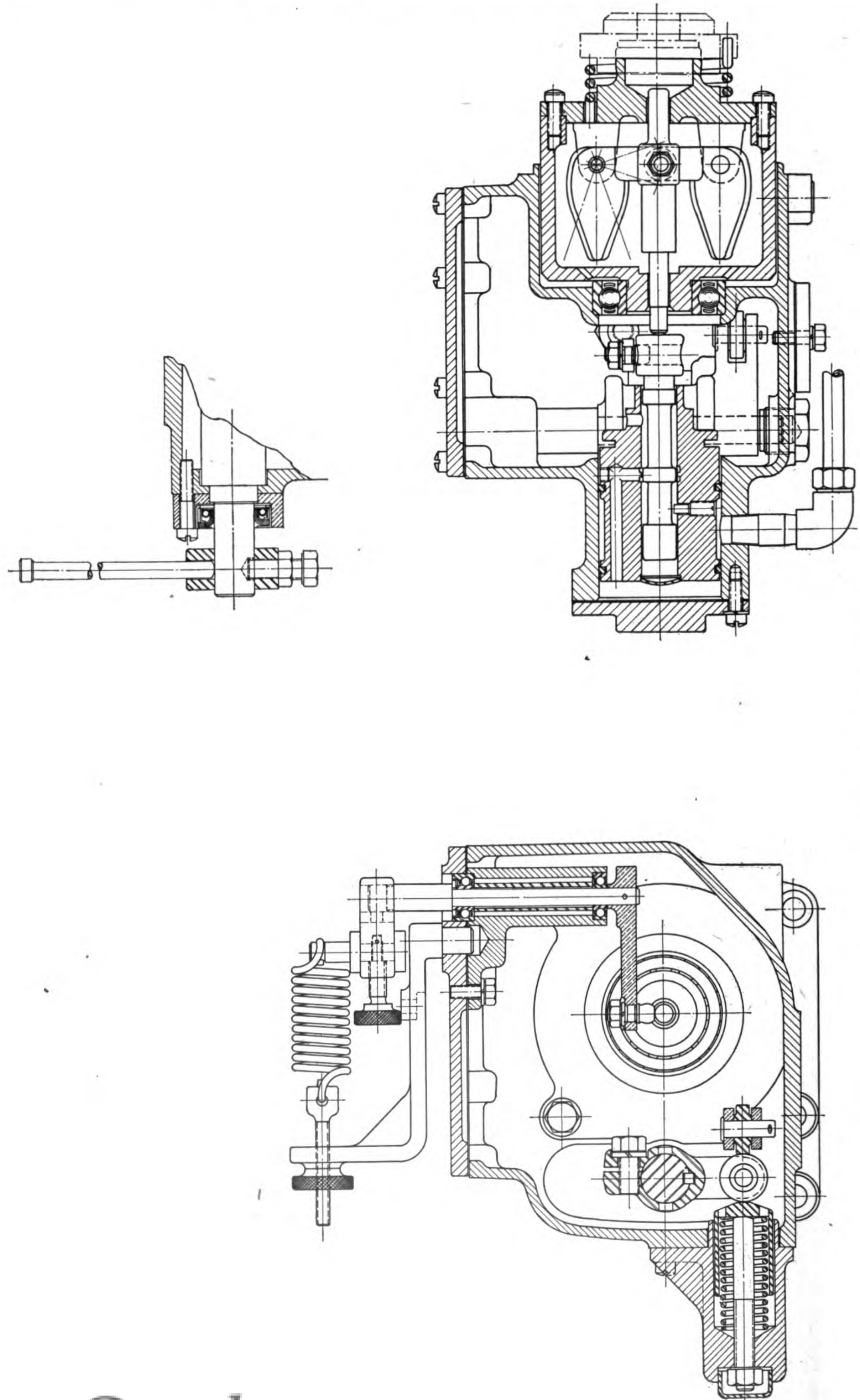


FIG. 39—Cross Section of Governor Assembly

MAINTENANCE OF THE GOVERNOR

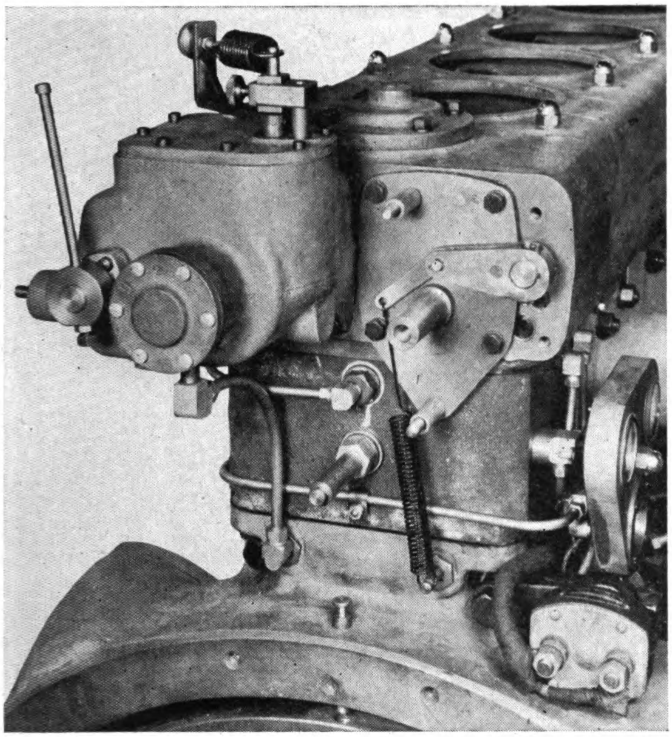


FIG. 40—Control Set Partially Removed

The first operation is disconnecting the control rod which links the governor control lever to the hand control lever. Remove the 8 capscrews holding the top cover which carries the spring mounting and lift this unit out of the governor. This will free the hydraulic Servo piston and the hydraulic spool valve so they may be removed after removing the cylinder head plate projecting in line with one of the camshafts. The spool valve can then be withdrawn from the hydraulic piston after removing the dog point screw inserted in the side of the piston which holds the spool valve in position. After removing this hydraulic piston together with the oil lines to the hydraulic cylinder which are mounted below and on the outside, remove the collar which acts as a socket for the primer lever, the oil seal housing around this shaft, and the return spring plunger which is contained in a casting mounted on the governor housing with 4 small capscrews. After removing the foregoing items, the capscrews can be removed from the inside and the outside of the governor housing which is mounted on the camshaft housing.

The flyball weights are carried inside of a cylindrical housing which is supported on one end with a ball bearing in the governor housing proper and on the forward end piloted in the camshaft. The drive of this governor weight housing is through a torsional spring with ears on each end. One of these ears registers with a drilled hole in the weight housing cover and the other in a drilled hole in the end of the camshaft.

These weights must be free, but not sloppy, in their fit on the trunnion pin. In the lever end of the governor weights there is a spherical headed screw which engages in a hole provided in the pin which extends completely through the weight housing and contacts the end of the spool valve working against the spring tension of the governor spring mounted above the case previously mentioned. This spring force works through the short lever arm carrying the adjustable spring anchor post through a small shaft supported in ball bearings and mounted on the governor cover, the lower end is equipped with a lever in the outer end of which is provided a spherical headed screw which engages in a hole provided in the spool valve. The actual forces used to control the injector is by means of a ball crank which contacts the end of the hydraulic piston pivoted on a vertical shaft through the governor case and through hardened roller contacts to a short lever mounted on the

MAINTENANCE OF THE GOVERNOR—*(Cont'd)*

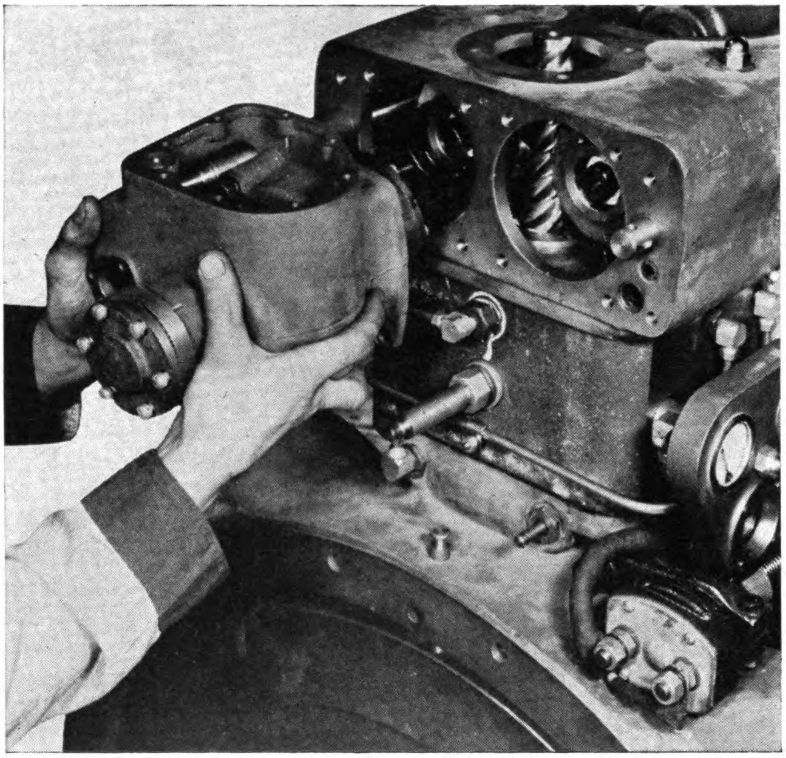


FIG. 41—Removing Governor Assembly

end of the injector control shaft. The injector control lever with its roller contacts is carried between the return spring plunger which is heavily spring loaded and forces this shaft to the stop position or through the bell crank back against the position taken by the hydraulic piston as a result of the movements of a spool valve controlled by the flyball weights. The bell crank which carries this force is mounted on a vertical pin through the governor housing and may be removed by unscrewing the special bearing which carries a hex head from the lower side of the governor housing and driving up.

The entire governor runs approximately half full of oil, that is, above the center line of the camshaft. This oil comes from the venting of and the leakage from behind the hydraulic piston back into the governor case and from there to the camshaft housing, where it joins the regular flow of oil to the engine crankcase.

In re-assembling, the governor parts must fit freely but not sloppily. Use care to avoid any tight spots or binding on these parts as such a condition causes considerable over-run and failure to respond to the position determined by the flyballs.

CAUTION:

After having any part of this governor apart or disconnected care should be exercised that the engine does not run away in starting. This precaution may be taken by disconnecting 4 of the injectors or preferably by keeping hold of the hand control lever which can then be quickly swung to the upper or compression release position which will stop the engine regardless of fuel injection.

This governor is simple but because of the hydraulic Servo action and the required flow of oil to and from the various parts the simplicity is not immediately apparent.

OIL PUMP

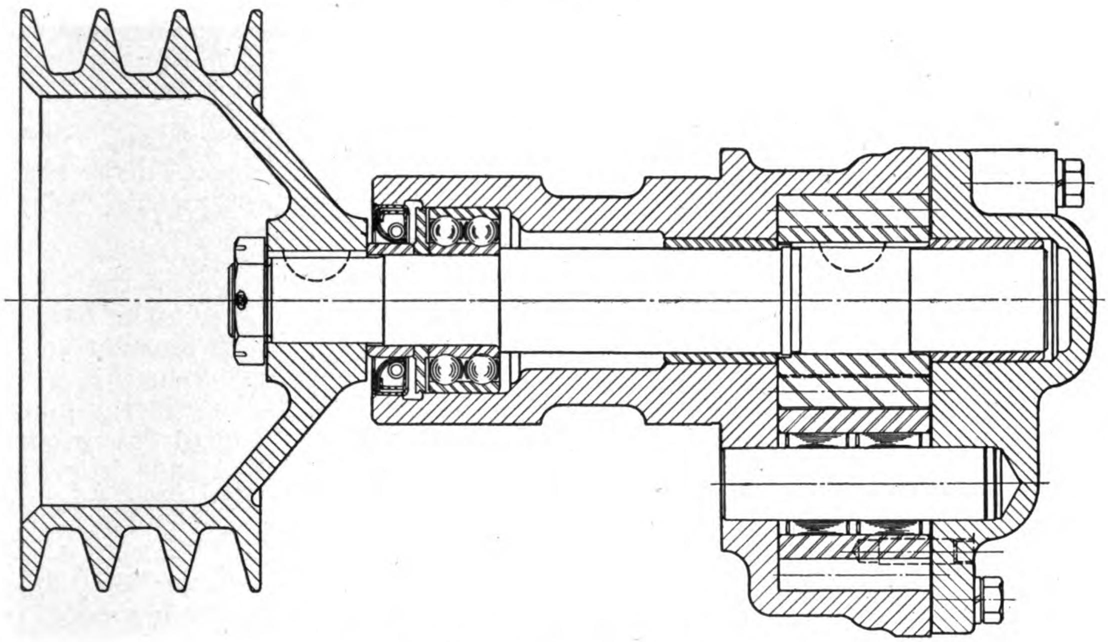


FIG. 42—Cross Section of Oil Pump

The lube oil pump is mounted on the outside of the engine below the generator, and is driven by the three V-belts which also drive the generator, water pump and fan. If the belts break or fail for any reason the oil pump will stop, thereby dropping the oil pressure which causes the hydraulic governor to shut down the engine. The pump is of the gear type, having a drive gear and one idler gear. Oil leaking past the gears is led back to the engine oil sump. There is also a leather seal to keep oil from leaking out along the shaft and to prevent dirt from entering the pump. The suction side of the oil pump is connected to the single oil pickup in the bottom of the sump. The discharge from the pump is divided by the pressure regulating valve, part going through the cooler and filters and then to the engine bearings, while the surplus is returned to the oil pump suction line.

Repairing Oil Pump

1. To remove pump from engine, first disconnect the inlet and outlet pipes at the nearest hose connection, then remove the four capscrews from the cap which holds the pump in place. Loosen fan belts and remove pump assembly.

2. Remove capscrews from pump cover and screw in two of the capscrews into the tapped holes provided which will remove the cover from its locating dowels.

3. Remove idler gear and needle bearings, also thrust washers. The idler shaft is pressed into the pump body and if worn should be replaced. Be sure new shaft is started square with face of pump body when pressed in.

OIL PUMP—(Cont'd)

4. To remove drive gear or examine bearings and seal, first pull off belt sheave, remove Woodruff key, then tap shaft assembly out. The seal can then be tapped out with a punch or rod from the inside of the pump body, after which the ball bearing can be removed in the same manner.

5. The drive gear is held onto the shaft with a Woodruff key and a light press fit. If the gear or shaft are replaced, assembly of the gear on the shaft will be aided if the gear is dropped into hot water before pressing on. When removing the gear, press it off the short end of the shaft.

6. The bronze bushing in the oil pump body and the one in the cover should be replaced if worn excessively. The bushing in the cover has an oil groove for its full length. This groove must register with another small groove in the face of the cover which leads to an oil channel in the cover and furnishes pressure lubrication to the bushing. The bushing in the pump body is grooved for only part of its length. The open end of the groove must face the gears in the pump. A connecting groove also leads from the open end of the groove in the bushing to an oil channel in the pump body to provide pressure lubrication.

7. When assembling the pump, first press in the ball bearing, then drop in the thin oil slinger. Next press in the oil seal, with the wiping edge, of the seal facing in toward the gears. When pressing in this seal use a sleeve or piece of pipe about the same outside diameter as the seal to prevent deforming the seal. Next slip the spacer through the leather part of the seal and insert the shaft and gear assembly from the other side. Install the idler gear, being sure one thrust washer is on each end of the gear and one in the middle between the two sets of needle roller bearings. Be sure all needle bearings are in place.

8. Install the cover with one thin gasket and tighten down the capscrews. This should provide .004″ to .008″ end clearance on the gears and allow the pump shaft to rotate freely. If the dowels in the cover are removed insert the turned down end into the pump body.

9. Replace the belt sheave and install the pump on the engine. The cap is dowelled to the oil pump body to locate the pump correctly.

FLYWHEEL, FLYWHEEL HOUSING AND BEVEL GEARS

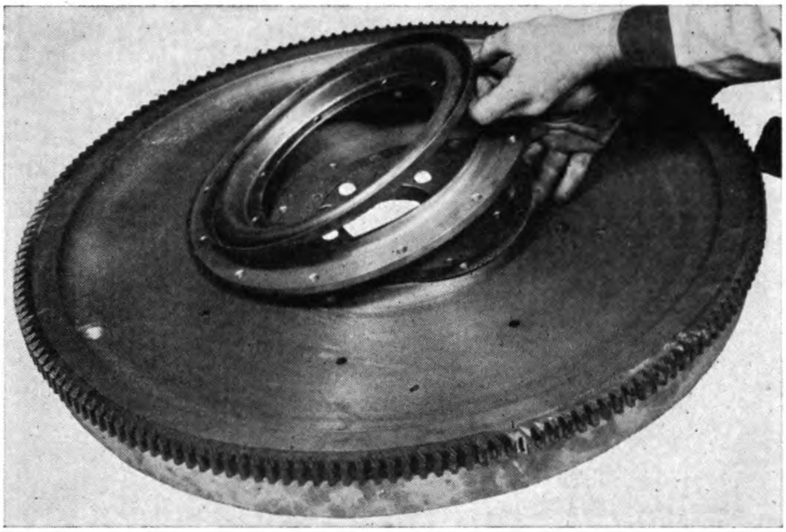


FIG. 43—Installing Flywheel Oil Slinger

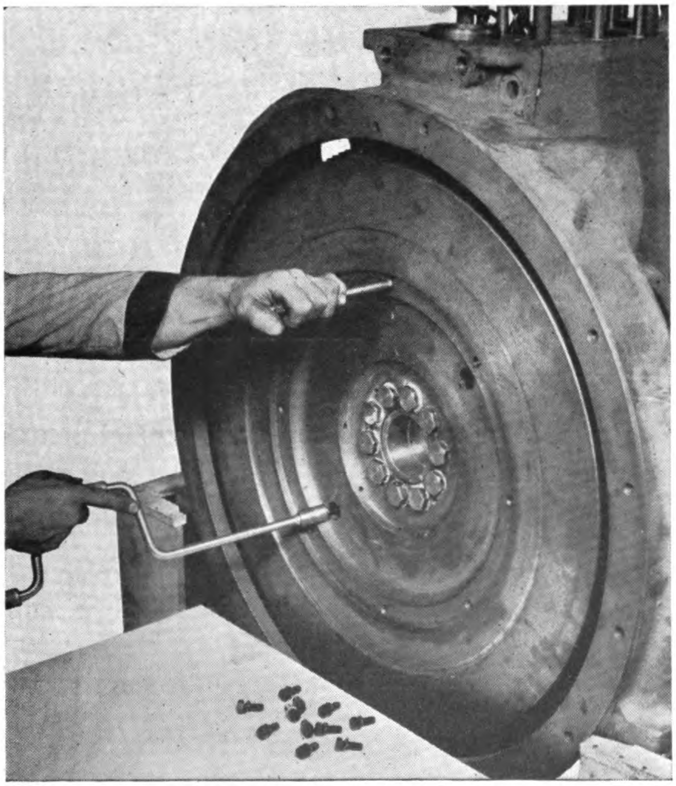


FIG. 44—Installing Capscrews to Hold Slinger in Position

FLYWHEEL, FLYWHEEL HOUSING AND BEVEL GEARS—*(Cont'd)*

Flywheel and Rear Oil Seal

There is an oil seal at the rear of the engine, consisting of two interlocking parts. The slinger, or rotating part, is bolted to the flywheel hub, and the stationary, or other part of the seal, is bolted to the inside of the flywheel housing. These are circular interlocking rings, and in order to remove the flywheel, it is necessary to unbolt the stationary ring from the flywheel housing before the flywheel can be taken off.

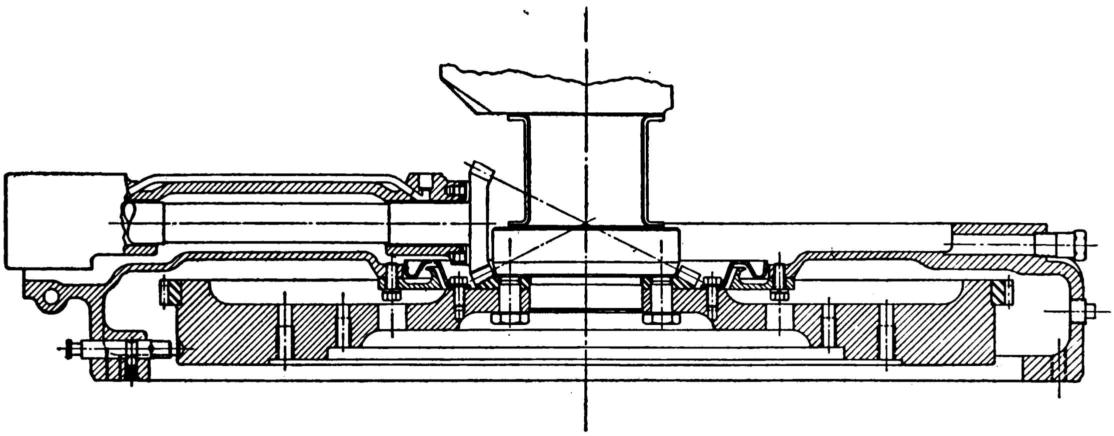


FIG. 45—Cross Section of Flywheel and Oil Slinger

Removing Flywheel

1. There are twelve capscrews with lock washers that bolt the stationary part of the seal to the flywheel housing, these capscrews and lock washers must be removed through the two holes in the face of the flywheel, before attempting to remove the flywheel.

2. Lock the engine on top dead center by pushing the timing plunger into the hole in the flywheel.

3. Remove the ten flywheel capscrews.

4. Release the timing pin from the hole in the flywheel.

5. Screw a ⅝″ eyebolt or stud into the upper hole in the flywheel face to facilitate handling.

6. Screw two ½″-13 N.C. capscrews into the tapped holes near the center of the flywheel to force wheel off crankshaft hub.

FLYWHEEL, FLYWHEEL HOUSING AND BEVEL GEARS—*(Cont'd)*

Replacing Flywheel

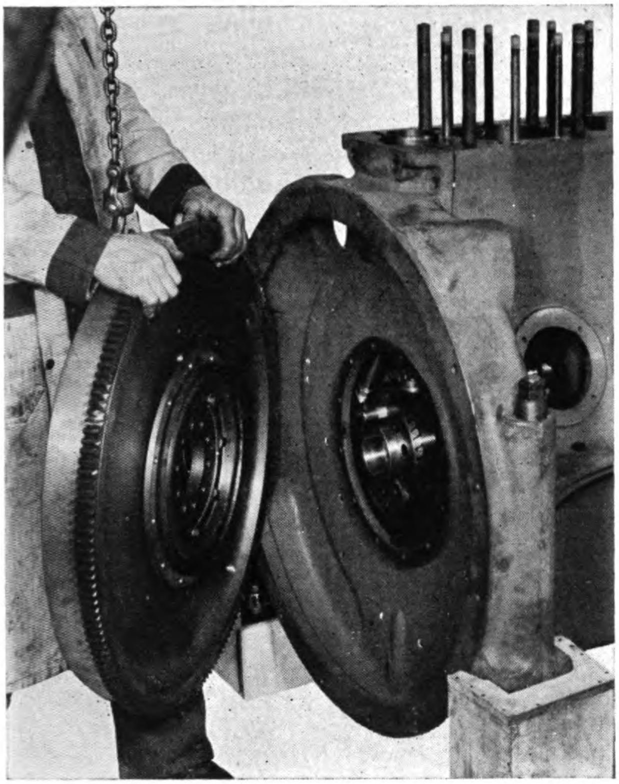


FIG. 46—Installing Flywheel and Gear Ring Assembly

1. In order to insure that the flywheel will always be mounted to the crankshaft in the proper relation, the holes in the flywheel and crankshaft are not all symmetrical. When No. 1 piston is on top dead center and the timing hole in the rim of the flywheel is at the top, the lowest capscrew hole will be found to be 1/16″ closer to the center of the flywheel than the others.

2. Before the flywheel is assembled to the crankshaft, an inspection of the circular gasket between the stationary circular oil ring and back of the flywheel housing should be made. If it is not in perfect condition, it should be replaced to prevent oil leaking out of the bottom of the flywheel housing while running.

3. After the ten capscrews have been firmly drawn up the twelve capscrews with washers should be assembled, into the stationary oil ring that bolts to the crankcase, being careful not to drop lock washers down behind the wheel.

Flywheel Housing

1. Remove flywheel and starter.

2. Drain engine oil and support rear of engine under oil sump.

3. Remove all capscrews holding the housing to the crankcase, oil sump, and cylinder head, including the two capscrews inside the housing.

4. Drive out the two dowel pins locating the flywheel housing with the crankcase.

5. Remove the flywheel housing.

BEVEL GEAR ADJUSTMENT

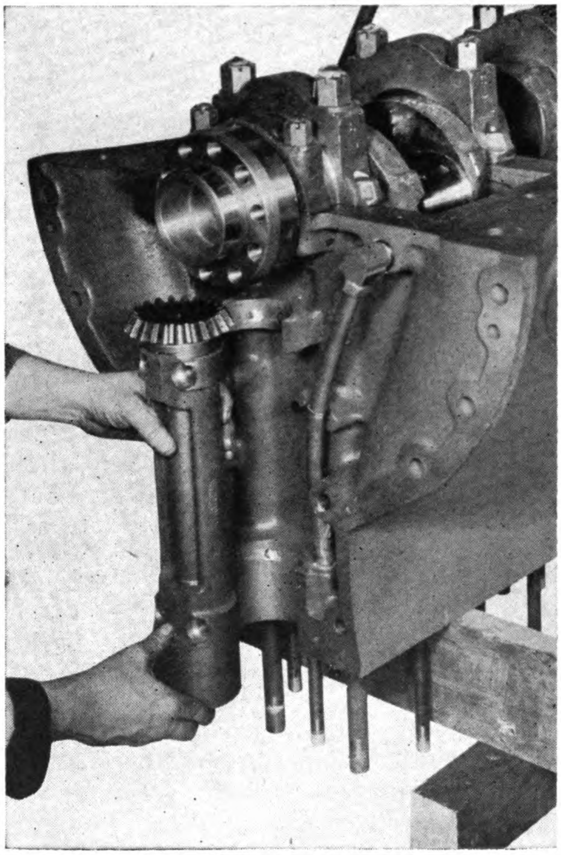


FIG. 47—Installing Pinion Assembly

The back of the tooth faces of the bevel gear pinion should be in line, or flush. When the original parts are being replaced there should be no change necessary in the adjustment of either the bevel pinion or gear. When a new gear and pinion are installed in the engine and it is necessary to adjust the pinion vertically, refer to Bevel Pinion Assembly for procedure.

As it is necessary to check the clearance between the teeth when the flywheel is off, spacers should be used on the capscrews to hold the gear tight against the shims. When the gear is put in place, make certain that the mesh of the teeth of the gear and pinion are in accordance with the markings, also, that the 1/16″ off-center holes are in line.

If the gear is tight on the crankshaft, screw two 3/8″ x 16 capscrews into the two tapped holes in the gear to force the gear off.

The piston of No. 1 cylinder should be placed on top dead center before the flywheel is removed and before the bevel gear is unmeshed from the bevel pinion. It should be remembered that the engine cannot be turned over after the bevel gear is unmeshed from the vebel pinion as the pistons will interfere with the heads of the open valves and the valve stems will be bent.

The clearances between the teeth of the bevel gear and the bevel pinion should be .004″ to .006″ when the crankshaft is forced toward the front end of the engine. The clearance should be checked with a feeler gauge between the teeth, and adjusted by removing or adding thin brass shims between the hub of the gear and the flange of the crankshaft.

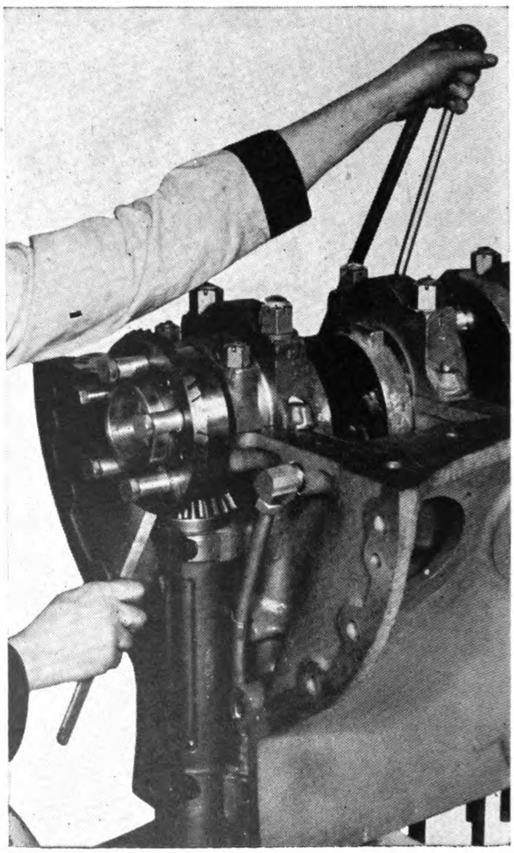


FIG. 48—Method of Checking Clearance Between Bevel Gear and Bevel Pinion. (Note that crankshaft is forced toward front of engine.)

BEVEL PINION ASSEMBLY

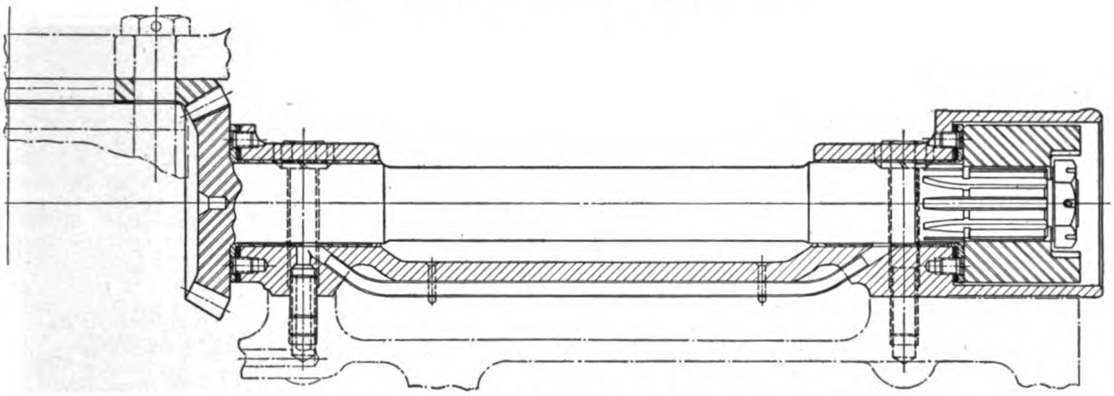


FIG. 49—Cross Section of Bevel Pinion Assembly

1. Remove camshaft housing, cylinder head, flywheel, bevel gear and flywheel housing.

2. Remove four capscrews holding the bevel pinion bearing cage to the crankcase.

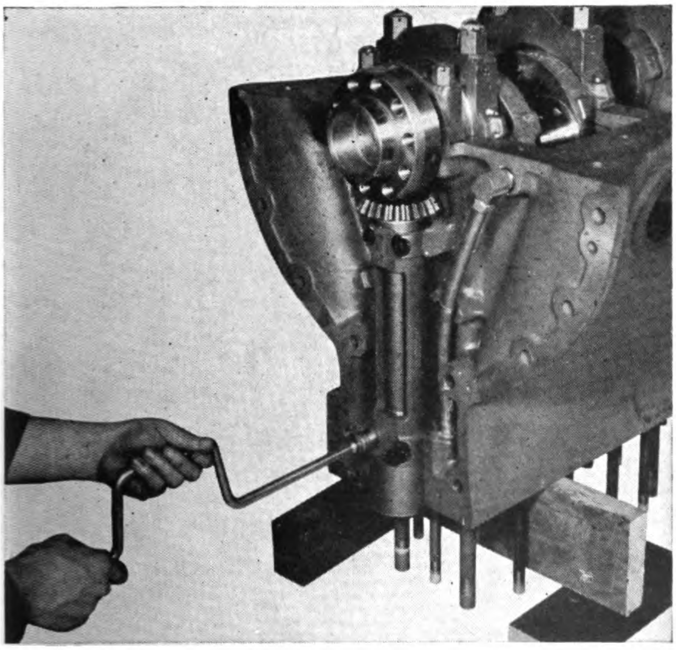


FIG. 50—Installing Pinion Assembly

3. Remove cotter pin and nut on end of pinion shaft, and take particular care to note markings on the end of bevel pinion shaft and the end of the coupling to assure assembling in exactly the same position.

4. Pull coupling from shaft with the special puller furnished in the tool kit.

5. Between the bronze thrust washers, one of which bears against the bevel pinion on the lower end and the coupling on the upper end is a stack of shims. These shims permit adjustment of the necessary clearances and vertical position of the bevel pinion by removing shims from one end and adding them to the opposite end, the pinion is either raised or lowered. By removing thin shims the adjustment of the play between the pinion shaft and the thrust bearings should be maintained at from .004″ to .006″ when the coupling is pulled down tightly into place. The shims are made in different thicknesses to make it easier to properly adjust this clearance.

6. When placing coupling on pinion shaft, select the proper spline so that timing marks will line up.

7. When replacing the assembly in the crankcase, draw down all four capscrews evenly, being certain that the pinion shaft will spin freely in its bearings after the final tightening.

CAMSHAFT HOUSING ASSEMBLY AND WORM GEARS

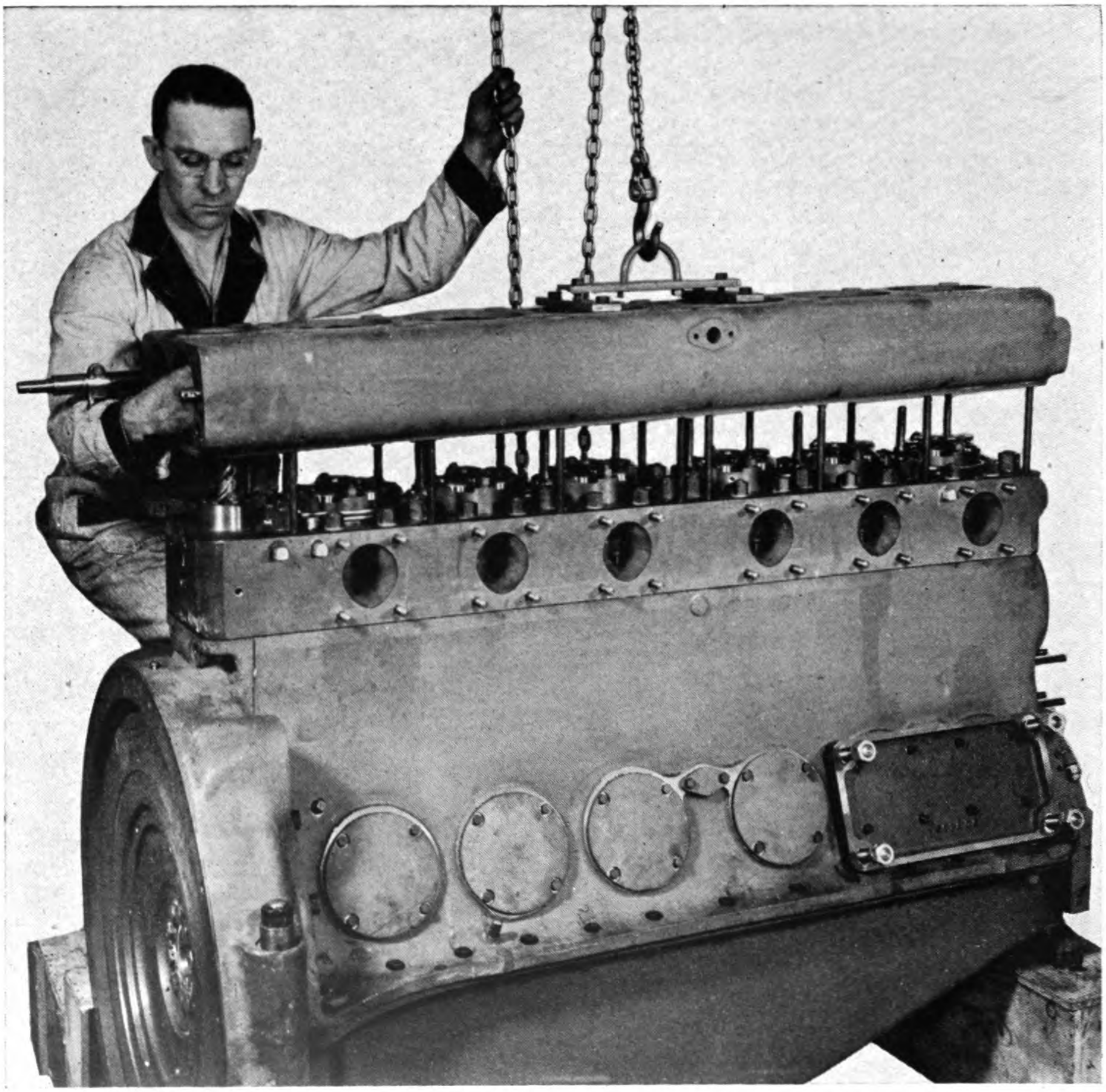


FIG. 51—Installation of Camshaft Housing Assembly

Removing Camshaft Housing

1. Remove valve covers on top of engine and remove injectors.
2. Remove camshaft drive cover and ball bearing on top of worm at rear of engine.
3. Remove radiator braces and all cap nuts and copper gaskets on top of camshaft housing.
4. Unhook the two springs attached to the controls at the rear of the engine.
5. Clamp the lifting straps furnished in the tool kit to the top wall of the camshaft housing at the two center cylinders. Then connect the top straps with the longer strap containing the U-bolt, using the capscrew furnished in the top lifting strap. Raise the camshaft housing with a small chain hoist or block and tackle, making sure it is kept level until the worm gears are unmeshed.

CAMSHAFT HOUSING ASSEMBLY AND WORM GEARS—(Cont'd)

CAUTION:

Do not use rope or chain to lift camshaft housing as it is likely to bend governor fuel control cross bars.

Valve Timing When Replacing Camshaft Housing

1. Clean the top surface of the cylinder head and the bottom surface of the camshaft housing and replace the camshaft housing gasket. Use only one gasket. Lock engine on top dead center by pressing down Timing plunger on top of flywheel housing while engine is very slowly turned by hand, until plunger slips into hole in flywheel rim. Turn engine from flywheel end or use screw driver through starter hole cover on exhaust side of engine to turn ring gear.

2. Rotate camshafts in housing until timing marks on camshafts line up with the center of the lower inside capscrew that holds the thrust collar in place. (Timing marks on the camshafts are found toward the rear of the engine right next to the camshaft thrust collars through opening of No. 6 valve cover.)

3. Carefully lower housing, keeping it level at all times, and at the same time check the rocker arms to see that they are held up in their correct position and do not drop down and interefere.

4. Thread the bronze worm gears onto the worm and lower housing into position.

5. Be sure the dowel locating the camshaft housing on the cylinder head at the front of the engine is in place in the cylinder head, and also that the camshaft housing locates correctly on the worm bearing cage at the rear of the engine.

6. Pull the camshaft housing down into place with four cap nuts and check to see that the timing marks on the camshaft and on top of the camshaft thrust collars now line up with the engine locked on top dead center. If marks line up properly, replace copper gaskets on studs, using only perfect gaskets and draw camshaft housing down against the cylinder head. These gaskets seal against engine oil pressure, so must always be replaced in perfect condition.

7. Replace springs on control set at rear of engine. Replace worm ball bearing and worm drive cover and tighten down into place. Engine should not be started with this off. Release timing plunger from flywheel by pulling up until it snaps into the out position. Replace and draw down into position all injectors except one.

8. Set valve clearance .012″ to .015″, starting on the cylinder without the injector. See "Valve Adjustment" Section.

Installing Rocker Arms

1. Remove control set, governor, and injectors.

2. Lift camshaft housing and block up as high as possible without unmeshing worm gears with worm.

CAMSHAFT HOUSING ASSEMBLY AND WORM GEARS—(Cont'd)

Installing Rocker Arms—(Cont'd)

3. Remove pipe plug from end of rocker arm shaft on side opposite governor.

4. Remove two rocker shaft locating screws found on the outside of camshaft housing toward the rear end and lower side of housing.

5. Screw a piece of 3/8" standard pipe with suitable handle into end of rocker arm shaft and pull out shaft (if pipe is not strong enough cut a pipe thread on a piece of 11/16" bar stock.)

6. When rocker arm shaft is put back in, see that arms and springs are in their proper place, and locate shafts so that hole will line up with end of locking screw. Install shaft in same location from which it was taken. Replace pipe plug in end of the rocker arm shaft on side opposite governor. The shaft on the governor side is left open.

7. Replace control set and governor and make all necessary connections of tubing, wires and throttle control.

8. Readjust valve clearance as explained under "Valve Adjustment."

Installing Camshaft Worm Gears

The worm gears on the end of the camshafts are composed of bronze cast into a steel hub, and are held on the camshaft with a taper fit and Woodruff key. The engine is first timed as explained below, then a keyway is cut in the gear hub in the correct location, using a special keyway cutter, obtained from the manufacturer. The following tools should be on hand when the job is started:

A. Bevel protractor and straight edge.

B. Fixture or bar with shaft in one end and hole in the other end to be clamped to front end of camshaft to permit camshaft to be moved endwise without turning.

C. Rocker arm shaft puller—a piece of 3/8" pipe, threaded on one end and with a suitable handle.

D. A flat washer 2¾" outside diameter, ¼" thick, with a 25/32" hole, to be used to hold the gear on the camshaft when locating the keyway. Another flat washer 1½" outside diameter, ¼" thick, and with a 25/32" hole to use in place of a lock washer on the capscrew when pulling the gear onto the camshaft. A heavy piece of bar stock 3" outside diameter, 1" thick or more, and with a 2-5/16" counterbore 9/16" deep, to be used to drive the gear into place on the camshaft.

E. A gear puller consisting of a bar 1" thick with a large enough hole in the center so it may be slipped over the camshaft, behind the gear, and with holes in either end spaced to clear the outside diameter of the gear; another bar 1" thick with holes spaced in its outer end to line up with the two holes in the other bar; two ¾" bolts with long S.A.E. threads and some cylindrical spacers to be placed between the outer bar and the end of the camshaft.

F. Keyway cutter obtainable from the Manufacturer or Dealer.

CAMSHAFT HOUSING ASSEMBLY AND WORM GEARS—*(Cont'd)*

Installing Camshaft Worm Gears—*(Cont'd)*

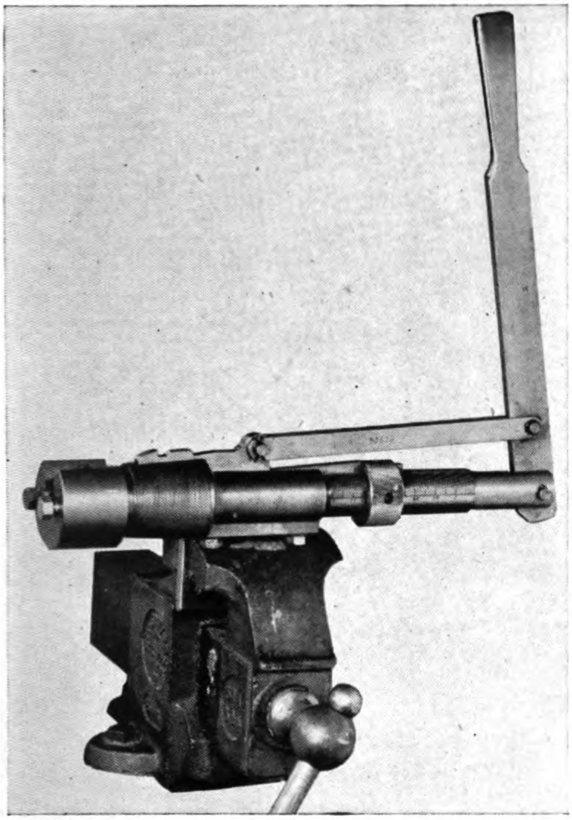


***FIG. 52—Special Tool Used to Cut Keyway in Worm Gears.* (This can be done with any other machine capable of cutting a keyway.)**

1. Remove governor and control set. Lift camshaft housing and block up high enough so that the worm gears are out of mesh with the worm.

2. Remove plug from rear end of rocker arm shaft, remove two rocket shaft locating screws from outside of camshaft housing (one from each side). Pull rocker arm shafts with puller.

3. Remove capscrews from split camshaft thrust collars and keep halves tied together.

4. Remove camshafts from housing.

5. Pull off worm gears with puller or suitable press. Do not interchange inlet and exhaust camshafts.

6. Slip camshafts back into housing and lower camshaft housing on to cylinder head. Be sure camshaft housing gasket is in place. Hold down camshaft housing with a few cap nuts.

7. Locate engine on top dead center by use of the timing plunger in the flywheel housing.

8. Attach the camshaft holding fixture to the front end of the camshaft by use of a capscrew in the end of the camshaft. Leave the capscrew slightly loose so that the camshaft may be turned.

9. Turn the camshaft until the flat portion of the fuel injector cam on No. 1 cylinder (Farthest from the flywheel) faces upward and toward the center line of the engine. Then with a gauge, or bevel protractor and straight edge, set this flat cam surface to make an angle of 25° with the top surface of the camshaft housing as indicated in illustration. Lock the camshaft holding fixture securely and then recheck the angle. The end of the steel scale should rest squarely on the flat of the cam.

CAMSHAFT HOUSING ASSEMBLY AND WORM GEARS—*(Cont'd)*

Installing Camshaft Worm Gears—*(Cont'd)*

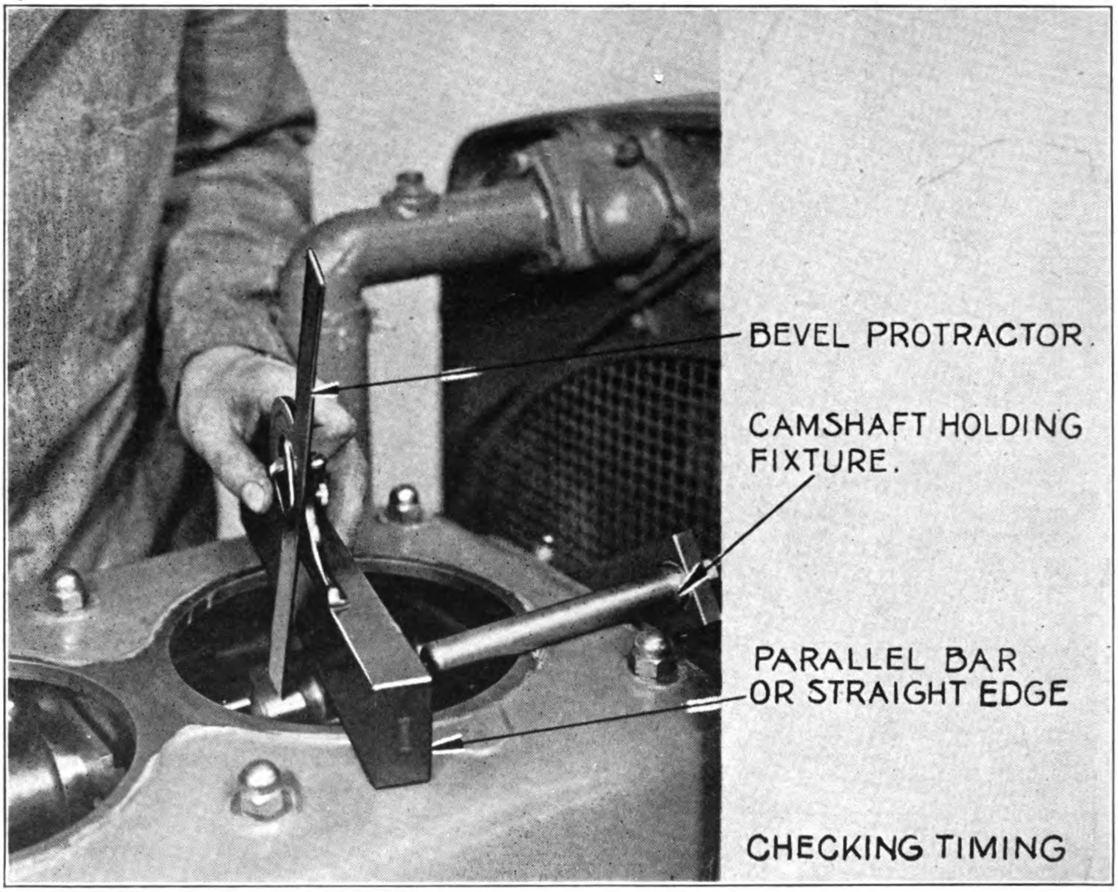


FIG. 53—Checking Injector Cam Angle with Protractor and Square Bar

NOTE: The bevel protractor should be set at 65° when checking the angle of the injection cam with the end of the scale of the protractor to get 25° between the face of the cam and the top surface of the camshaft housing. If one camshaft gear only is replaced, set the angle the same as the opposite camshaft.

10. Next slip the worm gear onto the tapered end of the camshaft and in mesh with the worm. Hold the gear loosely on the shaft with the bolt from the end of the camshaft, and a flat washer ($2\frac{3}{4}''$ outside diameter, $\frac{1}{4}''$ thick, $\frac{25}{32}''$ hole in the center). Then adjust the position of the camshaft and gear until the bronze gear and steel worm mesh correctly. With gears meshed correctly, there should be a gap of $\frac{1}{16}''$ from the rear camshaft bearing to the worm gear. When this position is found, tighten the capscrew sufficiently to keep the gear from moving on the camshaft. Then check to see if the holding fixture on the opposite end of the camshaft is resting on top of the camshaft housing, and recheck to make sure the gears are meshing correctly. Now carefully remove the capscrew and washer that holds the gear in place, and mark the keyway location on the worm gear, using the marking tool furnished with the keyway cutter.

CAMSHAFT HOUSING ASSEMBLY AND WORM GEARS—(Cont'd)

Installing Camshaft Worm Gears—(Cont'd)

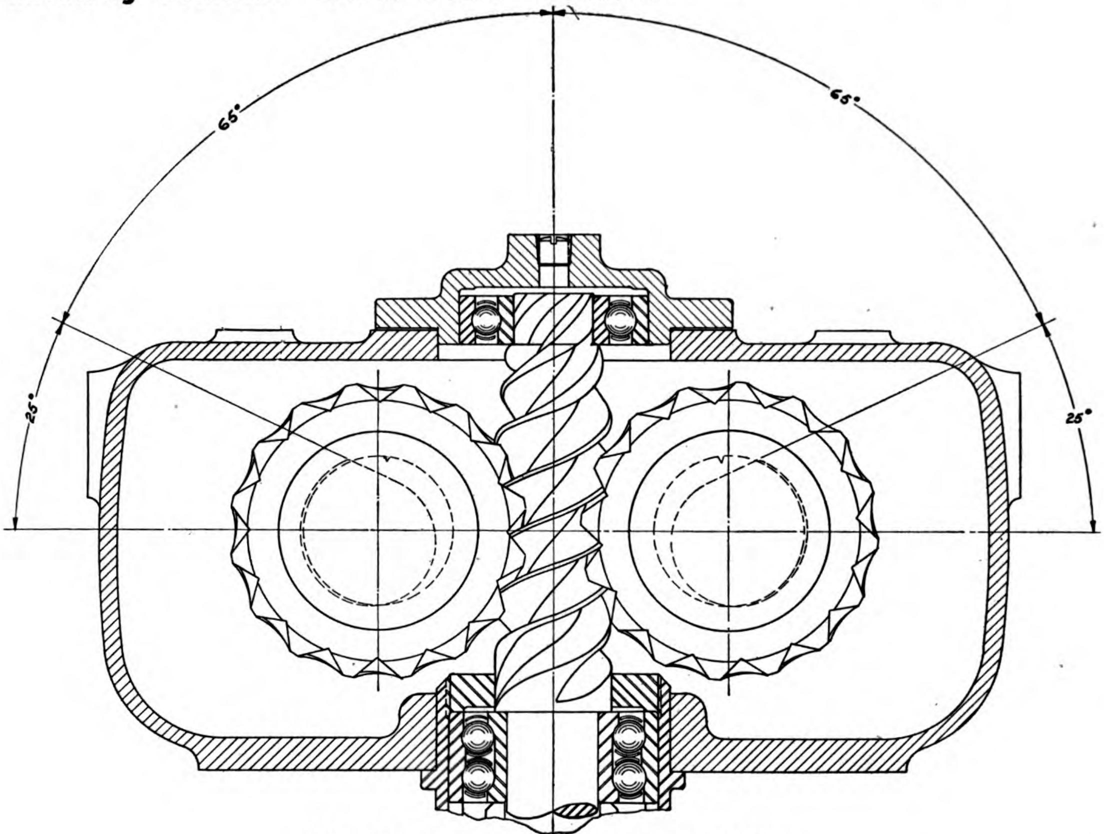


FIG. 54—Proper Injector Cam Angles

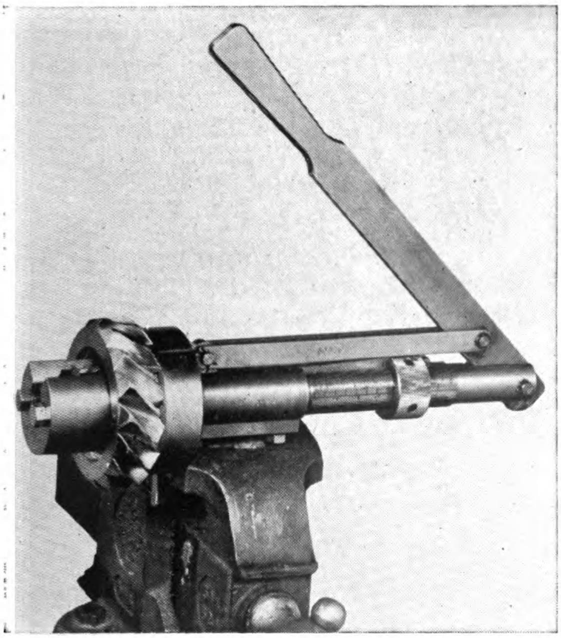


FIG. 55—Cutting Keyway in Worm Gear

11. Remove marked gear and cut keyway with special keyway cutter mounted at side of the camshaft housing or held in a bench vise. Remove two capscrews from the end of the cutter opposite the handle and insert the gear on the tapered end, carefully lining up the keyway marking to insure cutting the keyway in the right place. Back off the feed nut on the cutter until the cutting tool will pass through the gear, then gradually advance the feed until the tool starts cutting. Note and record the reading on the graduated scale. Start cutting the keyway with the handle toward the gear. Then advance the feed nut about half turn, and pull the handle back to make a cut. Use cutting oil on the cutter, and remove the chip from the tool after each cut. Always slide the tool back through the gear before advancing the feed nut, or the cutting edge of the tool will be ruined. Continue cutting until the feed nut has advanced 42 graduations from the starting point which you previously recorded.

CAMSHAFT HOUSING ASSEMBLY AND WORM GEARS—*(Cont'd)*

Installing Camshaft Worm Gears—*(Cont'd)*

12. Try the Woodruff key in the keyway in the gear and if it will not enter, cut it down with emery cloth until it will slide in the keyway. The key should fit tight in the camshaft.

13. Remove the camshaft from the engine and hold it in a vise equipped with copper jaws to prevent damaging the shaft when installing the gear. If the gear is placed in boiling water for a few minutes, the assembly will be easier. Place the gear on the camshaft and pull it into place with the flange and capscrew used to hold the gear onto the camshaft, first being sure to place a plain flat washer under the head of the capscrew, and coat the threads with white lead. Pull up on the capscrew until it is tight, then support the camshaft upright on a solid piece of wood. Place on top of the gear a heavy piece of steel with a counterbore to clear the inner ring of the flange and capscrew, and use a hammer to drive the gear into place against the shoulder on the camshaft. Again tighten the screw and alternate tightening and pounding until the gear is in place against the shoulder. Use a thin feeler gauge to make sure the gear is in place. Remove the plain washer from under the head of the capscrew and replace with a lockwasher.

14. Replace camshafts, camshaft thrust collars, rocker arms, rocker arm shafts, rocker shaft locating screws, and pipe plug in the end of the rocker arm shaft on the control set side.

When the rocker arm shafts are installed, see that they are put back in the same location from which they were taken, and so that the small oil holes drilled into the shafts register with the holes drilled into the bearings of the camshafts, and that the large oil hole near the end of the shaft registers with the oil hole in the rear support of the rocker arm shaft. It should be remembered that the path of the oil is from the rear support of the rocker arm shaft, through the hollow rocker arm shaft, through small holes in the rocker arm shaft to drilled holes leading to the camshaft bearings. When the engine is first started, see that oil is delivered to the cams.

Worm Assembly

The steel worm that meshes with the bronze camshaft gears is supported in a steel bearing cage pressed into the rear end of the cylinder head. Two double row ball bearings are located in the steel cage and a single row ball bearing in the cover plate on top of the camshaft housing. Remove the cover plate to inspect the top bearing, then put the control lever in the stop position and turn over the engine on Diesel compression with the starter. Worn bearings in the cage, a loose cage, or a loose nut on the end of the worm will be indicated by the worm jumping up and down. To repair proceed as follows:

1. Remove camshaft housing and cylinder head.

2. Remove the cotter pin and take off the nut from the end of the worm shaft. To keep the worm from turning while removing the nut, clamp the worm between two pieces of wood or suitable soft jaws which will not mar the worm, or use two wrenches to hold the tangs at the end of the splined coupling. Note the markings on the end of the worm shaft and end of splined coupling, as the coupling must be replaced on the shaft in the identical position from which it was removed.

CAMSHAFT HOUSING ASSEMBLY AND WORM GEARS—*(Cont'd)*

Worm Assembly—*(Cont'd)*

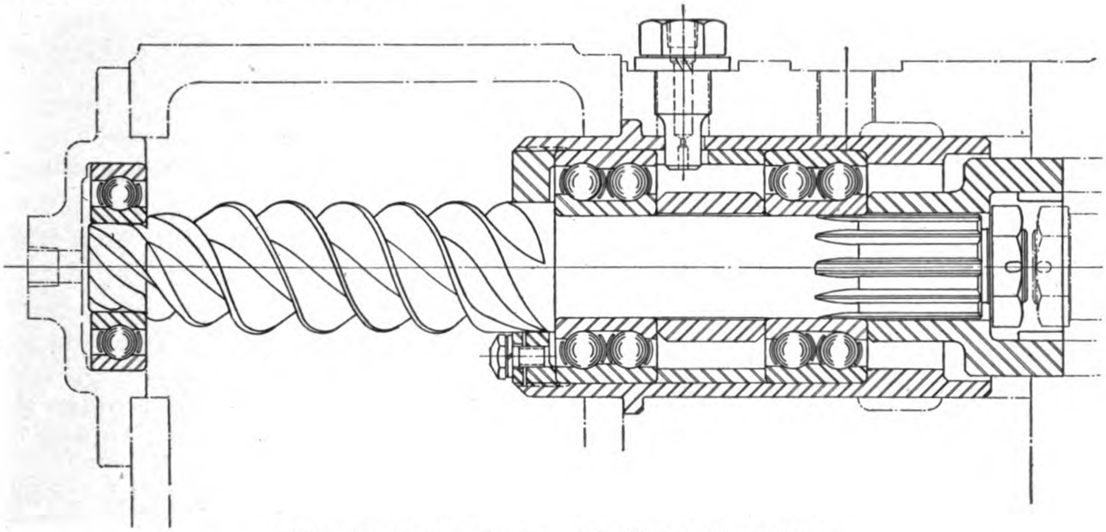


FIG. 56—Cross Section of Worm Assembly

3. Pull coupling from end of shaft with puller furnished in the tool kit. Press worm shaft out of bearings. If press is not available, carefully drive out worm using a small hammer to prevent damaging the bearings. Hold a piece of soft material on the end of the shaft to prevent damaging the threads.

4. Remove the large nut from the top of the worm bearing cage, first being sure to remove the $\frac{5}{16}$" lock screw.

5. Remove the oil line leading to the worm bearing cage at rear end of cylinder head, then remove screw which locates worm bearing cage. The two double row bearings and two bearing spacers may now be removed through the top of the cage.

6. The double row ball bearings are specially selected, and should be replaced only with bearings obtained from the manufacturer. When assembling the bearings in the housing, be sure that the faces on which the name is stamped are placed next to the two bearing spacers. If in an emergency it is necessary to use bearings other than those supplied by the manufacturer, check to make sure the faces of the inner and outer race on the side next to the spacers line up exactly. Lay a scale or straight edge across the inner and outer races to check. Screw the large retaining nut down securely and lock it in place with the $\frac{5}{16}$" lock screw. Make sure the hole in the outer spacer lines up with the hole in the steel bearing cage. Try turning the inner races of the bearings to make sure they turn free after tightening the nut.

7. Press the steel worm shaft through the bearings, and assemble the splined coupling on the end of the shaft, taking care to see that the markings register as before disassembling.

8. Replace the worm bearing cage locking screw and the oil line attached to the screw. The ball bearing on top of the worm fits snugly, but can be pushed onto the worm by hand.

NOTE: If a new steel worm is installed it is advisable to install new bronze worm gears at the same time. If, however, the old bronze gears are used, it will be necessary to retime the engine. Usually it is necessary to remove the bronze worm gears and retime the camshafts. See "Installing Camshaft Worm Gears."

CYLINDER HEAD, VALVES, AND INJECTOR TUBING ON CYLINDER HEAD

Removing Cylinder Head

1. Remove camshaft housing.
2. Remove air inlet manifold and exhaust manifolds to facilitate handling.
3. Remove all outside tubing connections and wiring interfering with removing the head.
4. Remove thermostat housing at front of head.
5. Remove all tie bolt nuts and cylinder head stud nuts from the top of the cylinder head, also the two capscrews from underneath the cylinder head at the top of the flywheel housing. It is not necessary to remove the tappet guides and the nuts that retain them, nor the connecting tubing on top of the cylinder head to take the cylinder head off.

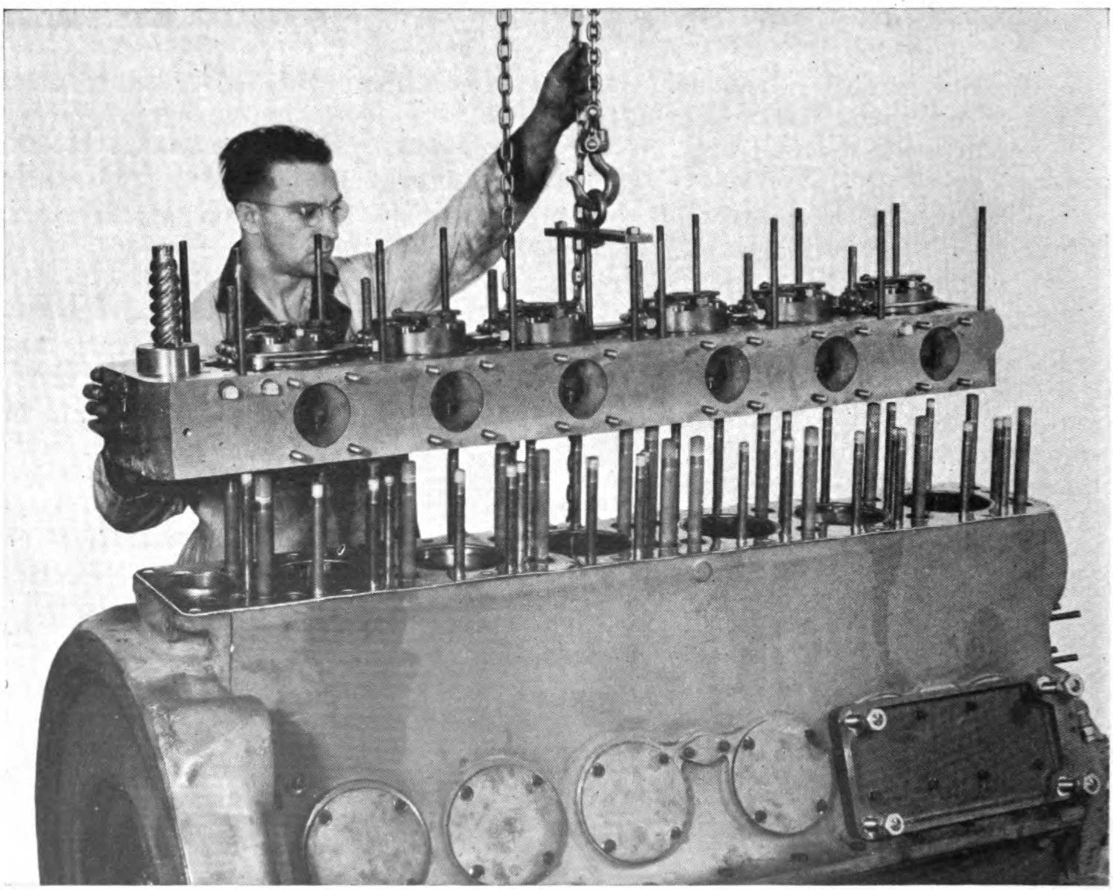


FIG. 57—Installing Cylinder Head Assembly

6. To lift head, place lifting strap with U-bolt cross-wise of head over the rear pair of the four long studs at the center of the head, and hook small chain hoist or block and tackle over U-bolt.
7. Remove the cylinder head gasket, wipe clean, and lay flat or hang up until ready for use again. Keep gasket dry at all times.

CYLINDER HEAD, VALVES, AND INJECTOR TUBING ON CYLINDER HEAD—(Cont'd)

Replacing Cylinder Head

1. Clean all surfaces on top of engine block carefully and apply some No. 2 Permatex at the outer edges of the joint between the bell-housing and the engine block.
2. Clean the head gasket and replace exactly as it was before being taken off.
3. Lift the head on to engine and lower carefully. Turn worm so that tang of coupling will enter slot as head is being lowered. This coupling can be put together in either position.
4. Tighten all cylinder head nuts on tie bolts and cylinder head studs securely as they cannot be drawn down after camshaft housing is in place.

Valve Adjustment

The Murphy Diesel engine has four valves per cylinder, which are operated by over-head camshafts. The operations of checking clearances and adjusting each 1000 hours are easy, on account of the unusual accessibility.

To adjust valve clearances, remove only the injector from the cylinder on which the valves are to be adjusted, as explained under "Injectors." Turn the engine so that the high point or nose of the cams points up, away from the valves that are to be adjusted. Set the control lever in the Diesel running position. Loosen the lock nut, and with a screw driver adjust the clearance between cam and rocker arm from .012 to 015 inches, and securely tighten the lock nut. Use feeler gauges furnished in the tool kit. The clearance should again be checked, after tightening the lock nut. Adjust all the valves of one cylinder, replacing the injector before proceeding with the next cylinder.

When the valves are adjusted, it is highly important that only the injector be removed from the cylinder on which the valves are to be adjusted, and all other injectors tightened down. If an attempt is made to adjust the valves with all the injectors out, when they are replaced and tightened down, the valve clearance will be reduced below the minimum for proper operation because of the force of the heavy springs in the injectors seating the camshaft in its bearings.

The control lever must be placed in the Diesel operating position when checking clearance and adjusting valves, as the intake valves are held off their seats when the lever is located in the upper position to relieve the high compression for easy turning, and must be returned to the Diesel running position when checking clearance and adjusting valves.

Grinding Valves

It is seldom, if ever, necessary to grind the valves except at the time the engine receives a major overhaul, because of the high amount of alloy in the steel from which the valves and valve seat inserts are made, the seats will show a spotted appearance which indicates good seating and that the valves are holding properly. These spots are not pits as indicated in other valves and do no harm.

CYLINDER HEAD, VALVES, AND INJECTOR TUBING ON CYLINDER HEAD—*(Cont'd)*

Grinding Valves—*(Cont'd)*

1. Remove camshaft housing and cylinder head.

2. Remove fuel tubing and tappet guide assemblies from the cylinder head. Note markings on tappet guides as they must be replaced in the same position and order as removed. Lay cylinder head on its side.

3. To compress valve springs so that valve spring keepers may be removed, use the two cast iron plates and long bolt furnished in the tool kit. Place plain plate on heads of four valves and notched plate on top of the valve spring seats, and draw together with bolt to compress springs.

4. Mark valves so they may be replaced exactly as removed. The exhaust valves have thick heads and the inlet valves have thinner heads. Take care to see that valves are replaced in their correct position.

5. Clean carbon from valves, valve guides and inside of ports.

6. If ridge appears on face of valve and valve seat, remove ridge on valve by refacing and reseat valve insert with suitable cutter.

7. A fine grinding compound and the grinding tool found in the tool kit should be used when grinding valves. Place a light spring on the valve stem under the head to unseat valve during grinding operation, rotating valve only a short arc at a time.

8. Wash all parts thoroughly and apply a small amount of light oil to the valve stems before inserting into the guides. Always replace the wire snap ring retainers to prevent the valves from falling into the cylinders in case of valve spring breakage. When assembling the locks, be sure they seat properly around the valve stems and in the spring washers. Assemble tappet guides and fuel tubing to cylinder head, making sure tappet guides are in the same position and order as when removed. Check tubing and connections for leaks as described under "Testing for Fuel Leaks of Injector Connections and Tubing on Cylinder Head."

9. Replace cylinder head and camshaft housing.

10. Adjust valve clearance from .012 to .015 inches as previously explained. After a few hours of operation, tighten up nuts on top of camshaft housing and recheck valves for clearance.

CONNECTING RODS, PISTONS, AND CYLINDER LINERS

Removing Rod Bearings

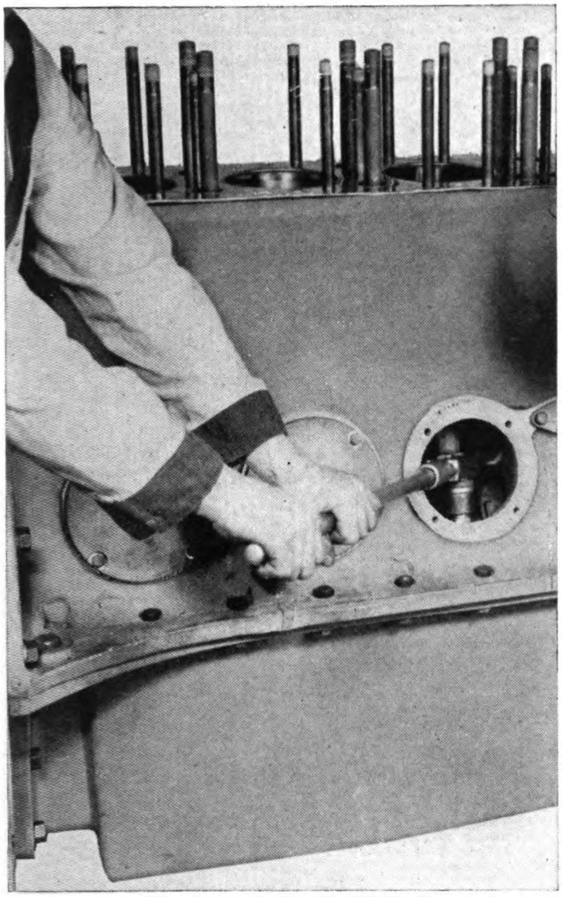


FIG. 58—Tightening Connecting Rod Bolts

1. Connecting rod bearing shells are interchangeable and require no fitting. To inspect, remove air cleaner oil cup and hand hole covers from both sides of crankcase, including generator bracket.

2. Turn engine until connecting rod nut is near the center of the handhole. Remove nut, then turn engine until the other nut can be reached from hand-hole on opposite side. (Do not partially remove one nut and turn the engine, as the nut will hit the cylinder liner.)

3. Tap lightly on top of connecting rod bolts to loosen the cap from the dowel pins. Pry connecting rod up and remove upper shell. When top side of crankshaft journal is set approximately level with lower edge of hand-hole, the connecting rod cap can be easily removed from the crankcase.

Replacing Rod Bearings

1. Clean oil holes in crankshaft and connecting rod.

2. In replacing shells, see that PROJECTION ON EDGE OF SHELLS FITS INTO RECESS IN ROD AND CAP. Apply film of oil before replacing cap.

3. Replace cap and tighten connecting rod nuts. The dowels in the cap are offset to prevent incorrect assembly. To insure the correct amount of tightening, draw up nuts snug until sure cap is seated squarely and in place, then tighten from 1 to 1½ flats on the nut. Do not tighten more than 1½ flats. Pull up nuts slightly past the cotter pin hole, then back off to line up with cotter pin holes. Use new cotter pins.

4. A check to see if the bearing is correctly assembled can be made by testing the end play of the rod on the crankshaft by hand. The rod should move perfectly free, if assembled correctly.

WARNING

A minimum clearance of .006″ is absolutely necessary. A closer fit may ruin the crankshaft. NEVER file bearing cap, connecting rod or bearing shells. Replace with new bearing shells if worn or damaged.

CONNECTING RODS, PISTONS, AND CYLINDER LINERS—*(Cont'd)*

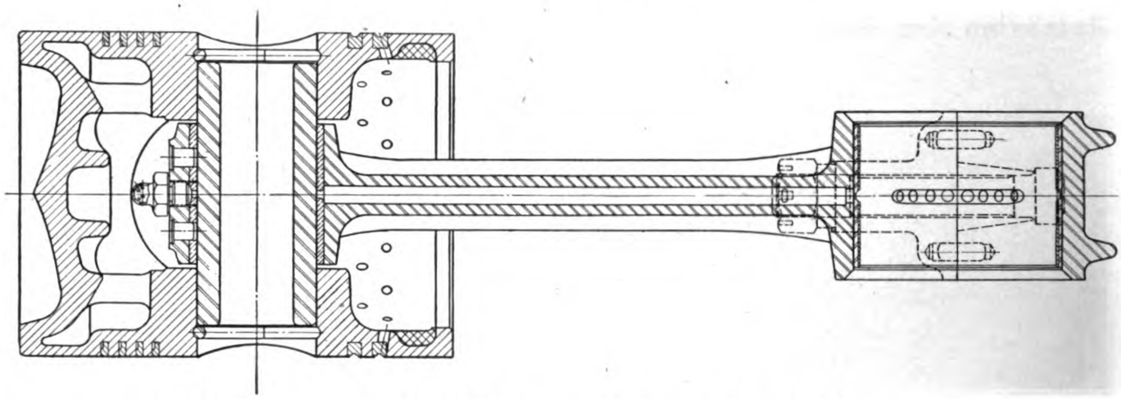


FIG. 59—Cross Section of Piston and Connecting Rod Assemblies

Markings on Pistons and Rods

Pistons are numbered on top for each individual cylinder, and No. 1 should be placed in the cylinder next to the radiator. The piston should be assembled in the engine with the number toward the radiator. The connecting rod and cap are stamped with matching numbers which also serve as position numbers in the engine. The connecting rod should be assembled on the crankshaft in the proper order, or with No. 1 starting at the radiator end with the numbers on the left side of the engine when viewed from the flywheel end. When assembling the connecting rod to the piston with the number on the piston to the left, the numbers on the rods should be up.

Removing Pistons and Rods

1. Remove camshaft housing.

2. Remove cylinder head and gasket.

3. Scrape carbon from cylinder liner between upper edge of ring travel and top of liner.

4. Remove connecting rod bearing cap and turn crankshaft until piston is up. Pry connecting rod up, taking care not to let it drop back on the crank.

5. Remove piston pin retainer springs and slip out piston pin.

6. Remove piston rings and clean all ring grooves and open all oil drain holes. Be certain that the new rings all fit freely in the ring grooves, and that they have .015″-.020″ end clearance when placed in the cylinder.

7. When replacing the piston on the rods make certain the piston pin retainers have sufficient tension to hold tight in the grooves of the piston. Replace with new retainers if old ones are worn or have lost their tension.

CONNECTING RODS, PISTONS, AND CYLINDER LINERS—*(Cont'd)*

Replacing Pistons and Rods

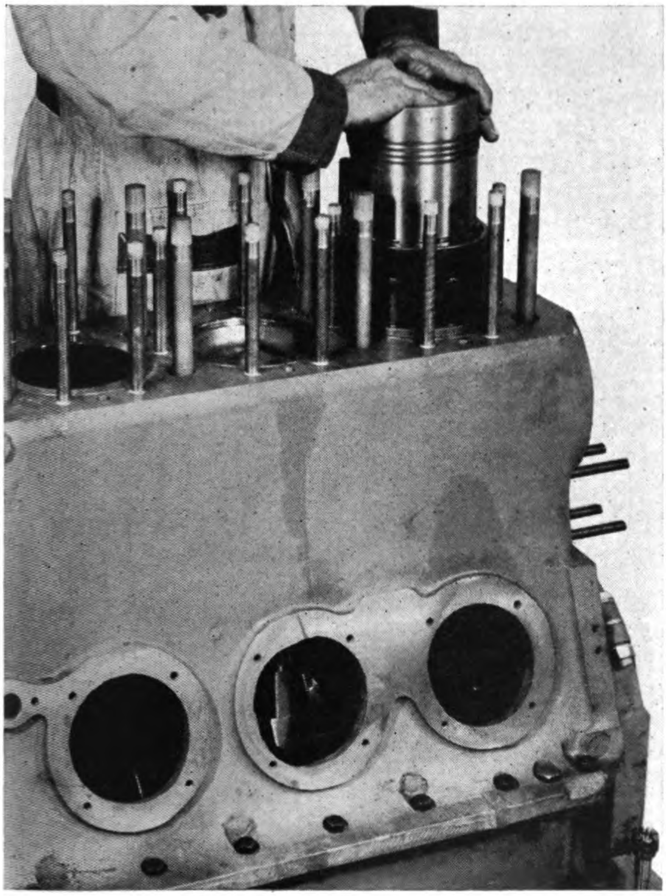


FIG. 60—Installing Piston and Connecting Rod Assemblies

1. First read paragraph on "Replacing Rod Bearings."

2. Turn engine until top of Crankshaft journal is just about even with the bottom of the hand-hole in the crankcase.

3. Clean the cylinder liner inside, and piston, and coat both with oil.

4. Turn the piston rings so that the gaps do not line up.

5. Compress the rings with a compressor or band made from sheet stock, and carefully work the piston into the cylinder from the top, taking care not to break the rings.

6. Hold the connecting rod from the crankshaft journal until the upper bearing shell is located in the rod, with the projection on the edge of shell located into the milled grooves of the rod, before lowering into place.

7. Properly locate the lower bearing shell in the cap and coat with oil before placing the cap in position.

8. After the nuts have been drawn up as explained under "Replacing Rod Bearings," lock in place with new cotter pins.

Pistons and Rings

The oil-cooled pistons have a solid head which is cooled by a spray of oil from a nozzle attached to the top of the connecting rod. When the piston is removed from the rod, check the spray holes in the nozzle and the long drilled hole in the connecting rod to see that all holes are open. Remove any carbon accumulation that may be found inside of the piston where the oil spray strikes. Check the cooling nozzle to see that it is screwed into the rod tight.

The oil cooled pistons will give very little trouble from stuck rings, but under some conditions, usually where an inferior lubricating oil has been used, the rings may become stuck tight in their grooves. This condition is evidenced by an excessive amount of smoke coming from the crankcase breather. Do not run an engine in this condition as the pistons and liners may become scored. Replace the piston rings and check with the factory concerning a suitable oil.

CONNECTING RODS, PISTONS, AND CYLINDER LINERS—*(Cont'd)*

Pistons and Rings—*(Cont'd)*

When installing new rings first clean all carbon from the ring grooves. The correct piston ring end clearance when tried in a new liner or at the bottom of a used liner is .015″ to .020″. RINGS WITH A NOTCH ON THE INSIDE DIAMETER MUST BE INSTALLED WITH THE NOTCH FACING UP TOWARD THE TOP OF THE PISTON.

Cylinder Liners

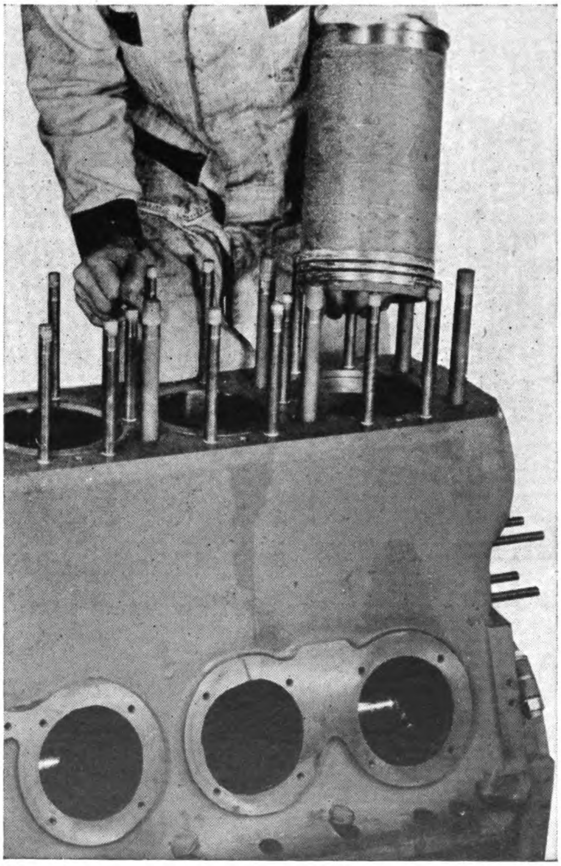


FIG. 61—Installing Liner Assembly

The cylinder liners are made from a high alloy, close grained, hard iron. The flange on the top of the liner seats into the counterbore on the top of the crankcase, making metal to metal contact, and these surfaces must be absolutely clean at the time of assembly. At the lower end of the liner, water is sealed from leaking into the crankcase from the water jacket by two rubber sealing rings located in grooves around the outside of the liner. The outside of the rubber ring should be given a liberal coating of soap and water at the time of assembly. New rubber seal rings should always be installed before a liner is pushed into the crankcase.

When a liner is to be removed, take off the camshaft housing, cylinder head, and remove the pistons and connecting rods. If a suitable liner puller is not available, insert a clean piece of 2″ x 4″ wood in either crankcase hand-hole, and pry the liner up.

MAIN BEARINGS AND CRANKSHAFT

Crankshaft Main Bearings

The main bearing shells are composed of an alloy of copper and lead securely bonded to a steel back. They are sized with extreme accuracy, and are directly replaceable or interchangeable without fitting. They bear against a file hard crankshaft journal. The combination of the copper-lead bearing and a very hard crankshaft journal results in long life without adjustment being required. About the only failure possible would be the burning out of a single bearing directly traceable to stopping up of the oil passage to the bearing, or ruining the bearings through use of a CORROSIVE LUBRICATING OIL.

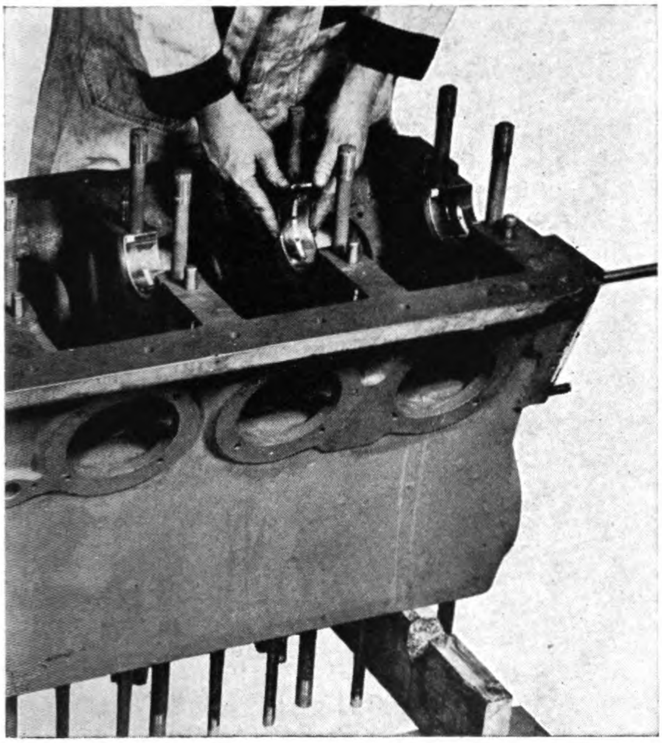


FIG. 62—Installing Main Bearing Shells

Oil is fed to the main bearings through cross channels drilled into the main distributing gallery, terminating in the tie bolt holes. The grooving in the main bearing cap breaks into the tied bolt holes, thereby providing a channel for the oil to be delivered to the crankshaft from the under side of the lower bearing shell. Both upper and lower shells have grooving on the inside and holes through the grooves for the purpose of interchangeability. If the engine is operated with the lubricating oil filters out of place, or out of the engine, sludge containing dirt or carbon will accumulate in these passages, eventually burning out a bearing. Oil passages, both in the crankshaft and crankcase, should be inspected to see if they are open, and blown out with air or oil under pressure whenever a bearing is replaced on account of failure.

Bearing caps are all located in the crankcase with dowel pins to assure proper alignment and replacement when removed.

MAIN BEARINGS AND CRANKSHAFT—(Cont'd)

Removing and Replacing Main Bearing Shells

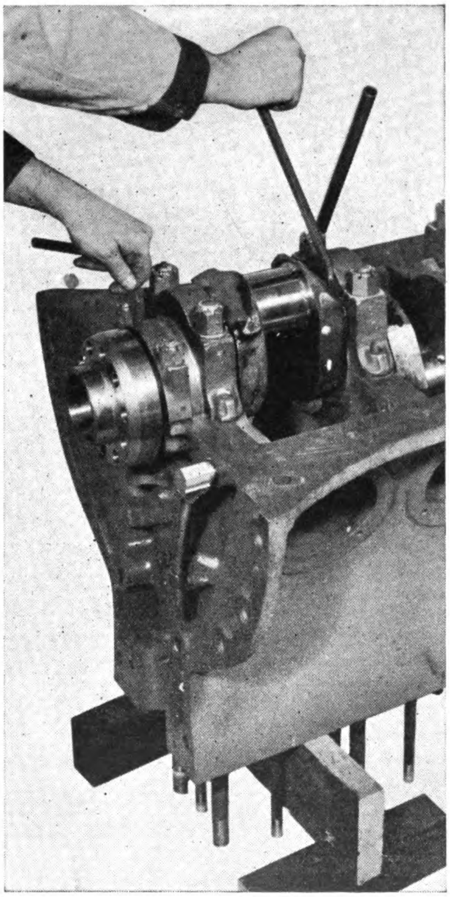


FIG. 63—Checking End Play in Thrust Bearing

1. To inspect a main bearing shell, drain oil and lower oil sump.

2. Remove the bearing cap in question.

3. If upper shell is to be removed, push up on left edge of the shell and rotate the crankshaft in a counter-clockwise direction when viewed from the front of the engine. To remove the upper shell of the rear main bearing, make a brass plug to fit in the crankshaft oil hole. This plug should project out far enough to contact the bearing shell but just miss the bore in the crankcase in which the bearing seats. Turn the crankshaft counter-clockwise to force out the bearing shell.

4. To replace an upper shell in the crankcase, reverse the procedure given above. Clean all crankshaft oil holes and the space around the tie bolts through which the oil is delivered to the bearing. Rotate the crankshaft clockwise when viewed from the front of the engine to assist working the shell into position. MAKE CERTAIN THAT THE LOCATING PROJECTION ON THE EDGE OF THE SHELL FITS INTO THE MILLED RECESS IN THE CRANKCASE.

WARNING:

All bearings must be clean and well oiled before assembled. A minimum clearance of .008″ on all main bearings is absolutely necessary. A closer fit may ruin the crankshaft. NEVER file the bearing caps or shells for adjustment. Replace the new interchangeable shells, if any change is necessary.

5. To definitely check the clearance of a bearing, lay around in the lower bearing shell a piece of tin foil cut $\frac{1}{4}$″ wide and rolled up into a diameter of about $\frac{1}{16}$″, and pull up bearing cap against crankcase to flatten rolled up tin foil. Remove cap and flattened tin foil and measure thickness with micrometers. The reading should be at least .008″. When installing a new main bearing shell, measure the clearance between the flange of the

MAIN BEARINGS AND CRANKSHAFT—(Cont'd)

Removing and Replacing Main Bearing Shells—(Cont'd)

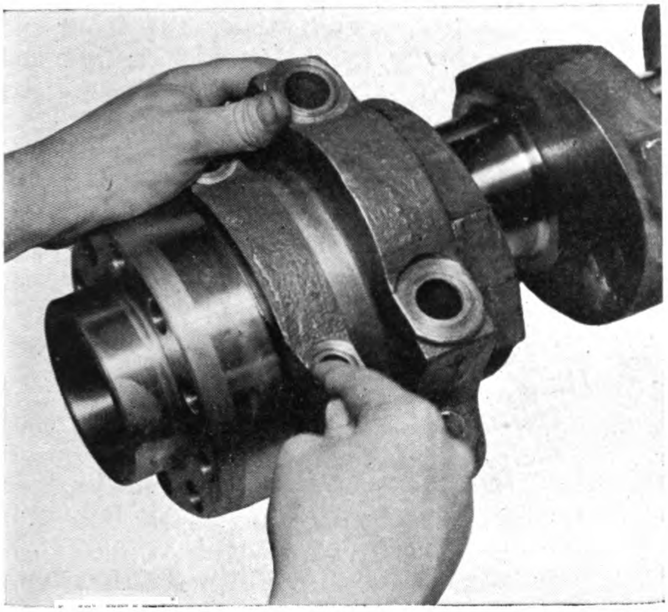


FIG. 64—Checking Rear Main (Thrust) Bearing Before Installing in Engine

shell and cheek of the crankshaft with a feeler gauge to see that there is from .006″ to .009″ clearance.

6. If the front bearing is to be removed it is necessary to take out the inner row of capscrews which hold the front support casting onto the engine. Support the engine at the front end by placing a bar between the crankcase and oil sump and blocking up both ends of the bar.

7. If any of the dowel pins stick in the caps, drive them out and drive them into the crankcase.

8. If the cork seals on the front or rear of the sump are broken or torn off, new ones should be substituted. If the old ones are in usable condition, give them a liberal coating of No. 2 Permatex particularly at the ends of the cork in the corners. If new cork seals are required at the end of the sump, sesure a $\frac{3}{16}$″ x ⅞″ strip of cork for the front and a $\frac{3}{16}$″ x ¾″ strip for the rear. In order to cut them to the right length, lay the cork strip around the lower edge of the front and rear main bearing caps to arrive at the correct measurement. The strips of cork should be slightly longer than the measurement indicates so they will fill the corners and prevent leaks at these points. Attach the seals to the lower edge of the bearing caps by sticking them in place with tacky shellac.

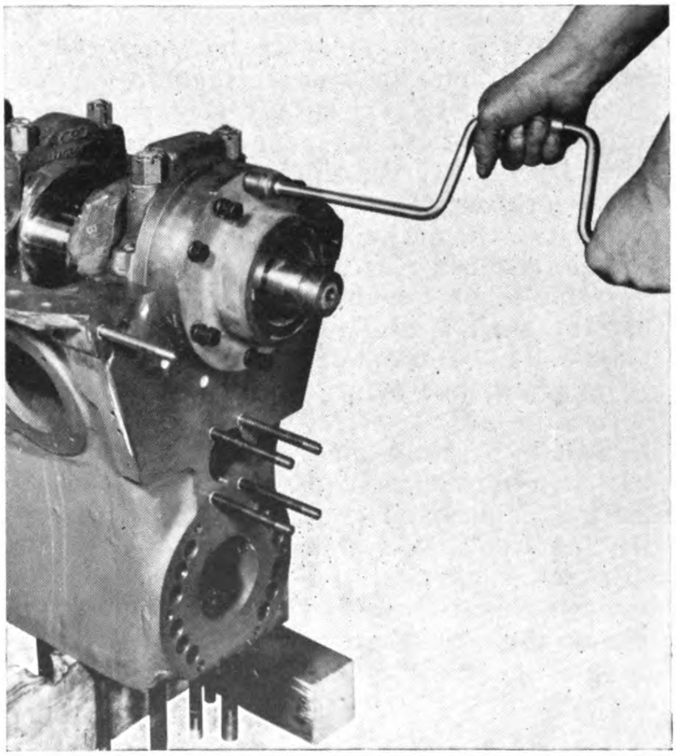


FIG. 65—Installing Front Engine Support and Oil Seal

9. With the aid of four long bolts with long threads, draw the sump up evenly and watch to see that the end cork seals stay in place and are not torn.

MAIN BEARINGS AND CRANKSHAFT—*(Cont'd)*

Crankshaft Front Oil Seal

A leather type seal prevents oil from leaking out along the front end of the crankshaft. This seal is pressed into the front support casting and rides on the hub of the crankshaft pulley.

To install a new seal remove the radiator and crankshaft pulley. Then split the old seal with a chisel to remove. Coat the outside of the new seal with Permatex No. 2 and install with the wiping edge of the leather seal pointing toward the engine. Use a hollow tube or piece of pipe with an outside diameter slightly smaller than the outside of the seal when driving in a new seal.

Crankshaft Replacement

1. Remove air cleaner, injectors, radiator, flywheel and filters.
2. Unscrew connecting rod nuts a turn or two.
3. Turn engine upside down with camshaft housing resting on wood blocking.
4. Remove all parts on the front end and rear end of the crankshaft, including flywheel housing and bevel gear.
5. Unbolt oil sump.
6. Take off the connecting rod bearing caps and push the pistons down into the ends of the cylinders.
7. Pry the main bearing caps up with a small bar placed on the side of the cap and remove the crankshaft.
8. Turn the pinion shaft so that the marks on the camshafts line up with the marks on the camshaft thrust collars.
9. After the crankshaft has been put in place, assemble the rear main bearing cap and check to see that there is at least .006″ end play.
10. With the engine inverted, the lower main and connecting rod bearing shells will have a tendency to drop out of the caps when being put into place. Do not lay the shell on the crankshaft and then try to install the cap as the locating projection on the shell is not likely to enter into the milled slot in the cap. The correct method is to coat the cap with a heavy oil to hold the shell in place when the cap is carefully placed over the studs. The caps should be drawn down evenly with nuts, checking occasionally to see that the shell is still in place in the cap. Do not drive on the caps as the shells will fall out and necessitates removing the caps. After the main bearings are in place, but before the connecting rod bearings are installed, see that the crankshaft is perfectly free and can be turned easily by hand. Crankshaft main bearings must have a minimum clearance of .008″ and the crankshaft a minimum end play of .004″. Read "Removing and Replacing Main Bearing Shells," this section and "Replacing Rod Bearings" Section.
11. Replace flywheel housing. Assemble the bevel gear and flywheel with crankshaft as outlined under "Bevel Gear Adjustment," before the connecting rods are attached to the crankshaft. Check the location of the bevel gear on the crankshaft by inserting a flywheel capscrew in the offset hole of the bevel gear and crankshaft flange, and at the same time see that the teeth on the crankshaft gear and pinion gear are in mesh in accordance with the markings on the ends of the teeth, to assure correct timing of the valves.
12. Replace the front engine support, and other parts on front end of crankshaft.
13. When replacing oil sump, be careful to avoid damaging the cork oil seals at the front and rear of sump. Use Permatex No. 2 where the oil sump gaskets touch these cork strips.
14. Turn engine right side up and complete assembly.

SUPERCHARGER

The supercharger on the right hand forward side of the engine is driven by 5 "B" section belts. The blower proper is mounted on an air intake housing casting which in turn is mounted on adapter plate replacing the two handhole covers for cylinders 1 and 2. Large studs are carried in this adapter plate and by means of nuts inside and outside of this receiver casting the supercharger unit is moved to and from the crankshaft to take care of belt adjustment.

The normal flow of the air is from the air cleaner through the appropriate piping and hose connections through the air receiver, then out through the blower and from there to the intake manifold.

The blower proper consists of two three lobe rotors which are held in correct timing relationship with each other by means of gears attached to these shafts on the drive end of the unit. The rotors are supported on the idle end by means of roller bearings which are packed in grease and which will require infrequent replacement of this lubricant. On the drive end, the lubrication is by means of engine oil poured in the small breather cover on the top of the unit, until the amount of oil in this gear case leaves an overflow plug or cock which is located on the lower side of the housing. Little oil is required, but the small amount which is, is very necessary as these gears and bearings turn at rather high speeds. Little servicing can be done with these outside of the replacement of bearings or gears (See Figure 31).

If dust is permitted to pass through these with the very small clearances between the aluminum rotors and the iron housing, gauling and complete destruction of the unit usually results.

The roller bearings supporting the idle end of these shafts are accessible through the bearing cover plates on the end where the lubricant can be washed out and the bearings inspected. After which they should be repacked with a suitable ball bearing lubricant.

The drive end of these blowers is held in place by means of a number of long capscrews projecting through the end and into the housing. Before removing this housing it is necessary to remove the driving sheave together with the hub provided for that purpose which is keyed to the shaft and retained by means of a nut. A leather seal runs on the outside of this hub so care should be taken to retain this smooth and polished surface necessary for the life of these leather seals. The housing can now be removed from the blower which will expose the two gears which act as timing and power transmission. The double row ball bearings support and locate the rotors at this end.

Inside of the ball bearings are leather seals with the lap turned to the rotors. This apparently reverse application is required because of the air pressure built up inside of the blower which would force the lubricant out of the bearings and the gears.

If gears are ever to be removed from the rotor always mark both the gears and the shafts so that they can be reassembled in exactly the same relationship, as the timing between the lobe rotors has a very marked effect on the air delivery from this unit.

MOUNTING OF GENERATOR TO ENGINE

The Murphy Diesel Generator Set is engineered into a single unit by the use of a special designed generator frame which bolts directly to the flywheel housing of the engine. We support the rear end of the engine in the generator and the front end of the engine is trunnioned so it is free to rotate a small amount to avoid stresses and strains caused by the lack of foundation and the skidding of the unit from place to place or other forms of handling. This construction enables us to have the basic structure of the engine and generator act as a rigid backbone of the completed unit. For the above reason most of the maintenance work on the generator and certain phases of maintenance in the engine have to be preceded by a separation of the two units.

Disassembly of Generator

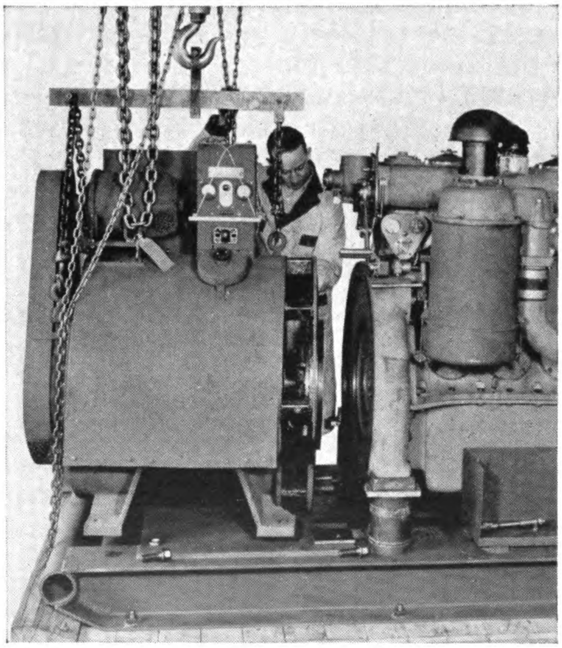


FIG. 66—Assembling Generator to Engine

When separating these units, the mechanics should provide themselves with preferably 2 hydraulic jacks together with some wood blocking, these items are not furnished with the unit. One jack should be placed under the shoulder on each side of the flywheel housing thus support the engine by bearing on the steel frame carrying the entire unit. These should be brought up so that they take a small initial strain. Remove the band which covers the opening necessary for access to the capscrews in both the frame and the flexible coupling. Note that the band is a solid piece of metal on top, but on the bottom it has perforations to permit ready flow of air necessary for the cooling of the electric unit and at the same time maintain the drip-proof construction which has been followed throughout the entire unit. Loosen the four capscrews which fasten the 4 feet of the generator to the frame. Remove the eight ½" capscrews which fastens one of the coupling spiders to the flywheel of the engine. It is seldom necessary to remove the bolts which fasten the steel flexible rings to each of the spiders. Then remove the 14 capscrews which fasten the generator frame to the flywheel housing.

CAUTION: Be very sure that the engine is properly supported on each side before breaking the joint, as outlined above. The engine depends on the support of the generator to keep it from rotating in the front trunnion, and carelessness in blocking up the two sides might result in the engine falling over on its side. After breaking the joint the generator can be moved backwards away from the engine. As these parts are separated and the coupling member slides out of the counterbore in the flywheel the entire rotor will drop,

MOUNTING OF GENERATOR TO ENGINE—(Cont'd)

Disassembly of Generator—(Cont'd)

to take up the air gap space and be supported by direct contact between the outside diameter of the rotor and the pole shoes. The other end of the rotor shaft is supported on a ball bearing which permits a small amount of endwise movement to eliminate the fight between the bearings, if they are not in perfect adjustment. Be careful to retain the spacers and shimming placed under the generator feet in the exact amounts as they are removed. In this way you can avoid the line-up adjustment necessary to arrive at the correct amount of spacers and shims to use. For actual servicing of the generator see "Generator Section." For servicing the engine, see "Engine Section."

Re-Assembly, Generator to Engine

To replace the generator on the engine make it a single rigid unit place the ½" thick spacer blocks under the two front feet of the generator, that is, the two toward the engine, together with approximately the same amount under the two rear feet. This will enable you to hold the generator close to level so the piloted flanges can be entered. The first part to enter must be the disc side of the coupling spider into its counterbore in the engine. If a little care is taken to have the capscrew holes in the disc properly register with the tapped holes in the flywheel, considerable trouble will be avoided. It will probably be necessary in doing this to use suitable bars or wooden timbers projecting through the generator frame to raise the front end of the rotor by the amount of the air gap necessary between the rotor and the pole shoes. Replace and tighten the capscrews. If the lockwashers under these screws show any signs of failure, replace them with new. After the coupling is suitably fastened to the flywheel, the flanges and counterbore of generator and flywheel housing must be brought into correct registry to permit them to enter and the screws to be started. It is at this point that you will find it necessary to raise and lower by very small amounts, the entire rear end of the engine which should be supported by jacks. These two joints will enter easily if properly aligned. If they are not aligned, no amount of forcing will accomplish the purpose. Tighten up all the screws fastening both of these joints. Should, for any reason, capscrews or lockwashers be dropped in the inside of the flywheel housing in either assembly or dis-assembly operations, they must be removed before the engine is started to eliminate a possible chance of wrecking the complete unit. Replace the band which covers the opening in the frame being careful to place the perforated opening portion on the bottom to maintain the drip-proof construction which has been designed.

In case the shims which are normally used under the rear generator feet have been lost or mixed up, proceed as follows: After the joint between the unit has been effected and the strain is taken from the jacks supporting the rear end of the engine, the entire weight of the unit is borne by the front feet resting on solid blocks. Check the rear feet with shims to raise the small round spacers to the necessary height so the load is carried uniformly over the 4 feet. This is done first by rough measurement and then using small amounts of shims added to the proper feet so all of the shims are tight merely by the weight of the generator resting on them. Then replace the capscrews and lockwashers which fasten the generator solidly to the base.

ADJUSTMENT FOR CLEARANCES OF VARIOUS PARTS

The clearances for the proper fits on various engine parts are shown below. It is important that these figures be followed when assembling and adjusting the engine. Bearings will burn out if the clearances as given below are not provided as copper lead precision bearings expand more from heat than other types.

All dimensions are in inches.

1. Bevel gear and pinion (Backlash)	.004 to .006
2. Bevel pinion end play	.004 to .006
3. Bevel pinion bearing	.0025 to .004
4. Intake and exhaust valve clearance	.012 to .015
5. Valve stem clearance in guide	.003 to .004
6. Oil pump gears end play	.004 to .008
7. Connecting rod bearing—Not under	.006
8. Crankshaft main bearing—Not under	.008
9. Crankshaft end play	.004 to .007
10. Camshaft bearings—Not under	.008
11. Camshaft end play	.003 to .005
12. Piston ring gap (end clearance)	.015 to .020
13. Piston clearance in liner (bottom of Skirt)	.006 to .007
14. Piston pin clearance in connecting rod	.002 to .005
15. Piston pin in piston	.0015 to .0023
16. Rocker shaft in rocker arm	.002 to .004

SYNCHRONOUS GENERATOR "A"

Two types of Generators are covered by this manual. This section of instructions refers only to generators attached to engine Nos. shown on page IV (Specification No. 299).

CONTENTS

CONTENTS

GENERAL DESCRIPTION

SYNCHRONOUS GENERATOR

Function of the Synchronous Generator

The synchronous generator (Fig. 1) is a device to convert mechanical power to electrical power. Mechanical power is transmitted from the diesel engine shaft extension (Fig. MD) through a flexible coupling (Fig. 8) and thus to the generator shaft (EM-518013, Fig. 11); and the electrical power output is obtained by simply making connections to the lead terminals, T1, T2, T3, (see Fig. 3).

Here—briefly—is how the mechanical power is converted to electrical power. The rotor (EM-518022, Fig. 8) turns with the generator shaft. Thus the field poles (EM-518081, Fig. 11) revolve within the armature (Fig. 15) and move past the armature coils (EM-518009, Fig. 13). At the same time current from the belted exciter (described in the following section) flows through the generator field coils making each of the field poles a strong magnet. The action of the revolving magnet generates an electrical voltage and current in the armature coils.

Electrical Rating

The generator is designed so that it can be operated to give either a 60 or 50 cycle output as follows:

60 Cycle Output—1200 RPM

132.5	Kva (kilovolt amperes)
106	Kw (kilowatts)
60	Cycles per second
80%	Power factor
220/127	Volts
348	Amperes full load per terminal
3	phase

50 Cycle Output—1000 RPM

118.7	Kva (kilovolt amperes)
95	Kw (kilowatts)
50	Cycles per second
80%	Power factor
400/230	Volts
171.5	Amperes full load per terminal
3	phase

Complete instructions for changing over from 60 to 50 cycle operation or vice versa are given on Page 6-7.

Temperature Rating

When operated at full load continuously the generator field poles (EM-518081, Fig. 11) will have a maximum temperature rise that will not exceed 50° C. (122° F.) above the ambient temperature (temperature of the surrounding air).

The armature core and coils (EM-518002, Fig. 15) will have a maximum temperature rise that will not exceed 40° C. (104° F.) above the ambient temperature.

When operated at **25% overload for 2 hours** the field will have a temperature rise that will not exceed 65° C. (149° F.) and the armature a temperature rise of 55° C. (131° F.) above the ambient temperature.

Mechanical Construction

The generator is of drip proof construction, self ventilated, complete with single ball bearing, special terminal box, and screen covers over the openings at the bottom (to prevent entrance of rodents and large insects). The generator is coupled directly to the diesel engine through a flexible coupling. See Figures 1, 8, 9, 11-18 inclusive.

Manufacturer's Identification

Identification of the generators to the Manufacturer is as follows:

Size AF-6

Production number ..66122

Serial numbers 84532-84611

EXCITER

The direct current generator which provides the direct current for the synchronous generator field coils of the synchronous generator is called the exciter (Fig. 2). Like the synchronous generator it is capable of converting mechanical power to electrical power. The belt drive illustrated in Fig. 8 transmits mechanical power to the exciter from the generator shaft but since that shaft gets its mechanical power from the diesel engine, it is apparent that the engine furnishes mechanical power not only for the synchronous generator, but also for the exciter.

The exciter also has field poles and an armature core, but unlike the synchronous generator the exciter field poles are stationary and the exciter armature rotates. This can be clearly seen by comparing Fig. 19 showing the exciter parts with Figs. 11 and 12 on the synchronous generators.

The exciter armature (EM-518101, Fig. 19) rotates in the stationary magnetic field set up by field coils mounted on the field frame (EM-518108, Fig. 19) inducing a voltage in the armature coils. Although the voltage induced in each individual coil is an alternating current voltage, these coils are connected to the commutator (EM-518118, Fig. 19) in such a way that there is a direct current voltage at the carbon brushes, to which the armature leads (EM-518136, Fig. 19) are connected.

The voltage at the exciter brushes and consequently the voltage on the exciter armature leads is increased by increasing the current in the field coils and consequently increasing the strength of the magnetic field.

To accomplish this for manual operation (when a voltage regulator is not used) all of the exciter field poles are connected in series and one end of this circuit is connected directly to one of the carbon brushes (EM-518129, Fig. 19) while the other end is connected in series with exciter field rheostat (Fig. 2) before eventually connecting to the other carbon brush.

So briefly, varying the resistance in the exciter field circuit increases or decreases the voltage on the exciter armature leads. But since these leads connect to the synchronous generator field coil circuit through the collector rings (EM-518045, Fig. 9) and brush holders it is apparent that varying the exciter field circuit resistance also controls the synchronous generator armature voltage.

Electrical Rating

The exciter is designed to develop a full load electrical output as follows:

2 Kw (kilowatts)
125 Volts DC.
16 Amperes

Temperature Rating

The exciter will operate at full load continuously with a maximum temperature rise at 40° C. (104° F.) above the ambient (surrounding air) temperature.

Mechanical Construction

The exciter is of drip proof construction, self ventilated, complete with two ball bearings, screen covers over the opening at the bottom (to prevent entrance of rodents or large insects). The exciter is mounted on top of the generator frame and is driven by three "V" belts from a sheave mounted on the generator shaft. (See Figures 1, 2, 8, and 19.)

VOLTAGE REGULATOR

The voltage regulator (Fig. 2) will automatically adjust exciter field circuit resistance as required to maintain a constant voltage at the terminals of the synchronous generator. This eliminates the need for making continuous adjustments to the setting of the exciter field rheostat. As illustrated, it is furnished complete with an AC voltmeter to indicate whether voltage is being properly maintained and with an AC ammeter to indicate how much current the generator is delivering.

The voltage regulator regulates the voltage output of the synchronous generator so that it will not vary, except momentarily, more than plus or minus 2% of the rated voltage.

The coil of a relay (EM-25601, Fig. 21) which actuates a vibrating contact, is connected across the generator terminals through a potential transformer. The voltage of the generator governs the magnitude of the vibrations of the contact so that when the voltage is high the contact vibrates with a shorter period of contact than when the voltage is low. The contact is connected into the exciter shunt field circuit. Thus when the alternating current output voltage of the generator is high, there is less contact of the vibrating contacts resulting in a weakened exciter field. When voltage is low there is more contact on the vibrating contacts resulting in a strengthened exciter field.

The strength of the exciter field determines the output of the exciter and the output of the exciter determines the strength of the rotating field of the generator, thus the voltage output of the generator. The voltage of the generator can be raised or lowered by changing the setting of the voltage adjusting knob on the front of the voltage regulator.

The regulator is mounted with rubber mountings (No. EM-25603 & EM-25604, Fig. 22) on the frame of the synchronous generator. These rubber mountings prevent excess vibration of the regulator. The voltage and current output of the generator can be read with the meters in the face of the voltage regulator. An ammeter jack (No. EM-25613, Fig. 20) is provided with the regulator to connect the ammeter into any one of the three phases of the generator.

SWITCH CABINETS

A switch cabinet Fig. 5 or 6 is provided with each generator to connect the synchronous generator output to the load. Each switch cabinet has two air circuit breakers (No. EM-25671, Fig. 23), one to connect the generator to the copper connections, called the bus (No. EM-25688, Fig. 24), and one to connect the load to the bus. Each circuit breaker is provided with automatic thermal overload trip attachments (No. EM-25672 A & B, Fig. 24) so that if the current becomes too high the breaker will automatically open and prevent damage to the equipment.

Some of the switch cabinets are provided with synchronous equipment so that two or more generator units may be operated in parallel (i.e., connected together so that the combined output of the two generators can be used to serve a single load). Fig. 6 shows the appearance of the switch cabinets having synchronizer equipment; Fig. 5 shows the appearance of those that do not.

The frequency of the generated AC voltage is determined entirely by the operating speed of the engine generator set. When the set is operating at 1200 rpm. the frequency is 60 cycles per second, while at 1000 rpm. the frequency is 50 cycles. A frequency meter (No. EM-25677, Figs. 23 & 24) is provided on each cabinet so that the frequency of the generator output as well as the operating speed can be checked when the generator is being operated at either 60 or 50 cycle output.

OPERATING INSTRUCTIONS

INSTALLING

In general, the engine generator set should be installed on a level floor or level ground in a clean, well-ventilated place, accessible for inspection and care. The generator should be protected as much as possible from excessive moisture, oil, dust and dirt. It should not be installed where inflammable gases or combustible material may float in the air.

The engine generator set should be so placed that the meter side of the voltage regulator is easily accessible for reading and adjustment.

CONNECTIONS

The terminal box of the generator (Figs. 3 & 4) provides for connections to operate at 220/127 volts, 60 cycles, 1200 rpm., or 400/230 volts, 50 cycles, 1000 rpm.

60 Cycle Operation

The proper terminal box connections for 400/230 volts, 60 cycle, 1200 rpm. operation are shown in Fig. 3. The large connecting links are connected between terminals 5 & 4, 4 & 6, 6 & 0, 8 & 2, 7 & 1, 9 & 3. The small connecting link is connected between terminals C & B.

The air circuit breaker overload trip unit for 60 cycle, 220 volt operation (EM-25672-B, Fig. 7 and 24) is identified with the number 350. This indicates that the trip unit is for 350 amperes maximum operation.

Refer to Fig. 7 showing the method of removing and replacing a trip unit. Remove the front of the switch cabinet and remove the cover of each breaker (Item No. EM-25695). The six nuts (Item EM-25696) are then removed and the six screws (Item EM-25697) are loosened. The remaining screws on the top middle terminal (Item EM-25698) is loosened and the trip unit can be removed by unhooking it from the tripping mechanism. When placing a trip unit in the breaker make sure that the center screw at the top of the trip unit is tight, engage the tripping mechanism and then replace the screws (EM-25697) and the six nuts (EM-256514).

The 350 ampere trip unit must be placed in each breaker for 60 cycle operation.

The transfer switch (EM-25655, Figs. 23 & 24), located behind the front cover of the cabinet, must be switched to the downward position for 60 cycle, 220 volt operation.

50 Cycle Operation

The proper terminal box connections for 220/127 volt, 50 cycle, 1000 rpm. operation are shown in Fig. 4. The large connecting links are connected between terminals 5 & 8, 4 & 7, 6 & 9. The small connecting link is connected between terminals C & A.

The air circuit breaker trip unit for 50 cycle, 440 volt operation is identified with the number 175. This indicates that the trip unit is for 175 amperes maximum operation.

Refer to Fig. 7 showing the method of removing and replacing a trip unit. The proper trip unit is installed as directed under 60 cycle operation.

The 175 ampere trip unit must be placed in each breaker for 50 cycle operation.

The transfer switch (EM-25655, Figs. 23 & 24), located behind the front cover of the cabinet, must be switched to the upward position for 50 cycle, 440 volt operation.

Load Connections

After the terminal box and the breakers are set for the operation required, connect terminals T1, T2, & T3 of the terminal box to terminals T1, T2 & T3 respectively of the generator circuit breaker of the control. Connect the load leads to terminals L1, L2 & L3 of the load circuit breaker of the control.

Terminal T0 of the terminal box is the neutral connection for use when the load consists of a 4 wire system.

Ground the frame of the generator in accordance with general practice of Army Engineers. The ground connection must be made with wire at least the size of that used to connect to the load so that the ground connection will carry short circuit current in case the generator becomes grounded.

BEFORE STARTING

1. When starting up first time, remove the blue protective lacquer from the generator collector rings, (EM-518045, Fig. 9) with alcohol or equivalent.
2. See that brushes on exciter commutator and generator field collector rings make contact and are free to move in their holders (Figs. 9, 10 & 19 illustrate these parts).
3. Make sure all moving parts have sufficient clearance from stationary parts and that no loose objects are lodged in the generator.

The ball bearing (EM-518053, Fig. 9) is properly packed with grease before shipment so no attention is required.

STARTING

1. See that the generator breaker and the load breaker are open (in the down position).
2. The synchronous generator output voltage may be controlled either automatically with automatic voltage using the voltage regulator or, by hand using the exciter rheostat.
   (a) **Automatic Regulation:** Turn the exciter rheostat handle Figure 2 all the way to the right (clockwise direction), or to the punch mark (See Page 27, Par. 2). Turn the "Hand-Auto" switch (EM-25622, Fig. 21), located under the regulator cover, to the "Auto" position. The regulator cover is removed by taking off the thumb nuts (EM-25619, Fig. 20) at the top of the regulator.
   (b) **Hand Regulation:** Turn the exciter rheostat handle all the way to the right or clockwise direction, or to the punch mark. Turn the "Hand-Auto" switch (EM-256022) to the "Hand" position.
3. Start the engine and bring generator up to speed, check frequency meter (No. EM-25677, Fig. 23).
4. See that the generator is operating at rated voltage, check voltmeter (No. EM-25610, Fig. 21), and close generator breaker.
   (a) If on automatic operation adjust the voltage regulator adjusting knob so that the voltmeter registers proper voltage.
   (b) If on hand operation adjust the exciter field rheostat so that the voltmeter registers proper voltage.
5. Make sure polarity reversing switch motor (EM-25602, Fig. 21) is running. (See voltage regulator maintenance instructions, Page 23.)

LOW VOLTAGE

The following conditions may prevent the generator from developing normal voltage.

Generator

1. Speed may be below normal. Check with the frequency meter (EM-25677, Fig. 23). If the speed is below normal the frequency meter will show low frequency.
2. Generator collector ring brushes (EM-518030, Fig. 10) may be making poor contact. See instructions for maintenance of generator brushes and collector rings, Page 14.

Exciter

1. Speed may be below normal. Check "V" belt drive (EM-518072, Fig. 8) for tightness. Belts should be just tight enough so that they do not slip.
2. Commutator, after long use or exposure, may become rough and dirty, or brushes may be excessively worn. See Fig. 19 and instructions for maintenance of exciter commutator and brushes, Page 20.
3. If on hand operation, the exciter field rheostat (EM-25618, Fig. 8) may not be turned all the way (counter clockwise) to the left.
4. Exciter field may lose residual magnetism. The field poles retain a slight amount of magnetism while idle. If this magnetism is lost, the exciter will not build up voltage. If all other efforts fail to correct the difficulty, connect a battery across F1 & F2 of the terminal block (EM-25703) in the terminal box (See Fig. 18). If, after building up voltage, the ammeter indicates in reverse, shut down and reverse the connections F1 & F2.

Voltage Regulator

1. Voltage may require adjustment with Voltage Adjusting Knob (EM-25641, Fig. 21).
2. Contacts of regulator may need attention: See maintenance instructions on voltage regulator contacts, Page 24.
3. Polarity of the connections from the exciter may be reversed. Reverse the connections at F1 & F2 on the terminal block (EM-25703, Fig. 18).
4. Voltmeter or ammeter may read incorrectly. Voltage may be higher than indicated or current may be higher than indicated. Check with another voltmeter or ammeter.

OPERATING TWO GENERATORS CONNECTED TOGETHER (PARALLEL OPERATION)

1. Before connecting the synchronous generator to be operated in parallel with others for the first time, check phase rotation to see that it is the same as that of the other generator on the power system with which it is to be paralleled. One method of checking phase rotation is to connect a three-phase induction motor first to one generator, then to the other generator, making sure that the motor is connected to the

OPERATING TWO GENERATORS CONNECTED TOGETHER (PARALLEL OPERATION) — (Cont'd)

correct corresponding phases. That is, tag the 3 leads of the motor to correspond with the marking on the terminals of the generators or power systems to be paralleled. When rotation of the motor is in the **same** direction for all generators, the phase rotations of the generators are the same. If rotation of the induction motor is opposite for the incoming generator than for the other generator, reverse any two of the three power terminals (i.e. not the neutral where neutral lead is used) of the generator and check again with motor until correct phase rotation is indicated.

2. Remove the covers on the sides of each of the generator switch cabinets, at least one of which is furnished with synchronizing equipment illustrated in Fig. 6 and connect the three bus lines together. These connections should not be made when the bus is connected to an operating generator (operator may suffer severe shock). If generator is running, open the generator breaker (Figs. 5 & 6) before connecting buses.

3. See instructions for starting generator on Page 8 and start up the generator whose switch cabinet does not have synchronizing equipment Fig. 5 (if both have synchronizing equipment, start up either one). Close the generator breaker so that the generator voltage is transmitted to the bus connections.

4. Start up the generator whose switch cabinet has synchronizing equipment Fig. 6 and bring it up to proper speed as indicated by the frequency meter (Fig. 6).

5. Turn the synchronizing lamp switch (Fig. 6) to the "ON" position.

6. The synchronizing lamp will flicker until the two generators are very close to the same speed or in other words, close to synchronism. As the generators approach synchronism the fluctuations of the lamp will become slower. When the fluctuations are very slow, about one fluctuation every two or three seconds, the breaker of the incoming generator may be closed when the light is dark, thus paralleling the generators. If the incoming generator is thrown on the line when the light is not dark, electrical disturbances will cause severe mechanical stresses which may result in misalignment of the engine and generator.

The governors of engines whose generators operate in parallel determine how much kilowatt load each generator carries. If governors are not set for the same speed and adjusted for the same droop in speed from no load to full load then they do not divide the kilowatt load proportionally. It sometimes happens that one engine will actually drive another through the generator, one generator acting as a motor. At such times the generator currents are high, totalling much more than the load. In such a case adjust the governor of the machine carrying the least current so as to increase its speed, until the sum of the currents of the generators is at minimum. The best check on whether engines are carrying their proper loads is by their indicating devices, or the exhaust of the diesel engine. (Refer to Maintenance, Voltage Regulator, Cross Current Compensation, Page 29.)

MAINTENANCE

To insure the best operation, make a systematic inspection of the generator, and its associated equipment once each 256 hours, giving special attention to the following points.

CLEANLINESS

See that both the interior and exterior of the generator, exciter, voltage regulator and control panel are kept free from an accumulation of dust, dirt, oil or water, and particularly metallic particles.

Blow out the generator and exciter each 1,024 hours by directing a stream of air through each unit lengthwise. The amount of cleaning necessary will depend on the service conditions under which the generator operates. When using air for blowing out, do not use excessive pressure, as it will curl up edges of insulation on windings.

GENERATOR

Bearings

(See Figures 8 & 9 for illustrations of the parts mentioned):

Lubrication

The generator ball bearing (No. EM-518053) shown in Fig. 9 is an SKF ball bearing No. 6314. The bearing housing (EM-518057) is packed with 3 ozs. of high grade neutral grease, Army Classification WB-2.

The bearing housing should be flushed out with flushing oil and refilled with new grease every 1,024 hours. Every 4,096 hours disassemble, remove bearing (see following) clean, inspect, repack and replace. To obtain the best efficiency fill the housing 1/3 to 2/3 full. The housing will hold approximately 6 oz. of grease, but it should never be filled more than 2/3 full.

The greasing plug (EM-518049-67-68) shown in Fig. 8 is accessible through the hand hole (EM-518066) in the front "V" belt guard (EM-518071). The drain plug (EM-518049-50-51) extends below the front "V" belt guard.

Bearing temperature rise above the ambient (surrounding air) temperature should not be more than 40 deg. C. (104 deg. F.). The temperature rise should be checked occasionally. A bearing may run hot for the following reasons:

1. Contamination of grease.
2. Insufficient amount of grease.
3. Too much grease which causes excessive heating due to churning.
4. Grease too stiff preventing free action in bearing.
5. Excessive thrust due to misalignment or excessive imposed loads.
6. Pounding caused by bearing being loose on shaft or balls being worn (detectable by noise.)
7. Actual bearing failure caused by broken ball case or flat balls (detectable by noise.)
8. Heat from external source causing high bearing temperatures.

Causes in Items 1, 2, 3, & 4 can be prevented by properly following lubrication instructions on Page 12.

The difficulty in Item 5 could be caused by a misalignment coupling or sprung stator frame. Do not exert excessive pressure on one end of frame to make it fit onto the engine bedplate.

Difficulties in Items 6 & 7 should be remedied by replacing the bearing. Before attempting to replace the bearing, determine the underlying cause and take steps to prevent a recurrence.

Removal of Generator Bearing

(See Figures 8 & 9):

1. Remove front "V" belt guard (EM-518071) by removing four bolts (EM-518052).
2. Loosen "V" belts (EM-518072) by loosening the bolt (EM-518069) holding the rear "V" belt guard (EM-518070) and lowering the four bottom jamb nuts on the exciter mounting studs (EM-518074). Remove the "V" belts.
3. Loosen the set screw in the exciter sheave (EM-518077) and remove that sheave.
4. Remove back "V" belt guard (EM-518070) by removing bolts (EM-518069 and EM-518052).
5. Remove screw (EM-518060) and retaining washer (EM-518061) at the end of shaft, loosen set screw (EM-518076) in hub of drive sheave (EM-518064) and pull the sheave off.
6. Remove the greasing and draining plugs (EM-518049-67-68 and EM-518049-50-51).
7. Remove the 4 bearing housing bolts (EM-518058) and 6 bearing bracket bolts (EM-518048), loosen the field leads (EM-518025) and remove the bearing bracket (EM-518047).
8. Remove the sheave spacer (EM-518059) by sliding it off the shaft.
9. Remove the four bearing housing cap screws (EM-516056) and remove the bearing cap (EM-518054).
10. Apply pressure to the inner race of the bearing (EM-518053) only, until the bearing comes off shaft. A steady pressure should be applied if possible rather than pouding by means of hammerblow. But if a hammer is the only available tool, the blows should be transmitted by means of a wooden or fibre block.
11. Put on the new bearing with steady pressure on the inner race of the bearing only. Before replacing the bearing cap wash it out with a flushing oil. After the housing is mounted make sure all screws and plugs are securely screwed in place.

To reassemble, follow back through the steps of disassembly.

Collector Rings and Brushes

(See Figures 9 & 10 for illustration, etc.):

The collector rings (EM-518045) are made of cast brass and are bolted (EM-518046) to a bakelite sleeve (EM-518044) which fits over the shaft and is secured with a socket head set screw (EM-518043). These rings are connected to the generator field coils and collect the direct current output of the exciter through carbon brushes (EM-518030) which are mounted in the brush holder as shown in Fig. 10. If the direct current of the exciter does not reach the generator field coils the generator will not generate electricity.

To reach the brushes and collector rings for servicing it is necessary to remove the bolts (EM-518052) holding on the front "V" belt guard and remove the guard (EM-518071). The brushes and rings can be reached through the openings in the bearing bracket.

Collector Rings and Brushes — *(Cont'd)*

Improper functioning of the collector ring and brushes is indicated by sparking. Sparking may be caused by one of the following conditions and may be remedied as indicated:

CAUSE	REMEDY
1. Collector rings not running concentric with shaft.	1. Turn rings concentric to shaft and surface polish with a commutator grinding stone or sandpaper. (DO NOT USE EMERY CLOTH).
2. Collector ring surface rough or pitted.	2. Turn rings or polish with a commutator grinding stone or sandpaper depending on roughness. This roughness is usually due to prolonged sparking.
3. Brushes tight in brush holders.	3. Remove brush by lifting spring and clean the holder socket. Check the brush for high spots. Clean off larger spots with sandpaper.
4. Oil on surface of collector rings.	4. Correct oil leakage and wipe off surface of rings and brushes.
5. Vibration of brush holder stud.	5. Tighten brush holder stud (EM-518034) which is mounted in the bearing housing cap and fastened with a jamb nut. Also tighten the screw (EM-518033) which holds the brush holder on the stud.

If it is necessary to remove the collector rings for turning or replacement proceed as follows:

1. Remove the bearing (EM-518053) by proceeding as described in detail on Page 13.
2. Remove the brush holders (EM-518031) by disconnecting field leads (EM-518025) and loosening screw (EM-518033) which holds the brush holder to the stud.

When installing new brushes, the ends of brushes should be ground to fit curvature of collector ring. This can be done by putting a piece of sandpaper on the surface of collector rings with rough side against the brush. While the brush is pressed against sandpaper, move sandpaper in direction of rotation of rings and repeat this motion until brush fits curvature of rings.

Field Poles

(See Figures 8 & 11):

Field poles (EM-518081) are made up of copper wire wound coils wound on a laminated steel pole after the pole is properly insulated. Damage which breaks the wire on a field pole or the connections between poles and the collector rings will make operation impossible.

If it is necessary to replace a field pole proceed as follows:

1. Remove the generator from the engine and base by removing bolts holding flexible coupling to engine flywheel and also the bolts holding generator to the base.
2. Press off the flexible coupling (MD-6111-A).
3. Remove 6 bolts (EM-518007) and remove coupling end baffle (EM-518008).
4. Carry out operations No. 1 to No. 9 inclusive as outlined on Pages 13 and 14 under the heading "Removal of Generator Bearings."
5. Place a pipe (at least 6 ft. long), with an inside diameter slightly larger than the coupling end shaft diameter, over the coupling end shaft extension. Place the lifting rope or chain of a hoist around the pipe as close to the rotor as possible and lift until hoist supports the end of the rotor. Apply downward pressure on the free end of the pipe until the rotor is completely supported by the hoist. Maintain the downward pressure on the pipe and pull the rotor out of the stator.
   If there is no pipe available, lift the shaft extension end as high as possible and slide a sheet of tin between the rotor and stator and remove the rotor by sliding it out of the stator.
6. Apply an even pressure around the inner race of the bearing or pound with hammer transmitting the blows by means of a wooden or fibre block and thus remove the bearing.
7. Remove bearing housing cap (EM-518054) and the brush holders (EM-518031).
8. Loosen the set screw (EM-518043) and remove the collector ring assembly (EM-518045).
9. Remove blower bolts (EM-518011) and remove both blowers (EM-518010).
10. Disassemble the damper winding by either of the following methods:
    (a) Drill out iron rivet (EM-518084) holding end segments (EM-518041) of the pole which is to be removed.
    Heat up the phos. copper weld between the end segments to at least 1300° F. so the phos. copper melts. Both ends of both end segments must be loosened.
    (b) Saw the weld and rivet by sawing along the welded portion of the segments.
11. Disconnect the connections to the field winding from adjacent pole winding.
12. Drive out the pole pin (EM-518083, Fig. 11) with a rod of slightly smaller diameter than the pole pin.
13. Remove the pole, in the direction which allows free movement of the end segments, by hammer blows transmitted by a wooden or fibre block against the lower part of the pole. Do not pound on the windings unless you know they are damaged beyond repair.

Field Poles — (Cont'd)

14. Put on a spare pole by reversing the above procedure. Make sure the spare pole has the ends of the windings brought out at the same place as those on the pole which was removed. Each pole is connected so that the field current flows opposite to that in the adjacent pole. The pole shims (EM-518082) consist of one piece of 18 gage and 1 piece of 29 gage steel sheet.
15. The overlapping portion of the end ring segments must be thoroughly cleaned. Place a small piece of phos-copper between the overlapping portions, drill and rivet, and (a) complete the connection with a phos-copper weld to insure a perfect electrical connection or (b) bolt tightly together.

Armature

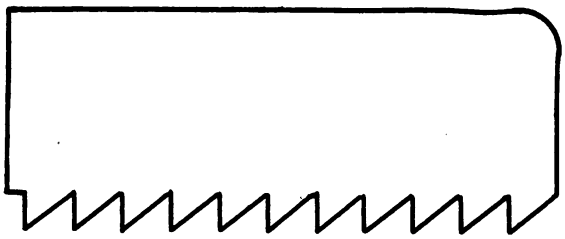
(See Figures 12 thru 15):

The armature core (EM-518003, Fig. 12) is made up of sheet steel punchings held together with steel straps and provides 72 slots for the armature coils (EM-518009, Fig. 13). Each slot is insulated (EM-518079) and the coils inserted in the slots. The slot insulation is trimmed off, folded over the top coil in the slot and wedges (EM-518078) are driven in the grooves at the top of the slot. (See Fig. 13.)

Replace Coils

If the armature winding is damaged and it is necessary to replace one or more of the armature coils proceed as follows:

1. Disassemble generator and remove rotor as directed on Page 15.
2. Refer to connection diagram A-613. Note that each coil is connected either to each adjacent coil or to one adjacent coil and an armature paralleling connection (EM-518085, Fig. 14). Determine how the coil to be removed is connected, cut away the insulation and unsolder the connections.



3. Facing the core from the connection end of the coils, remove the slot wedge from over the damaged coil and from the 10 or 11 slots to the right of the damaged coil. Wedges can be removed with a tool with saw like teeth as shown in sketch. Drive the teeth into the wedge and then drive out the wedge.
4. Cut the lashings around the coils and lashing ring which hold these coils which are to be removed.
5. Lift the top side of the coils in these slots with care so as to not damage the insulation. On coming to the tenth slot the damaged coil can be removed. It may be necessary to loosen a couple extra coils in order to make room for removing the damaged coil.
6. Place spare coil in the slot, replace all lifted coil sides, drive in slot wedges (Fig. 13), connect coil per connection diagram A-613, insulate connections and replace lashings.
7. Assemble the generator by following back through the steps followed in disassembling it.

Replace Core and Coils

If the core becomes damaged and it is necessary to remove the core with the coils proceed as follows:

1. Disassemble the generator and remove the rotor as directed on Page 15.
2. Disconnect the armature leads (EM-518038, Fig. 17) from the terminal box studs (EM-25690, Fig. 17) and pull the armature leads one by one through the opening in the stator ring.
3. Place the stator so that it rests on end with the connection end up.
4. Remove the core pins (EM-518021, Fig. 15) from the bottom of the ring by drilling them out.
5. Remove the lifting eyebolts (EM-518005) from the top of the bearing bracket and place one on each side of the ring, screwing them into the bearing bracket bolt holes.
6. Apply considerable pressure on the core if necessary and lift the ring by the eyebolts with a crane. The ring will slide off the core.
7. Drop the ring over a new core (Fig. 15), drive in core pins and reassemble the generator.

Terminal Box

(See Figures 8, 16, 17 & 18):

The terminal box (EM-25700, Fig. 8) is mounted, over the opening through which the armature leads are brought out, at the side of the generator frame, with six bolts (EM-518056). The ends of the armature leads (EM-518038) are punched out so they fit over the terminal studs (EM-25690) and are fastened down with the jamb nuts.

To remove the terminal box, disconnect the armature leads, disconnect the exciter and voltage regulator leads (EM-25710, Fig. 18) from the terminal block (EM-25703), remove the six mounting bolts (EM-516056, Fig. 8) and remove the complete terminal box.

EXCITER

(See Fig. 19)

Bearings

Lubrication

The exciter is a two bearing direct current generator. The sheave end bearing is a SKF No. 305 ball bearing and the commutator end bearing is a SKF No. 304 ball bearing. Plugs (EM-518089, Fig. 19) are provided in each bearing housing for greasing the bearing and draining the housing.

The exciter is shipped with the bearing housings properly filled with 2 oz. of high grade neutral grease, Army Classification WB-2.

The bearing housing of each bearing should be flushed out with OE10 oil and refilled with new grease every 1,024 hours. Every 4,096 hours disassemble, remove bearing (see following) clean, inspect, repack and replace. When filling housing, fill 1/3 to 2/3 full to obtain best efficiency. The housing will hold approximately 4 oz. of grease but should never be filled more than two-thirds full.

EXCITER

Bearings Lubrication — *(Cont'd)*

Bearing temperature rise above the ambient (surrounding air) temperature should not be more than 35° C. (95° F.). Causes for high bearing temperatures are as follows:

1. Contamination of grease.
2. Insufficient amount of grease.
3. Too much grease which causes excessive heating due to churning.
4. Grease too stiff preventing free action in bearing.
5. Excessive thrust due to misalignment or excessive imposed leads.
6. Pounding caused by bearing being loose on shaft or balls being worn detectable by noise.
7. Actual bearing failure caused by broken ball cage or flat balls detectable by noise.
8. Heat from external source causing high bearing temperatures.

Causes 1, 2, 3, and 4 can be prevented by properly following lubrication instructions.

The difficulty in Item 5 is not very probable because the exciter is mounted on an adjustable plate.

Difficulties 6 and 7 require a replacement bearing. Before replacing the bearing, determine the underlying cause of the bearing failure and take steps to prevent recurrence.

Removal

To remove the exciter bearings first drain the grease from the housing, refer to Figs. 8 and 19 and proceed as follows:

Sheave End Bearing

1. Remove front "V" belt guard (EM-518071).
2. Loosen "V" belts by loosening bolt (EM-518069) and the four bottom jamb nuts on the exciter mounting studs (EM-518074). Remove "V" belts (EM-518072).
3. Loosen set screw in exciter sheave and remove exciter sheave (EM-518077).
4. Remove bolts (EM-518069 and EM-518062) and remove back "V" belt guard (EM-518070).
5. Remove three bolts (EM-518088) holding bearing cap (EM-518094).
6. Remove four bolts (EM-518098) holding sheave end bearing bracket and remove bracket (EM-518097).
7. Remove locknut (EM-518090) and lock washer (EM-518091). Some units have a snap ring. Remove the snap ring by prying up a free end with a screw driver.
8. Apply pressure to inner race only of bearing (unless bearing has failed) and remove bearing. Pressure can best be applied against the bearing housing cap to remove bearing.

Commutator End Bearing

1. Remove two bolts (EM-518125) holding bearing cap (EM-518114).
2. Remove drip cover (EM-518116) and lift brush holder fingers (EM-518134) and brushes (EM-518129) placing brush holder finger at side of brush so the brushes will not slide in the holder (EM-518130).
3. Remove four bolts (EM-518098) holding the commutator end bearing bracket (EM-518128) and remove bearing bracket.
4. Remove lock nut (EM-518122) and lock washer (EM-518121). Some units have a snap ring. Remove the snap ring by prying up a free end with a screw driver.
5. Apply pressure to inner race only of bearing (unless bearing has failed) and remove bearing. Pressure can best be applied to the bearing cap to remove bearing.

After replacing bearings, wash out bearing cap with flushing oil. Be sure all screws are securely screwed in place when reassembling exciter.

Armature

The armature (EM-518101) is the rotating part of the exciter. If the armature winding or core becomes damaged and it is necessary to replace the armature proceed as follows:

Remove each bearing bracket as instructed above and lift the rotor out of the frame. Place a new rotor in the stator and assemble by reversing the disassembly procedure.

Commutator and Brushes

The exciter commutator (EM-518118) is made up of copper segments insulated from each other with small mica segments. Each commutator copper segment is connected to an armature coil. The electrical output of the exciter is carried to the commutator where it is picked up by carbon brushes which ride under pressure on the commutator. It is important to keep the commutator surface clean so that good contact can be made with the carbon brushes.

Use no grease or lubricant on the brushes or on commutator. Keep the mica segments undercut about 1/64 inch and keep the undercut slots clean.

The commutator surface should require only occasional cleaning under normal conditions. Clean it with a piece of canvas or similar hard-woven non-linting material. The canvas may be very slightly moistened with a few drops of clean lubricating oil or kerosene for the first rubbing. Finish with a piece of dry canvas.

A roughened commutator may need to be polished with a block of sandstone fitted to the curvature of the commutator. If this is not available, sandpaper can be used by pressing it against the commutator with a block of wood having the same curvature. All the brushes should be lifted and the commutator should be run at full speed while the polishing block is moved slowly back and forth along the surface parallel to the shaft. All grit should be carefully wiped off before the brushes are lowered. NEVER USE EMERY OR CARBORUNDUM CLOTH on a commutator or brush.

Make sure that the brush yoke (EM-518127) is rigidly locked in its proper position. Each machine has its brushes set, by very accurate methods, on the test floor at the factory, and the brush yoke is locked and marked in the proper position. Do not change this position. Interpole exciters do not require and will not permit brush shifting for different loads.

Commutator and Brushes — (Cont'd)

Under normal conditions of operation there should be no sparking at the brushes. Injurious sparking should never be permitted to continue. The causes of sparking are:

(a) Brushes not set at the proper place.
(b) Brushes not properly fitted to commutator.
(c) Brushes not having proper pressure.
(d) Some brushes having excessive pressure thus taking more than their share of the current.
(e) Brushes being burnt at contact surface due to excessive overloads.
(f) A rough commutator.
(g) A loose, high, or low commutator bar, or high mica.
(h) Dirty or oily commutator.
(i) A loose connection between the armature conductors and the commutator bars, or an open circuit in the armature winding.

Overheating of the commutator may be caused by overloads, or excessive brush pressure, or excessive sparking. Red hot brush tips may be caused by particles of copper imbedded in the contact surface of the carbon. Such particles should be removed, and the brush refitted with fine sandpaper.

Brushes

The brushes are mounted in brush holders (EM-518130) which clamps (EM-518131) to a brush holder stud (EM-518119). The stud is mounted on a brush yoke rocker (EM-518127) which clamps (EM-518126) to the bearing housing of the commutator end bearing bracket.

If necessary to replace brushes, remove the drip covers (EM-518116) on the bearing bracket thus giving access to the brushes. Disconnect the tails of the brushes from the brush holder, lift the brush holder fingers and remove the brushes.

After placing new brushes in the holders, carefully fit the rubbing or contact surface of the brushes to the curvature of the commutator by means of strips of flintpaper or sandpaper, first using No. 1 and then a finer grade, such as No. OO. NEVER USE EMERY OR CARBORUNDUM CLOTH OR PAPER. Cut the sandpaper into strips slightly wider than one brush. Insert a strip under a brush with smooth side of paper next to commutator and draw the strip back and forth around the commutator in the manner of a slipping belt. The final sanding in of the brush should be made by drawing the sandpaper under the brush in the direction of rotation of the commutator and on the return stroke the brush should be lifted. This will prevent a rounded brush which is caused by the brush being loose in the holder.

Blow out all carbon dust, wipe off the commutator, the connections and the carbon brushes.

The brushes are so arranged that those on a positive stud are staggered with relation to those on the opposite positive stud, and those on a negative stud are staggered with relation to those on the other negative stud. This arrangement must be maintained to avoid the wearing of ridges on the commutator. The brush holder springs should be so adjusted that all brushes will have the same pressure. About one and one-half pounds per square inch of brush contact may be taken as a guide to the proper pressure.

Examine the contact that the brushes make after a short period of operation and continue this inspection and fitting until a thoroughly good contact of the full surface of the brush is obtained.

Frame and Field

The exciter field coils (EM-518107) are mounted on poles (EM-518106) which bolt (EM-518105) to the frame (EM-518108). To replace a field coil it is necessary to remove the armature as directed above. Disconnect the coil leads, remove pole bolts (EM-518105) and remove pole and coil. When replacing spare coil make sure connections are made in same manner as before. Each coil must be connected so that the current flows in direction opposite to direction of current flow in adjacent pole.

Frame can be removed by removing the four exciter bolts (EM-518056, Fig. 8) after removing other parts as directed.

VOLTAGE REGULATOR

All that is ordinarily required to keep the voltage regulator (EM-25600, Fig. 20) in first class operating condition is to:

1. See that the Polarity Reversing Switch Motor (EM-25602, Fig. 21) is in operation. This will insure maximum life of contacts.
2. Maintain the relay contacts (EM-25615, Fig. 21) in good condition as described in the following.

Polarity Reversing Switch

Polarity of the relay contacts of the Voltage Regulator is automatically reversed regularly to insure even wear and maximum life of the relay contacts (EM-25615). This is taken care of by means of the **Automatic Polarity Reversing Switch** (EM-25602). See that the polarity reversing switch motor is running at all times the Regulator is in operation. Disc seen through window in front of Regulator indicates when motor is in operation.

Regulator Contacts

The Voltage Regulator is supplied with fine-grain tungsten contacts (EM-25615). Sparking and excessive wear of the contacts is minimized by means of spark-suppressor condensers (EM-25605). **The contacts are, however, subject to wear in normal operation.** Adjustment of voltage to compensate for contact wear may be made by turning the Voltage-Adjusting Knob (EM-25641) on the front of the Regulator case. This adjustment need be made only occasionally.

Erratic voltage, or inability to maintain normal voltage may indicate that the Regulator contacts need attention.

Care

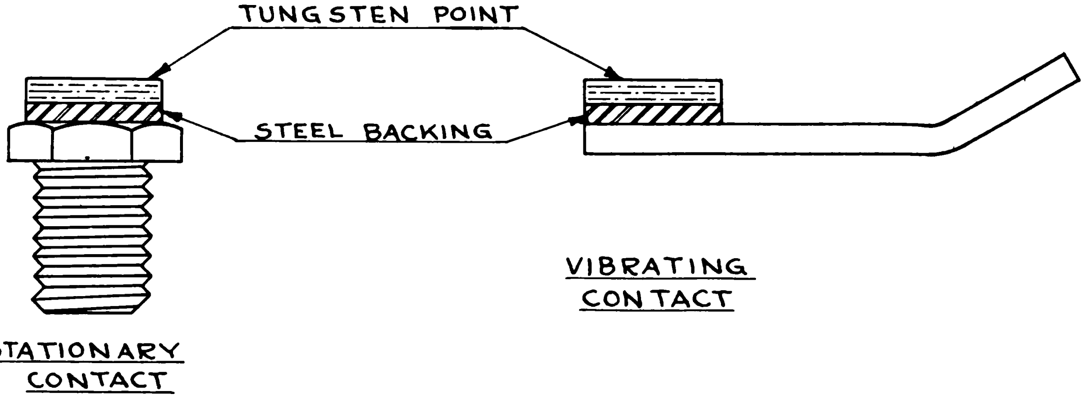
If inspection shows that the contacts are quite pitted and there are sharp points on the surface they can be smoothed to some extent by use of an automobile distributor contact file. It is better practice, however, to remove the contacts and dress them down with a fine emery stone or a fine oil stone. Do not grind any more than just enough to take off the main projections.

Replacement

Pitting or blackening of the contacts **does not** necessarily mean that they need replacement. Smoothing the high spots as instructed in the previous paragraph will put them in good condition.

THE CONTACTS ARE MADE BY WELDING A TUNGSTEN DISC .040" THICK TO A PIECE OF STEEL OF THE SAME DIAMETER. A LINE SHOWS WHERE THE WELD TOOK PLACE.

CONTACTS NEED REPLACING ONLY WHEN THE BLUE STEEL BACKING SHOWS THROUGH THE TUNGSTEN POINTS, THAT IS, WHEN THE CONTACTS ARE WORN CLEAR THROUGH TO THE STEEL BACKING.



Replacement — *(Cont'd)*

As soon as the tungsten tips of the contacts are worn through to the steel backing, the contacts must be replaced.

To replace contacts, loosen the two bolts in the relay (EM-25601, Fig. 21) which hold the vibrator, and remove vibrator. Unscrew the stationary contact and replace with a new one. Insert the new vibrator, line up the contacts, tighten securely and adjust the air-gap as follows:

Insert the stationary contact and screw back as far as it will go if it is new, or leave at the previous setting if only refaced. Then after inserting the vibrator, back off the vibrator contact by means of the voltage adjusting knob (EM-25641) until the voltage setting is normal—approximately three turns past the point where the contacts first touch. With this contact pressure adjust the air-gap between the core and vibrator to 1/32″. This adjustment is made by turning the "Vibrator Reed Air-Gap Adjustment Screw" (Fig. 21) after loosening the set screw. The air-gap adjustment is now as close as is ever required.

Tungsten contacts must spark in order to operate well. For this reason sparking of the contacts of the voltage regulator has not been eliminated but has been reduced to a safe value by means of the spark-suppressor condenser (EM-25605).

Working on Contacts with Generator in Service

Should it become necessary to remove contacts and still keep the generator in service, it can be done as follows:

1. Stand on a dry board and otherwise avoid touching "live" parts when working on any part of the unit.

2. Shift from automatic to hand regulation as follows:
   Cut out resistance by turning the exciter rheostat hand-wheel to the left (counter-clockwise) until the voltage has been increased a few volts and then lower the voltage back again by the regulator control knob. Repeat this until the regulator control knob CANNOT lower the voltage further. Now the exciter rheostat has full control and the "AUTO-HAND" (EM-25622) switch can be thrown to the "HAND" position.

3. To put the regulator back in service, throw the switch back to the "AUTO" position, cut in exciter rheostat resistance (by turning the handle to the right) and turn the regulator knob until the regulator has full control and the rheostat is all cut in (all the way to the right, or to the punch mark on the rheostat.)

Air-Gap Between Vibrator and Core of Regulator

The Voltage Regulator performs best when the air-gap between the core of the relay (EM-25601) and vibrator (EM-23615) is approximately 1/32″ but the action may be satisfactory with an air-gap as small as 1/64″ or as large as 1/16″. This air-gap is adjusted by screwing the stationary contacts up or down with the Vibrator Reed Air-Gap Adjustment screw (See Fig. 21). As the contacts wear the air-gap will increase and cause a slower restoration of voltage on load changes. This is not serious in most cases but can be corrected by adjusting the stationary contacts to give the normal air-gap of 1/32″ between the vibrator and core of the regulator. Check regularly.

Troubles and Their Elimination

In case of voltage irregularity or inability to maintain normal voltage, remove cover of Voltage Regulator and check contacts as previously instructed. When contacts are in proper operation and voltage is still irregular or cannot be maintained, see that generator collector-ring brushes, and exciter commutator brushes are clean and have proper pressure. Also check for possible loss of generator speed or exciter speed due to looseness of belts.

Do not change or tamper with wiring of the Voltage Regulator except to check tightness of connections where necessary, or as instructed below:

Voltage Will Not Build Up

1. If vibrator does not vibrate see that voltage is getting to the coil of the Voltage Regulator. There may be a loose or open connection in the Regulator or exciter circuit.
2. Regulator contacts may be excessively dirty and need cleaning up.
3. Check the commutator and brushes on the exciter to make sure contact is good. Clean brushes and commutator of dust or other foreign material. Check brush pressure.
4. Make sure that the exciter rheostat hand-wheel is all the way to the right for automatic operation. Check exciter operation by cutting out rheostat, turning handwheel to the left for a few seconds. If voltage builds up, exciter is operating properly.
5. Check for excessive belt slip which will cause a reduction in exciter speed.
6. Check up on generator collector-ring brushes and connections.
7. The Voltage Adjusting Knob may be turned too much in the decrease voltage direction.

Voltage Regulator Does Not Control the Voltage at All

1. Be sure "AUTO-HAND" switch is in position for automatic operation.
2. Be sure exciter rheostat is turned "IN" (to decrease excitation) completely, or to the punch mark indicated on the rheostat.
3. Check large resistor (EM-25612, Fig. 22) on back of regulator panel for open circuit.
4. Check relay (EM-25601) coil for open circuit or short circuit. If the relay coil has no voltage the regulator will not operate. The normal operating voltage on the relay coil is 40 to 60 volts A. C.
5. Check exciter rheostat (EM-25618, Fig. 8) circuit for a short circuit in the rheostat or its wiring.
6. Contact vibrator may be bent or contacts stuck.
7. Voltage adjusting knob (EM-25641) may be turned too much in the increase voltage direction.

Voltage Becomes Erratic

1. The anti-hunt resistor (EM-25606) may not be adjusted properly. To increase the anti-hunt effect, increase the resistance of this resistor. CAUTION: In the adjustment of this resistor never cut out more than 50% of the resistance in decreasing the anti-hunt force. After this resistor setting has been changed it will be necessary to re-set the voltage by means of the voltage adjusting knob on the front of the regulator. This resistor is set properly at the factory and should need no further adjustments.
2. The exciter field rheostat adjustment will affect the operation of the voltage regulator. Too high a resistance will cause the regulator to "hunt". The proper setting for the exciter field rheostat is just below the setting which produces "hunting". Too low a setting will cause the sensitivity of the regulator to be poor. This rheostat is adjusted at the factory and a punch mark is put on the rheostat to indicate the correct setting of the rheostat.

   NOTE: The term "hunting" refers to a periodic variation of generator voltage from normal voltage. The period of variation is usually 1 to 5 times per second.
3. Check for tightness of Regulator connections and other connections in the generator or exciter circuit.
4. Check for excessive build-up or pitting of the Regulator contacts.
5. Make sure no contact is stuck.
6. In some obstinate cases it is found that exciter brushes are off neutral. Shifting the brushes against the rotation may correct the difficulty. Do not shift more than necessary, since it may cause sparking at the commutator.
7. The relay air-gap (Fig. 21) will sometimes affect the stability of the regulator. In some cases the erratic or "hunting" condition of the regulator may be corrected by readjustment of the air-gap. In most cases it will be found that the air-gap must be reduced to a smaller value than the recommended setting of 1/32". In unusual cases where the "hunting" is produced by too much stabilizing effect, it may be necessary to increase the air-gap to about 1/16". This should be done only if items 1 to 6 above fail to correct the trouble.

Voltage Sensitivity is Poor

1. Make sure that the Exciter Rheostat Handwheel is turned all the way to the right, or to the punch mark on the rheostat.
2. See that no screws or mechanical parts of the Voltage Regulator relay have become loose.
3. Check connections for tightness.
4. Air-gap may be too large or too small. Adjust air-gap to 1/32".
5. Contacts may need to be cleaned or refaced.

Voltage Droops Excessively with Increase in Generator Load

1. Regulator "AUTO-HAND" switch may not be in the "AUTO" position.
2. Exciter Field Rheostat may not be cut in enough.
3. The voltage droop is determined by the setting of the exciter field rheostat. To decrease the droop increase the resistance (decrease excitation) slightly.

Contact Sparks Too Much

1. The spark-suppressor condenser (EM-25606) may be disconnected, or open-circuited. A contact that does not spark may have a condenser with a short-circuit in it. A contact whose spark is large and shows a yellow flame may have a condenser that is open-circuited. Condensers are easily checked by any standard condenser test set.
2. A lead may be broken or loose between the contacts and the spark-suppressor condenser.
3. A lead may be loose to the hand rheostat, or the rheostat burned out or broken.

Cross Current Compensation

When operating generators in parallel the division of the **kilowatt load** between the generators depends upon the driving power of the diesel engines which is controlled by the engine governors. (Refer to Operating Instructions, Parallel Operation of Generators, Page 10.) This division of kw load is practically independent of the field current of the generator as supplied by the exciter. However, certain types of loads (low power factor loads) when connected to the generator, cause the output of the generator to consist partly of current which is not convertable to power. This current is technically called "reactive kva" and generally called "wattless current".

The division of the "wattless current" between generators operating in parallel depends entirely upon the excitation of the generator field. If the excitation of one generator is greater than others with which it is operating in parallel, it will furnish more than its share of the "wattless current". It is therefore necessary to provide a means of correcting the excitation of individual generators which take more or less than their proper share of wattless current. Although the voltage regulators control the field excitation (See General Information, Voltage Regulator, Page 4) it isn't possible to make two voltage regulators exactly the same. That is, it isn't possible to regulate the output of the generator so close that it will not vary a slight bit from that of any other generator. The slightest change will cause unequal division of "wattless current".

To correct this discrepancy, the voltage regulator relay coil (EM-25601, Fig. 21) is connected in parallel to the secondary of a current transformer (EM-25616, Fig. 16) across a rheostat (EM-25612, Fig. 22), as well as across the generator terminals. Thus the vibration of the vibrating reed is effected by the current output as well as by the voltage output of the generator. This is called "Cross-Current Compensation".

As the current output of the generator increases, the energy into the voltage regulator coil increases causing the vibrator reed to increase the magnitude of its vibrations thus causing the contact to be open more and cut down the excitation. Reduced excitation of course cuts down the generator current output. The voltage however, will reduce only slightly because the generator is connected to the bus on which the voltage is maintained by the other generator or generators. The amount of current shunted through the relay coil can be varied by the Cross Current Compensation rheostat.

SYNCHRONOUS GENERATOR "B"

This section of Generator Instructions refers to all Generators except those listed on pages VI (Specification No. 310), VIII and IX (Specification No. 315), XI (Specification No. 375), XIII (Specification No. 368).

CONTENTS

CONTENTS

GENERAL DESCRIPTION

GENERAL DESCRIPTION

SYNCHRONOUS GENERATOR

Function of the Synchronous Generator

The synchronous generator (Fig. 25) is a device to convert mechanical power to electrical power. Mechanical power is transmitted from the diesel engine through a flexible coupling and thus to the generator shaft (Fig. 26); and the electrical power output is obtained by simply making connections to the lead terminals, L1, L2, L3, L0, (see Fig. 28).

Here—briefly—is how the mechanical power is converted to electrical power. The rotor (Fig. 26) turns with the generator shaft. Thus the field poles (Fig. 26) revolve within the armature (Fig. 26) and move past the armature coils. At the same time current from the belted exciter (Fig. 26) (described in the following section) flows through the generator field coils making each of the field poles a strong magnet. The action of the revolving magnet generates an electrical voltage and current in the armature coils.

Electrical Rating

The generator is designed so that it can be operated to give either a 60 or 50 cycle output as follows:

60 Cycle Output—1200 RPM

127.5	Kva (kilovolt amperes)
102	Kw (kilowatts)
60	Cycles per second
80%	Power factor
220/127	Volts
335	Amperes full load per terminal
3	phase

50 Cycle Output—1000 RPM

113.7	Kva (kilovolt amperes)
91	Kw (kilowatts)
50	Cycles per second
80%	Power factor
400/230	Volts
164	Amperes full load per terminal
3	phase

Complete instructions for changing over from 60 to 50 cycle operation or vice versa are given on Pages 118-119.

Temperature Rating

When operated at full load continuously the generator field poles (Fig. 26) will have a maximum temperature rise that will not exceed 50 deg. C. (122 deg. F.) above the ambient temperature (temperature of the surrounding air).

The armature core and coils (EM-518002, Fig. 38) will have a maximum temperature rise that will not exceed 40 deg. C. (104 deg. F.) above the ambient temperature.

When operated at **25% overload for 2 hours** the field will have a temperature rise that will not exceed 65 deg. C. (149 deg. F.) and the armature a temperature rise of 55 deg. C. (131 deg. F.) above the ambient temperature.

Mechanical Construction

The generator is of drip proof construction, self ventilated, complete with single ball bearing, special terminal box, and screen covers over the openings at the bottom (to prevent entrance of rodents and large insects). The generator is coupled directly to the diesel engine through a flexible coupling (see Fig. 93).

Manufacturer's Identification

Identification of the generators to the Manufacturer is as follows:

Size AF-6

Production number..67728

Serial numbers .....85367 to 85446 incl.

85522 to 85867 incl.

EXCITER

The direct current generator which provides the direct current for the synchronous generator field coils of the synchronous generator is called the exciter (Fig. 26). Like the synchronous generator it is capable of converting mechanical power to electrical power. The belt drive illustrated in Fig. 27 transmits mechanical power to the exciter from the generator shaft but since that shaft gets its mechanical power from the diesel engine, it is apparent that the engine furnishes mechanical power not only for the synchronous generator, but also for the exciter.

The exciter also has field poles and an armature core, but unlike the synchronous generator the exciter field poles are stationary and the exciter armature rotates. This can be clearly seen by comparing Fig. 41 showing the exciter parts with Figs. 33 and 34 on the synchronous generators.

The exciter armature (EM-518101, Fig. 41) rotates in the stationary magnetic field set up by field coils mounted on the field frame (EM-518108, Fig. 41) inducing a voltage in the armature coils. Although the voltage induced in each individual coil is an alternating current voltage, these coils

EXCITER — (Cont'd)

are connected to the commutator (EM-518118, Fig. 41) in such a way that there is a direct current voltage at the carbon brushes, to which the armature leads (EM-518136, Fig. 41) are connected.

The voltage at the exciter brushes and consequently the voltage on the exciter armature leads is increased by increasing the current in the field coils and consequently increasing the strength of the magnetic field.

To accomplish this for manual operation (when a voltage regulator is not used) all of the exciter field poles are connected in series and one end of this circuit is connected directly to one of the carbon brushes (EM-518129, Fig. 41) while the other end is connected in series with exciter field rheostat (Fig. 29) before eventually connecting to the other carbon brush.

Varying the resistance in the exciter field circuit thus increases or decreases the voltage on the exciter armature leads. But since these leads connect to the synchronous generator field coil circuit through the collector rings (EM-518045, Fig. 34) and brushholders it is apparent that varying the exciter field circuit resistance also controls the synchronous generator armature voltage.

Electrical Rating

The exciter is designed to develop a full load electrical output as follows:

2	Kw (kilowatts)
125	Volts DC
16	Amperes

Temperature Rating

The exciter will operate at full load continuously with a maximum temperature rise of 40 deg. C. (104 deg. F.) above the ambient (surrounding air) temperature.

Mechanical Construction

The exciter is of drip proof construction, self ventilated, complete with two ball bearings, screen covers over the opening at the bottom (to prevent entrance of rodents or large insects). The exciter is mounted on top of the generator frame and is driven by three "V" belts from a sheave mounted on the generator shaft. (See Figs. 26 and 27.)

GENERATOR TERMINAL BOX

The generator terminal box (Fig. 26) is mounted on the right side of the generator frame when facing the shaft extension end. Links (Figs. 30 and 31) provide a means of easily changing connections to obtain either generator output as listed under Electrical Ratings, Page 112.

Proper link arrangements are explained under Operating Instructions, Connections, Pages 118-119. These connections, when properly made, take care of all changes required to make the meters and instruments on the Generator Line Unit (See Page 134) operate correctly.

GENERATOR LINE UNIT

The generator line unit (Fig. 27) is mounted on the left side of the generator frame when facing the shaft extension end. An instrument panel (EM-25800) generator circuit breaker (EM-25671-1) and line terminal lugs (EM-25674), voltage regulator (EM-25600-1), and exciter rheostat (EM-25770) are mounted on the line unit.

Instrument Panel

The instrument panel is mounted in rubber on the frame of the generator line unit. The rubber mounting prevents the vibration of the engine and generator from effecting the reading or adjustment of the sensitive meter parts.

A voltmeter is provided, along with a voltmeter switch, making it possible to read the voltage between each of the three line leads (L-L 1, 2, 2 on switch) and between each line lead and the neutral (L-N 1, 2, 3 on switch).

An ammeter and ammeter switch are provided to indicate the current in each of the three phases.

A frequency meter indicates the frequency at which the alternating current is being generated when operating on either 50 or 60 cycles.

A total hour meter indicates the total number of hours that the unit has operated up to 99,999 hours and then the meter starts over again like a mileage speedometer on an automobile.

Synchronizing lamps and synchronizing lamp switch provide a means of synchronizing the generator with other similar generators or with an existing source of 3-phase, 50 or 60 cycle power of the same voltage. (See Pages 121-122).

Two 12 volt panel lights are furnished for operation in series with the 24 volt diesel engine battery. A panel lamp switch is provided to switch the lights on or off. These lights are operated from the battery so that in case of breakdown of the generator it is possible to obtain light at the panel.

Generator Circuit Breaker

The generator circuit breaker provided the means of connecting the generator to the load. In other words it is the means of connecting the power output of the generator to the power line serving the equipment requiring electrical power.

The breaker is provided with trip units (EM-25672A or 1B, Fig. 32) which automatically disconnect the generator from the load if the load current becomes too much for the engine and generator to carry. The trip unit operates on a thermal principle. The flow of current causes heating. Higher currents cause greater heat. The trip unit is set to disconnect the generator from the line when a predetermined amount of heating takes place. This prevents damage to the unit due to heavy currents.

A trip unit rated 175 amperes maximum is used on 50 cycle—1000 rpm operation and 500 amperes maximum on 60 cycle, 1200 rpm operation. This is because the generator has different generating capacity at the different speeds.

Voltage Regulator

The voltage regulator (Fig. 29) will automatically adjust exciter field circuit resistance as required to maintain a constant voltage at the terminals of the synchronous generator. This eliminates the need for making continuous adjustments to the setting of the exciter field rheostat.

The voltage regulator regulates the voltage output of the synchronous generator so that it will not vary, except momentarily, more than plus or minus 2% of the rated voltage.

The coil of the relay (EM-25601-1, Fig. 28) which actuates a vibrating contact, is connected across the generator terminals through a potential transformer. The voltage of the generator governs the magnitude of the vibrations of the contact so that when the voltage is high the contact vibrates with a shorter period of contact than when the voltage is low. The contact is connected into the exciter shunt field circuit. Thus when the alternating current output voltage of the generator is high, there is less contact of the vibrating contacts resulting in a weakened exciter field. When voltage is low there is more contact on the vibrating contacts resulting in a strengthened exciter field.

The strength of the exciter field determines the output of the exciter and the output of the exciter determines the strength of the rotating field of the generator, thus the voltage output of the generator. The voltage of the generator can be raised or lowered by changing the setting of the voltage adjusting knob on the front of the voltage regulator.

Exciter Rheostat

The exciter rheostat (Fig. 29) is a variable resistor which is connected into the field circuit of the exciter. The resistance of the rheostat can be varied manually and since the strength of the exciter field effects the voltage of the generator, the generator voltage can be varied by hand. The rheostat is not in the exciter field circuit when the voltage regulator is used to regulate the generator voltage.

OPERATION

OPERATING INSTRUCTIONS

INSTALLING

In general, the engine generator set should be installed on a level floor or level ground in a clean, well-ventilated place, accessible for inspection and care. The generator should be protected as much as possible from excessive moisture, oil, dust and dirt. It should not be installed where inflammable gases or combustible material may float in the air.

The engine generator set should be so placed that the Generator Line Unit is easily accessible for reading meters and adjusting the voltage regulator.

CONNECTIONS

The generator terminal box (Figs. 30 and 31) provides for connections to operate at 220/127 volts, 60 cycles, 1200 rpm, or 400/230 volts, 50 cycles, 1000 rpm.

220/127 Volt, 60 Cycle Operation

The proper terminal box connections for 220/127 volts, 60 cycle, 1200 rpm operation are shown in Fig. 30. The large connecting links are connected between terminals 0 & 4, 4 & 5, 5 & 6, 7 & 1, 8 & 2, 9 & 3. The small connecting link labeled "Voltage Regulator" is connected between terminals A & C. The small connecting link labeled "Synchronizing Lamps" is connected between terminals D & F.

The generator circuit breaker overload trip unit for 60 cycle, 220 volt operation (EM-25672-1B, Fig. 32) is identified with the number 500. This indicates that the trip unit is for 500 amperes maximum operation.

Refer to Fig. 32 showing the method of removing and replacing a trip unit. Remove the front of the Generator Line Unit labeled "Generator Circuit Breaker" and remove the cover of the breaker (Item EM-25695). Use the wrench provided in the tool compartment to remove the six nuts (Item EM-25696) and loosen the six screws (Item EM-25697). The remaining screw on the top middle terminal (Item EM-25698) is loosened and the trip unit can be removed by unhooking it from the tripping mechanism. When placing a trip unit in the breaker make sure that the center screw at the top of the trip unit is tight, engage the tripping mechanism and replace the screws (EM-25697) and the six nuts (EM-25696).

The 500 ampere trip unit must be placed in each breaker for 60 cycle operation.

400/230 Volt, 50 Cycle Operation

The proper terminal box connections for 400/230 volt, 50 cycle, 1000 rpm operation are shown in Fig. 31. The large connecting links are connected between terminals 4 & 7, 5 & 8, 6 & 9. The small connecting link labeled "Voltage Regulator" is connected between terminals A & B. The small connecting link labeled "Synchronizing Lamps" is connected between terminals D & E.

400/230 Volt, 50 Cycle Operation — *(Cont'd)*

The generator circuit breaker trip unit for 50 cycle, 400/230 volt operation is identified with the number 175. This indicates that the trip unit is for 175 amperes maximum operation.

Refer to Fig. 32 showing the method of removing and replacing a trip unit. The proper trip unit is installed as directed under 60 cycle operation.

The 175 ampere trip unit must be placed in each breaker for 50 cycle operation.

Load Connections

After the terminal box and the breaker are set for the operation required, use the wrench provided in the tool compartment to connect the load leads to terminals L1, L2, L3 and L0 of the generator circuit breaker. The terminal lugs are reached by removing the panel labeled "Remove this panel for access to load terminals". See Fig. 28.

Terminal L0 is the neutral connection for use when the load consists of a 4 wire system. **This neutral connection should be used only in accordance with the general practice of the U. S. Army Engineers.**

Ground the frame of the generator in accordance with general practice of Army Engineers. The ground connection must be made with wire at least the size of that used to connect to the load so that the ground connection will carry short circuit current in case the generator becomes grounded.

BEFORE STARTING

1. When starting up first time, remove the blue protective lacquer from the generator collector rings, (EM-518045, Fig. 34) with alcohol or equivalent.
2. See that brushes on exciter commutator and generator field collector rings make contact and are free to move in their holders (Figs. 41 and 35 illustrate these parts).
3. Make sure all moving parts have sufficient clearance from stationary parts and that no loose objects are lodged in the generator.

The ball bearing (EM-518053, Fig. 34) is properly packed with grease before shipment so no attention is required.

STARTING

1. See that the generator circuit breaker is open (in the down position). Use the circuit breaker handle from tool compartment to operate the breaker.
2. The synchronous generator output voltage may be controlled either automatically with automatic voltage using the voltage regulator or, by hand using the exciter rheostat.
   (a) **Automatic Voltage Regulation:** Turn the exciter rheostat handle all the way to the right (clockwise direction), or

STARTING — *(Cont'd)*

"Increase Excitation" direction. Turn the regulator switch (EM-25622, Fig. 52), located in the regulator cover, to the "Auto" position.

(b) **Manual Voltage Regulation:** Turn the exciter rheostat handle all the way to the right (clockwise direction) or "Increase Excitation" direction. Turn the regulator switch (EM-25622) to the "Hand" position.

3. Start the engine and bring generator up to speed. The speed can be checked accurately by observing the frequency meter. At correct speed the frequency meter will indicate the proper frequency for either 50 or 60 cycle operation.
4. See that the generator is operating at rated no load voltage, (check voltmeter, EM-25801, Fig. 46), and close generator circuit breaker.
   (a) If on automatic operation adjust the voltage regulator adjusting knob so that the voltmeter registers proper voltage.
   (b) If on hand operation adjust the exciter field rheostat so that the voltmeter registers proper voltage.
5. Make sure the automatic polarity reversing switch motor (EM-25602, Fig. 52) is running. (See voltage regulator maintenance instructions, Page 137).

LOW VOLTAGE

The following conditions may prevent the generator from developing normal voltage.

Generator

1. Speed may be below normal. Check with the frequency meter (EM-25806, Fig. 52). If the speed is below normal the frequency meter will show low frequency.
2. Generator collector ring brushes (EM-518030, Fig. 35) may be making poor contact. See instructions for maintenance of generator brushes and collector rings, Page 126.

Exciter

1. Speed may be below normal. Check "V" belt drive (EM-518072, Fig. 33) for tightness. Belts should be just tight enough so that they do not slip. Remove the back plates (EM-518206 and EM-518205, Fig. 33) of the drip proof covers to get at the "V" belts.
2. Commutator, after long use or exposure, may become rough and dirty, or brushes may be excessively worn. See Fig. 41 and instructions for maintenance of exciter commutator and brushes, Page 131.
3. If on hand operation, the exciter field rheostat (EM-25770, Fig. 50) (See Fig. 29) might be turned all the way (counter clockwise) to the left.
4. Exciter field may lose residual magnetism. The field poles retain a slight amount of magnetism while idle. If this magnetism is lost, the exciter will not build up voltage. If all other efforts fail to correct the difficulty, connect a battery across F1 and F2 of the terminal block (EM-25865, Fig. 45) in the generator line unit. If, after building up voltage, the ammeter indicates in reverse, shut down and reverse the connections F1 and F2.

Voltage Regulator

1. Voltage may require adjustment with Voltage Adjusting Knob (EM-25641, Fig. 52).
2. Contacts of regulator may need attention. See maintenance instructions on voltage regulator contacts, Page ....
3. **Polarity** of the connections from the exciter may be reversed. Reverse the connections at F1 and F2 on the terminal block (EM-25865, Fig. 45).
4. Voltmeter or ammeter may read incorrectly. Voltage may be higher than indicated or current may be higher than indicated. Check with another voltmeter or ammeter.

OPERATING TWO GENERATORS CONNECTED TOGETHER (PARALLEL OPERATION)

1. Before connecting the synchronous generator to be operated in parallel with others for the first time, check phase rotation to see that it is the same as that of the other generator on the power system with which it is to be paralleled. One method of checking phase rotation is to connect a three-phase induction motor first to one generator, then to the other generator, making sure that the motor is connected to the **correct corresponding phases.** That is, tag the 3 leads of the motor to correspond with the marking on the terminals of the generators or power systems to be paralleled. When rotation of the motor is in the **same** direction for all generators, the phase rotations of the generators are the same. If rotation of the induction motor is opposite for the incoming generator than for the other generator, reverse any two of the three power terminals (i.e. not the neutral where neutral lead is used) of the generator and check again with motor until correct phase rotation is indicated.
2. Connect the generator to the line making sure proper phases are connected together. The connections should not be made when one generator is operating unless absolutely necessary (operator may suffer severe shock). After making connections start up the first generator in accordance with instructions close the generator circuit breaker.
3. Start up the second generator and bring it up to proper speed as indicated by the frequency meter (Fig. 46).
4. Synchronizing lamps all carried in the tool compartment. Place them in the sockets and turn the synchronizing lamp switch (EM-25813) of the second generator to the "ON" position.
5. The synchronizing lamps will flicker until the two generators are very close to the same speed or in other words, close to synchronism. As the generators approach synchronism the fluctuations of the lamps will become slower. When the fluctuations are very slow, about one fluctuation every two or three seconds, the breaker of the incoming generator may be closed when the lights are dark, thus paralleling the

OPERATING TWO GENERATORS CONNECTED TOGETHER (PARALLEL OPERATION) — *(Cont'd)*

generators. If the incoming generator is thrown on the line when the lights are not dark, electrical disturbances will cause severe mechanical stresses which may result in misalignment of the engine and generator.

The governors of engines whose generators operate in parallel determine how much kilowatt load each generator carries. If governors are not set for the same speed and adjusted for the same droop in speed from no load to full load then they do not divide the kilowatt load proportionally. It sometimes happens that one engine will actually drive another through the generator, one generator acting as a motor. At such times the generator currents are high, totalling much more than the load. In such a case adjust the governor of the machine carrying the least current so as to increase its speed, until the sum of the currents of the generators is at minimum. The best check on whether engines are carrying their proper loads is by their indicating devices, or the exhaust of the diesel engine. (Refer to Maintenance, Voltage Regulator, Cross Current Compensation, Pages 141-142).

MAINTENANCE

MAINTENANCE

To insure the best operation, make a systematic inspection of the generator, and its associated equipment once every 300 operating hours at normal service. If particularly hard service has been given check whenever possible. Special attention should be given to the following:

CLEANLINESS

See that both the interior and exterior of the generator, exciter, generator line unit and generator terminal box are kept free from an accumulation of dust, dirt, oil or water, and particularly metallic particles.

Blow out each part of the unit occasionally by directing a stream of air through each part. The amount of cleaning necessary will depend on the service conditions under which the generator operates. When using air for blowing out, do not use excessive pressure, as it will curl up edges of insulation on windings.

GENERATOR

Bearings

(See Figs. 33 through 40 for illustrations of the parts mentioned.)

Lubrication

The generator ball bearing (EM-518053) shown in Fig. 34 is an SKF ball bearing No. 6314. The bearing housing (EM-518057) is packed with 3 oz. of high grade neutral grease, Army Classification WB-2.

The bearing housing should be flushed out with flushing oil and refilled with new grease every 1000 hours of normal service. If gasoline or other solvents are used for flushing out housing, be sure to remove all traces of the solvent before filling the housing with grease. To obtain the best efficiency fill the housing 1/3 to 2/3 full. The housing will hold approximately 6 oz. of grease, but it should never be filled more than 2/3 full.

The greasing plug (EM-518049) shown in Fig. 33 is accessible through the hand hole by removing the hand hole cover (EM-518066) in the lower rear cover plate (EM-518205). The drain plug (EM-518050) extends below the guard screen (EM-518204).

Bearing temperature rise above the ambient (surrounding air) temperature should not be more than 40 deg. C. (104 deg. F.). The temperature rise should be checked occasionally. A bearing may run hot for the following reasons:

1. Contamination of grease.
2. Insufficient amount of grease.
3. Too much grease which causes excessive heating due to churning.
4. Grease too stiff preventing free action in bearing.
5. Excessive thrust due to misalignment or excessive imposed loads.
6. Pounding caused by bearing being loose on shaft or balls being worn detectable by noise.
7. Actual bearing failure caused by broken or flat balls detectable by noise.
8. Heat from external source causing high bearing temperatures.

Causes in Items 1, 2, 3, & 4 can be prevented by properly following lubrication instructions on Pages 124-125, 129-130.

Lubrication — (Cont'd)

The difficulty in Item 5 could be caused by a misaligned coupling or sprung stator frame. Do not exert excessive pressure on one end of frame to make it fit onto the engine bedplate.

Difficulties in Items 6 & 7 should be remedied by replacing the bearing. Before attempting to replace the bearing, determine the underlying cause and take steps to prevent a recurrence.

Removal of Generator Bearing

(See Figures 9 & 10):

1. Remove upper (EM-518206) and lower (EM-518205) rear cover plates by removing the 10 screws (EM-518202). (Screw driver is provided in the Tool compartment.)
2. Loosen "V" belts (EM-518072) by loosening the bolts (EM-518201) holding the exciter sheave covers (EM-518208 and EM-518209) and lowering the four bottom jamb nuts on the exciter mounting studs (EM-518074). Remove the "V" belts.
3. Loosen the set screw in the exciter sheave (EM-518077) and remove the sheave.
4. Remove exciter sheave covers (EM-518208 and EM-518209) by removing bolts (EM-518204) and taking the cover apart.
5. Remove screw (EM-518060) and retaining washer (EM-518061) at the end of shaft, loosen set screw (EM-518076) in hub of drive sheave (EM-518064) and pull the sheave off.
6. Remove the greasing and draining plugs (EM-518049) and (EM-518050).
7. Remove the 4 bearing housing bolts (EM-518058) and 6 bearing bracket bolts (EM-518048), loosen the field leads (EM-518025) and remove the bearing bracket (EM-518047) allowing the rotor to rest on the stator.
8. Remove the sheave spacer (EM-518059) by sliding it off the shaft.
9. Remove the four bearing housing cap screws (EM-516056) and remove the bearing housing (EM-518057).
10. Apply outward pressure to the inner race of the bearing (EM-518053) only, until the bearing comes off shaft. A steady pressure should be applied if possible rather than pounding by means of hammer blows. But if a hammer is the only available tool, the blows should be transmitted by means of a wooden or fibre block.
11. Put on the new bearing with steady inward pressure on the inner race of the bearing only. Before replacing the bearing housing wash it out with a flushing oil. After the housing is mounted make sure all screws and plugs are securely tightened in place.

To reassemble, follow back through the steps of disassembly.

Collector Rings and Brushes

(See Figures 33, 34, and 35 for illustration):

The collector rings (EM-518045) are made of cast brass and are bolted (EM-518046) to a bakelite sleeve (EM-518044) which fits over the shaft and is secured with a socket head set screw (EM-518043). These rings are connected to the generator field coils and collect the direct current output of the exciter through carbon brushes (EM-518030) which are mounted in the brush holder (EM-518031) as shown in Fig. 35. If the direct current of the exciter does not reach the generator field coils the generator will not generate electricity.

To reach the brushes and collector rings for servicing it is necessary to remove the bolts (EM-518202) holding on the lower rear cover plate (EM-518205) and remove the plate. The brushes and rings can be reached through the openings in the bearing bracket.

Improper functioning of the collector ring and brushes is indicated by sparking. Sparking may be caused by one of the following conditions and may be remedied as indicated:

CAUSE	REMEDY
1. Collector rings not running concentric with shaft.	1. Turn rings concentric to shaft and surface polish with a commutator grinding stone or sandpaper. (DO NOT USE EMERY CLOTH.)
2. Collector ring surface rough or pitted.	2. Turn rings or polish with a commutator grinding stone or sandpaper depending on roughness. This roughness is usually due to prolonged sparking.
3. Brushes tight in brush holders.	3. Remove brush by lifting spring and clean the holder socket. Check the brush for high spots. Clean off larger spots with sandpaper.
4. Oil on surface of collector rings.	4. Correct oil leakage and wipe off surface of rings and brushes.
5. Vibration of brush holder stud.	5. Tighten brush holder stud (EM-518034) which is mounted in the bearing housing cap and fastened with a jamb nut. Also tighten the screw (EM-518033) which holds the brush holder on the stud.

If it is necessary to remove the collector rings for turning or replacement proceed as follows:

1. Remove the bearing (EM-518053) by proceeding as described in detail under bearing removal.
2. Remove the bearing housing cap (EM-518054) along with the brush holders after disconnecting the field leads.
3. Loosen socket head set screw (EM-518043) and remove collector rings.

When installing new brushes, the ends of brushes should be ground to fit curvature of collector ring. This can be done by putting a piece of sandpaper on the surface of collector rings with rough side against the brush. While the brush is pressed against sandpaper, move sandpaper in direction of rotation of rings and repeat this motion until brush fits curvature of rings.

Field Poles

(See Figures 33, 34 and 36):

Field poles (EM-518081) are made up of copper wire wound on a laminated steel pole after the pole is properly insulated. Damage which breaks the wire on a field pole or the connections between poles and the collector rings will make operation impossible.

If it is necessary to replace a field pole proceed as follows:

1. Remove the generator from the engine and base by removing bolts holding flexible coupling to engine flywheel, the bolts holding generator to the base, and disconnect any wire connections between engine and generator.
2. Press off the flexible coupling (MD-6111A).
3. Remove 6 bolts (EM-518007) and remove coupling end baffle (EM-518008).
4. Carry out operations No. 1 to No. 9 inclusive as outlined on Page 125 under the heading "Removal of Generator Bearings."
5. Disconnect field leads from brushes by loosening bolt (EM-518036).
6. Place a pipe, (at least 6 ft. long), with an inside diameter slightly larger than the coupling end shaft diameter, over the coupling end shaft extension. Place the lifting rope or chain of a hoist around the pipe as close to the rotor as possible and lift until hoist supports the end of the rotor. Apply downward pressure on the free end of the pipe until the rotor is completely supported by the hoist. Maintain the downward pressure on the pipe and pull the rotor out of the stator. If there is no pipe available, lift the shaft extension end as high as possible and slide a sheet of tin or similar hard surface sheet material between the rotor and stator and remove the rotor by sliding it out of the stator.
7. Apply an even pressure around the inner race of the bearing or pound with hammer transmitting the blows by means of a wooden or fibre block and thus remove the bearing.
8. Remove bearing housing cap (EM-518054) and the brush holders (EM-518031).
9. Loosen the set screw (EM-518043) and remove the collector ring assembly (EM-518045).
10. Remove blower bolts (EM-518011) and remove both blowers (EM-518010).
11. Disassemble the damper winding on the pole to be removed by either of the following methods:
    (a) Drill out iron rivet (EM-518084) holding end segments (EM-518041) of the end ring.
    Heat up the phos. copper weld between the end segments to at least 1300 deg. F. so the phos. copper melts. Both ends of both end segments must be loosened.
    (b) Saw the weld and rivet by sawing along the welded portion of the segments.
12. Disconnect the connections to the field winding from adjacent pole winding.

Field Poles — *(Cont'd)*

13. Drive out the pole pin (EM-518083, Fig. 36) with a rod of slightly smaller diameter than the pole pin.
14. Remove the pole, in the direction which allows free movement of the end segments, by hammer blows transmitted by a wooden or fibre block against the lower part of the pole. Do not pound on the windings unless you know they are damaged beyond repair.
15. Put on a spare pole by reversing the above procedure. Make sure the spare pole has the ends of the windings brought out at the same side as those on the pole which was removed. Each pole is connected so that the field current flows opposite to that in the adjacent pole. The pole shims (EM-518082) consist of one piece of 18 gage and 1 piece of 29 gage steel sheet.
16. The overlapping portion of the end ring segments must be thoroughly cleaned. Place a small piece of phos-copper between the overlapping portions, drill and rivet, and (a) complete the connection with a phos-copper weld to insure a perfect electrical connection or (b) bolt tightly together.

Armature

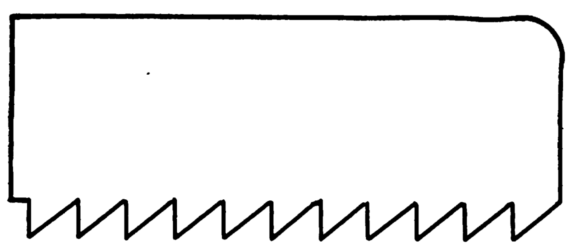
(See Figures 37 through 40):

The armature core (EM-518003, Fig. 37) is made of sheet steel punchings held together with steel straps and provides 72 slots for the armature coils (EM-518009, Fig. 38). Each slot is insulated (EM-518079) and the coils inserted in the slots. The slot insulation is trimmed off, folded over the top coil in the slot and wedges (EM-518078) are driven in the grooves at the top of the slot. (See Fig. 38.)

Replace Coils

If the armature winding is damaged and it is necessary to replace one or more of the armature coils proceed as follows:

1. Disassemble generator and remove rotor as directed under Field Poles on Pages 127-128.
2. Refer to connection diagram A-613. Note that each coil is connected either to each adjacent coil or to one adjacent coil and an armature paralleling connection (EM-518085, Fig. 39). Determine how the coil to be removed is connected, cut away the insulation and remove the solder from the connections.
3. Facing the core from the connection end of the coils, remove the slot wedge from over the damaged coil and from the 10 or 11 slots to the right of the damaged coil. Wedges can be removed with a tool with saw like teeth as shown in sketch. Drive the teeth into the wedge and then drive out the wedge.



WEDGE REMOVING TOOL

4. Cut the lashings around the coils and lashing ring which held those coils which are to be removed.

Replace Coils — *(Cont'd)*

5. Lift the top side of the coils in these slots with care so as not to damage the insulation. On coming to the tenth slot the damaged coil can be removed. It may be necessary to loosen a couple extra coils in order to make room for removing the damaged coil without damaging the adjacent coils by too much bending.
6. Place spare coil in the slot, replace all lifted coil sides, drive in slot wedges (Fig. 38), connect coil per connection diagram A-613, insulate connections and replace lashings.
7. Assemble the generator by following back through the steps followed in disassembling it.

Replace Core and Coils

If the core becomes damaged and it is necessary to remove the core with the coils proceed as follows:

1. Disassemble the generator and remove the rotor as directed on Pages 127-128.
2. Disconnect the armature leads (EM-518038, Fig. 33) from the terminal box studs (EM-25690-1, Fig. 43) and pull the armature leads one by one through the opening in the stator ring.
3. Place the stator so that it rests on end with the connection end up. In this position the ring is resting on the engine adapter ring. Care should be taken to protect the generator line unit and terminal box.
4. Remove the core pins (EM-518021, Fig. 40) from the bottom of the ring by drilling them out
5. Place two ⅝" lifting eyebolts at the sides of the ring, screwing them into the bearing bracket bolt holes.
6. Apply considerable pressure on the core if necessary and lift the ring by the eyebolts with a crane. The ring will slide off the core.
7. Drop the ring over a new core (Fig. 40), drive in core pins and reassemble the generator.

EXCITER

Bearings

Lubrication

The exciter is a two bearing direct current generator. The sheave end bearing is a SKF No. 305 ball bearing and the commutator end bearing is a SKF No. 304 ball bearing. Plugs (EM-518089, Fig. 41) are provided in each bearing housing for greasing the bearing and draining the housing.

The exciter is shipped with the bearing housings properly filled with 2 oz. of high grade neutral grease, Army Classification WB-2.

The bearing housing of each bearing should be flushed out with flushing oil and refilled with new grease every 1000 hours of normal service. If gasoline or other solvents are used be sure to remove all traces of the solvent before filling the housing with grease. When filling housing, fill 1/3 to 2/3 full to obtain best efficiency. The housing will hold approximately 4 oz. of grease but should never be filled more than two-thirds full.

Bearing Lubrication — *(Cont'd)*

Bearing temperature rise above the ambient (surrounding air) temperature should not be more than 35 deg. C. (95 deg. F.). Causes for high bearing temperatures are as follows:

1. Contamination of grease.
2. Insufficient amount of grease.
3. Too much grease which causes excessive heating due to churning.
4. Grease too stiff preventing free action in bearing.
5. Excessive thrust due to misalignment or excessive imposed loads.
6. Pounding caused by bearing being loose on shaft or balls being worn detectable by noise.
7. Actual bearing failure caused by broken ball cage or flat balls detectable by noise.
8. Heat from external source causing high bearing temperatures.

Causes 1, 2, 3, & 4 can be prevented by properly following lubrication instructions.

The difficulty in Item 5 is not very probable because the exciter is mounted on an adjustable plate.

Difficulties 6 & 7 require a replacement bearing. Before replacing the bearing, determine the underlying cause of the bearing failure and take steps to prevent recurrence.

Removal

To remove the exciter bearings first drain the grease from the housing, refer to Figs. 33 & 41 and proceed as follows:

Sheave End Bearing

1. Remove rear cover plates by removing bolts (EM-518202) and three bolts (EM-518203).
2. Remove exciter sheave enclosures by taking covers apart removing four bolts (EM-518201).
3. Loosen "V" belts loosening the four bottom jamb nuts on the exciter mounting studs (EM-518074). Remove "V" belts (EM-518072).
4. Loosen set screw in exciter sheave and remove exciter sheave (EM-518077).
5. Remove three bolts (EM-518088) holding bearing cap (EM-518094).
6. Remove four bolts (EM-518098) holding sheave end bearing bracket and remove bracket (EM-518097).
7. Apply pressure to inner race only of bearing (unless bearing has failed) and remove bearing. Pressure can best be applied against the bearing housing cap to remove bearing.

Commutator End Bearing

1. Remove two bolts (EM-518125) holding bearing cap (EM-518114).
2. Remove drip cover (EM-518116) and lift brush holder fingers (EM-518134) and brushes (EM-518129) placing brush holder finger at side of brush so the brushes will not slide in the holder (EM-518130).
3. Remove four bolts (EM-518098) holding the commutator end bearing bracket (EM-518128) and remove bearing bracket.
4. Apply pressure to inner face only of bearing (unless bearing has failed) and remove bearing. Pressure can best be applied to the bearing cap to remove bearing.

After replacing bearings, wash out bearing cap with flushing oil. Be sure all screws are securely screwed in place when reassembling exciter.

Armature

The armature (EM-518101) is the rotating part of the exciter. If the armature winding or core becomes damaged and it is necessary to replace the armature proceed as follows:

Remove each bearing bracket as instructed above and lift the rotor out of the frame. Place a new rotor in the stator and assemble by reversing the disassembly procedure.

Commutator and Brushes

The exciter commutator (EM-518118) is made up of copper segments insulated from each other with small mica segments. Each commutator copper segment is connected to an armature coil. The electrical output of the exciter is carried to the commutator where it is picked up by carbon brushes which ride under pressure on the commutator. It is important to keep the commutator surface clean so that good contact can be made with the carbon brushes.

Use no grease or lubricant on the brushes or on commutator. Keep the mica segments undercut about 1/64 inch and keep the undercut slots clean.

The commutator surface should require cleaning every 200-300 hours operation under normal conditions. Clean it with a piece of canvas or similar hard-woven non-linting material. The canvas may be very slightly moistened with a few drops of clean lubricating oil or kerosene for the first rubbing. Finish with a piece of dry canvas.

A roughened commutator may need to be polished with a block of sandstone fitted to the curvature of the commutator. If this is not available, sandpaper can be used by pressing it against the commutator with a block of wood having the same curvature. All the brushes should be lifted and the commutator should be run at full speed while the polishing block is moved slowly back and forth along the surface parallel to the shaft. All grit should be carefully wiped off before the brushes are lowered. NEVER USE EMERY OR CARBORUNDUM CLOTH on a commutator or brush.

Make sure that the brush yoke (EM-518127) is rigidly locked in its proper position. Each machine has its brushes set, by very accurate methods, on the test floor at the factory, and the brush yoke is locked and marked in the proper position. Do not change this position. Interpole exciters do not require and will not permit shifting for different loads.

Under normal conditions of operation there should be no sparking at the brushes. Injurious sparking should never be permitted to continue. The causes of sparking are:

(a) Brushes not set at the proper place.
(b) Brushes not properly fitted to commutator.
(c) Brushes not having proper pressure.
(d) Some brushes having excessive pressure thus taking more than their share of the current.
(e) Brushes being burnt at contact surface due to excessive overloads.
(f) A rough commutator.
(g) A loose, high, or low commutator bar, or high mica.
(h) Dirty or oily commutator.
(i) A loose connection between the armature conductors and the commutator bars, or an open circuit in the armature winding.

Overheating of the commutator may be caused by overloads, or excessive brush pressure, or excessive sparking. Red hot brush tips may be caused by particles of copper imbedded in the contact surface of the carbon. Such particles should be removed, and the brush refitted with fine sandpaper.

Brushes

The brushes are mounted in brush holders (EM-518130) each of which clamp (EM-518131) to a brush holder stud (EM-518119). The stud is mounted on a brush yoke rocker (EM-518127) which clamps (EM-518126) to the bearing housing of the commutator end bearing bracket.

If necessary to replace brushes, remove the drip covers (EM-518116) on the bearing bracket thus giving access to the brushes. Disconnect the tails of the brushes from the brush holder, lift the brush holder fingers and remove the brushes.

After placing new brushes in the holders, carefully fit the rubbing or contact surface of the brushes to the curvature of the commutator by means of strips of flintpaper or sandpaper, first using No. 1 and then a finer grade, such as No. 00. NEVER USE EMERY OR CARBORUNDUM CLOTH OR PAPER. Cut the sandpaper into strips slightly wider than one brush. Insert a strip under a brush with smooth side of paper next to commutator and draw the strip back and forth around the commutator in the manner of a slipping belt. The final sanding in of the brush should be made by drawing the sandpaper under the brush in the direction of rotation of the commutator and on the return stroke the brush should be lifted. This will prevent a rounded brush which is caused by the brush being loose in the holder.

Blow out all carbon dust, wipe off the commutator, the connections and the carbon brushes.

The brushes are so arranged that those on a positive stud are staggered with relation to those on the opposite stud, and those on a negative stud. This arrangement must be maintained to avoid the wearing of ridges on the commutator. The brush holder springs should be so adjusted that all brushes will have the same pressure. About one and one-half pounds per square inch of brush contact may be taken as a guide to the proper pressure.

Examine the contact that the brushes make after a short period of operation and continue this inspection and fitting until a thoroughly good contact of the full surface of the brush is obtained.

Frame and Field

The exciter field coils (EM-518107) are mounted on poles (EM-518106) which bolt (EM-518105) to the frame (EM-518108). To replace a field coil it is necessary to remove the armature as directed above. Disconnect the coil leads, remove pole bolts (EM-518105) and remove pole and coil. When replacing spare coil make sure connections are made in same manner as before. Each coil must be connected so that the current flows in direction opposite to direction of current flow in adjacent pole.

Frame can be removed by removing the four exciter bolts (EM-518056, Fig. 41) after removing other parts as directed.

GENERATOR TERMINAL BOX

The terminal box (EM-25700-1, Fig. 33) provides:

1. A convenient means of changing the connections between the 10 armature leads (EM-518038) and the load. This is done by changing the large links (EM-25692) which are bolted between the terminal studs (EM-25690-1). The armature leads are connected to these studs. See operating instructions, Pages 118-119.

GENERATOR TERMINAL BOX — *(Cont'd)*

2. A link (EM-25693) and three studs (EM-25691-1) for changing the connections between the voltage regulator relay coil (EM-25601-1) and the potential transformer (EM-25608). This link is called the Voltage Regulator Link and must be connected properly to get proper voltage regulator operation. See operating instructions, Page 118.

3. A link (EM-25693) and three studs (EM-25691-1) for changing the resistances (EM-25722 and EM-25721) in series with the synchronizing lamps. This link is called the "Synchronizing Lamp Link" and must be connected properly to keep from burning out the synchronizing lamps. See operation instructions, Page 118.

The voltage regulator potential transformer (EM-25608) mentioned in No. 2 above is mounted on the back of the link panel (EM-25706-1). The resistors (EM-25722 and EM-25721) mentioned in No. 3 above are mounted on the front of the link board behind a cover plate (EM-25724).

Donut current transformers (EM-25607) are mounted on each of the three phase bus bars (EM-25764) which extend below the link board. These current transformers are used with the ammeter (EM-25803) and ammeter switch (EM-25804) to give current readings in each of the 3 phases. Bolts (EM-25709) are provided on each phase bus bar (EM-25764) and the neutral bus bar (EM-25763). These bolts fasten to the cross leads (EM-25751, EM-25752 and EM-25753, Fig. 44) which go through the generator frame and connect to the generator circuit breaker.

The terminal box also provides mounting for the cross current compensation transformer (EM-25616). (See Voltage Regulator Maintenance Instructions, Page 137).

A terminal block (EM-25703-1) provides a connection point for all wiring. These connections are transferred through the generator frame to a terminal block (EM-25865) on the generator line unit by means of a cross cable (EM-25755, Fig. 44).

There are no moving parts in the terminal box so only careful inspection of electrical connections, mounting bolts and condition of the wiring is all that is required.

To Remove the Terminal Box

Proceed as follows:

1. Remove upper (EM-518206, Fig. 33) and lower (EM-518205, Fig. 33) rear cover plates and the exciter sheave covers (EM-518208 and EM-518209, Fig. 33).
2. Remove the rear cover plate (EM-25714-3) and disconnect each of the armature leads (EM-518038, Fig. 33) from the terminal box studs.
3. Disconnect each of the four cross leads (Fig. 44) from bus bars (EM-25764 and EM-25763, Fig. 43).
4. Disconnect each lead of the cross cable (EM-25755, Fig. 44) from the terminal block (EM-25627, Fig. 42).
5. Remove screws in each angle iron brace (EM-518210, Fig. 33) holding the terminal box.

To Remove the Terminal Box — *(Cont'd)*

6. Remove 2 screws (EM-518203, Fig. 33) holding the guard screen (EM-518704, Fig. 33) to the terminal box.
7. Remove link panel compartment cover (EM-25714-4, Fig. 43) and current transformer compartment cover (EM-25714-5, Fig. 43) and remove the two screws (EM-518203, Fig. 33) holding lower part of the terminal box frame to the armature ring (EM-518004-1, Fig. 33).
8. Remove the four screws (EM-518203, Fig. 33) holding the upper part of the terminal box frame to the armature ring (EM-518004-1, Fig. 33) and lift off the terminal box.

GENERATOR LINE UNIT

(See Figures 45 through 52.)

The Generator Line Unit (EM-25670-1) contains all equipment necessary to control the operation of the generator. It is called the line unit because it is the unit which connects the generator to the line.

Equipment included in the Line Unit is as follows:

Instrument Panel (EM-25800)—for metering generator output.

Generator Circuit Breaker (EM-25671-1)—for opening or closing the connections from the generator to the A.C. line.

Exciter Rheostat (EM-25770)—for manual control of the voltage of the generator output.

Voltage Regulator (EM-25600-1)—for automatic control of the voltage of the generator output.

Instrument Panel

The instrument panel (EM-25800) has mounted on it the following:

Alternating Current Ammeter (EM-25803)—to indicate in amperes the current load being carried by the generator.

Ammeter Switch (EM-25804)—to change connections to the ammeter so that the ammeter can indicate the amperes of current being generated in anyone of the three phases. (Labeled 1, 2, & 3 on the switch.)

Alternating Current Voltmeter (EM-25801)—to indicate the voltage of the output of the generator.

Voltmeter Switch (EM-25802)—to change the connections to the voltmeter to indicate the voltage between each of the three combinations of 2 phase lines (LL 1, 2, 3 on switch) and between each phase line and the neutral (LN 1, 2, 3 on switch).

Frequency Meter (EM-25806)—to indicate the frequency of the voltage generated. It also serves as a speed indicator because the speed of rotation is 1000 RPM when the frequency is 50 cycles and is 1200 RPM when the frequency is 60 cycles.

Total Hour Meter (EM-25807)—to indicate the total number of hours that the engine and generator have been operated.

Synchronizing Lamps (EM-25812)—and Synchronizing Lamp Switch (EM-25813)—to provide a means of manually synchronizing the generator with other sources of electrical power of the same rating as described on Page 121.

Instrument Panel — (Cont'd)

Panel Lights (EM-25808) and Panel Light Switch (EM-25811)—to provide light at the panel.

Alternating Current Voltmeter Potential Transformer (EM-25815)—to step generator voltage down to a voltage suitable for voltmeter with a 150 meter element. This voltmeter is mounted on the frame (EM-25818) of the Instrument Panel in the back of the panel as shown in Fig. 46.

The instrument panel is a separate unit mounted on 6 rubber mountings (4—EM-25819, 2—EM-25603) in the frame (EM-25870) of the line unit. See Fig. 47. The rubber mountings prevent vibrations of the diesel engine and the generator from effecting the meter indications and from damaging sensitive meter parts.

All wiring of the instruments is brought to a terminal block (EM-25816) to which is brought the wiring from the other parts of the Generator Line Unit. See drawing No. C-8619 for wiring diagram.

Figures 46 and 47 show the method of mounting and the parts used in mounting the various instruments.

A general inspection of the wiring connections and mountings of the instruments and panel should be made after each 200 or 300 hours of normal operation. Make sure all connections are secure and that all mounting bolts are tight. Inspect wiring insulation carefully for openings which may cause short circuits.

If any of the instruments do not operate, check at the terminals of the instrument with a test instrument to see that voltage or current is reaching the instrument. If it is, replace the unit. If not, check the wiring of the circuit in which the instrument is located for open circuit or short circuit. A short circuit would occur where insulation is worn off forming an electrical contact between the circuit and the frame or with bare wires of some other circuit. This of course prevents proper operation of the instruments in the short circuited circuits. In checking circuits with test equipment make sure the test equipment is suitable for testing the voltage or current in the circuit being tested.

Generator Circuit Breaker

The Generator Circuit Breaker (EM-25671-1) provides a means of manually connecting or disconnecting the generator from the line. Also, an overload trip unit (EM-25672-A or EM-25672-1B) will automatically disconnect the generator from the line in case of heavy current overloads.

The breaker is mounted by four bolts (EM-25743) on the Line Unit frame (EM-25870) with strips of micarta (EM-25745) and micarta washers (EM-25744) between the breaker and the frame to provide adequate insulation between the breaker terminals and the frame of the line unit. The three upper or generator side terminals of the breaker are three copper straps (EM-25731, EM-25732, and EM-25733). These three terminals are fastened with two bolts each (EM-25739) to three copper bus bars (EM-25735, EM-25736, and EM-25737) which are mounted (EM-25740) on the asbestos plate (EM-25742) at the back of the line unit. The three cross leads (EM-25751, EM-25752, and EM-25753) bolt (EM-25739) to the end of the bus bars thus completing the connection of the three phase leads to the generator side of the breaker.

Generator Circuit Breaker — *(Cont'd)*

The load side of the breaker has three load side terminals (EM-25730) which are fastened by studs (EM-25746) which connect through an ebony asbestos plate (EM-25747) to clamp type lugs (EM-25674) which furnish a means of connecting to the load.

The neutral cross lead (EM-25754) connects directly to the clamp type lug load connection through a copper bus (EM-25738) which is bolted (EM-25740) to the ebony asbestos plate (EM-25747).

See Fig. 48 for breaker and buswork parts.

A general inspection of all breaker parts and copper buswork should be made every 200-300 hours of normal operation. Make sure that all connections are tight. Also, if compressed air is available, direct a stream of air through the breaker and around the buswork to remove all foreign particles which might cause short circuits.

Failure of the breaker would be indicated by failure to close the contacts. The complete breaker must be replaced in case of failure.

Excessive heating would be indicated by smoking of the breaker. This would indicate:

1. Dirt in the contacts or poor contact. Blow out the breaker and tighten all connections.

2. Failure of trip unit thus allowing excessive loads on the breaker. If cleaning breaker does not stop heating, check the load carefully. If the breaker allows loading beyond the ampere rating of the trip unit, replace the trip unit (EM-25672-A or 1B).

Exciter Rheostat

The exciter field rheostat (EM-25770, Fig. 50) provides a manual means of controlling the output of the belted exciter by varying the resistance in an enclosure (EM-25771) which is mounted with three bolts (EM-25785) and micarta spacers (EM-25784) on the frame of the generator line unit. The drive rod (EM-25772) of the rheostat connects to the rheostat through a fibre coupling (EM-25774) and extends through the front of the line unit to the rheostat operating handle (EM-25773). The nameplate (EM-25781) on the handle of the rheostat shows in which direction to turn the rheostat to raise or lower the excitation or in other words, the output of the exciter.

The rheostat is connected in series with the shunt field of the exciter. If, when the generator is operating with the Regulator Switch (EM-25622) in the "HAND" position, the output of the generator is only enough to barely indicate on the instruments with the rheostat turned in the direction of increase excitation, switch the Regulator Switch to the "AUTO" position. In this position of the switch the rheostat is out of the field circuit and the regulator controls the exciter field. If the generator output is then normal it indicates that there is an opening in the rheostat circuit. Check all connections and wiring for openings or short circuits. If trouble cannot be located replace the rheostat.

Voltage Regulator—"Synchrostat"

All that is ordinarily required to keep the voltage regulator (EM-25600-1, Fig. 51) in first class operating condition is to:

1. See that the Polarity Reversing Switch Motor (EM-25602, Fig. 52) is in operation. This will insure maximum life of contacts.
2. Maintain the relay contacts (EM-25615, Fig. 52) in good condition as described in the following.

Polarity Reversing Switch

Polarity of the relay contacts of the Voltage Regulator is automatically reversed regularly to insure even wear and maximum life of the relay contacts (EM-25615). This is taken care of by means of the **Automatic Polarity Reversing Switch** (EM-25602). See that the polarity reversing switch motor is running at all times the Regulator is in operation. Disc seen through window labeled "Automatic Polarity Reversing" in the front of the Regulator panel indicates when motor is in operation.

Regulator Contacts

The Voltage Regulator is supplied with fine-grain tungsten contacts (EM-25615). Sparking and excessive wear of the contacts is minimized by means of spark-suppressor condensers (EM-25605-1). **The contacts are, however, subject to wear in normal operation.** Adjustment of voltage to compensate for contact wear may be made by turning the Voltage-Adjusting Knob (EM-25641) on the front of the Regulator case. This adjustment need be made only occasionally.

Erratic voltage, or inability to maintain normal voltage may indicate that the Regulator contacts need attention.

Care

If inspection shows that the contacts are quite pitted and there are sharp points on the surface they can be smoothed to some extent by use of an automobile distributor contact file. It is better practice, however, to remove the contacts and dress them down with a fine emery stone or a fine oil stone. Do not grind any more than just enough to take off the main projections.

Replacement

Pitting or blackening of the contacts **does not** necessarily mean that they need replacement. Smoothing the high spots as instructed in the previous paragraph will put them in good condition.

THE CONTACTS ARE MADE BY WELDING A TUNGSTEN DISC .040″ THICK TO A PIECE OF STEEL OF THE SAME DIAMETER. A LINE SHOWS WHERE THE WELD TOOK PLACE.

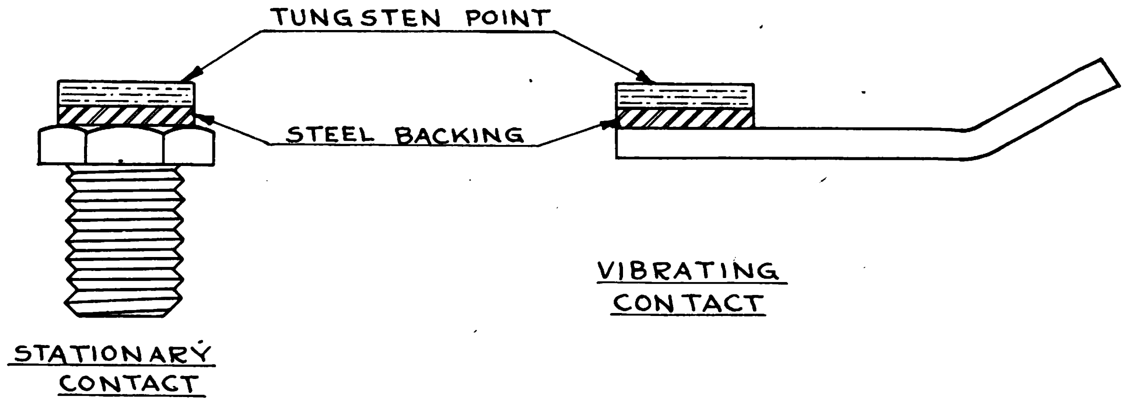
CONTACTS NEED REPLACING ONLY WHEN THE BLUE STEEL BACKING SHOWS THROUGH THE TUNGSTEN POINTS, THAT IS, WHEN THE CONTACTS ARE WORN CLEAR THROUGH TO THE STEEL BACKING.

Replacement — *(Cont'd)*

As soon as the tungsten tips of the contacts are worn through to the steel backing, the contacts must be replaced.

To replace contacts, loosen the vibrator clamp screws in the relay (EM-25601-1, Fig. 52) which hold the vibrator, and remove vibrator. Unscrew the stationary contact and replace with a new one. Insert the new vibrator, line up the contacts, tighten securely and adjust the air-gap as follows:

Insert the stationary contact and screw back as far as it will go if it is new, or leave at the previous setting if only refaced. Start up the gener-



ator and back off the vibrator contact by means of the voltage adjusting knob (EM-25641) until the voltage reads at normal value. This is usually three turns past the point where the contacts first touch. With this contact pressure adjust the air-gap between the core and vibrator to 1/32". This adjustment is made by turning the "Stationary Contact Adjusting Screw" (Fig. 52) after loosening the stationary contact set screw. The air-gap adjustment is now as close as is ever required.

Tungsten contacts must spark in order to operate well. For this reason sparking of the contacts of the voltage regulator has not been eliminated but has been reduced to a safe value by means of the spark-suppressor condenser (EM-25605-1).

Working on Contacts with Generator in Service

Should it become necessary to remove contacts and still keep the generator in service, it can be done as follows:

1. Stand on a dry board and otherwise avoid touching "live" parts when working on any part of the unit.
2. Shift from automatic to hand regulation as follows:

   Cut in resistance by turning the exciter rheostat handwheel in the decrease excitation (to the left) direction until the voltage has been decreased a few volts and then raise the voltage back up again by the regulator control knob. Repeat this until the regulator control knob CANNOT raise the voltage further. Now the exciter rheostat has full control and the Voltage Regulator switch (EM-25622) can be thrown to the "HAND" position.
3. To put the regulator back in service, throw the switch back to the "AUTO" position, cut out exciter rheostat resistance (by turning the handle to the right or increase excitation direction) and turn the regulator knob until the regulator has full control and the rheostat is all cut out (all the way to the right).

Air-Gap Between Vibrator and Core of Regulator

The Voltage Regulator performs best when the air-gap between the core of the relay (EM-25601-1) and vibrator (EM-25615) is approximately 1/32 in. but the action may be satisfactory with an air-gap as small as 1/64 in. or as large as 1/16 in. This air-gap is adjusted by screwing the stationary contacts up or down with the Vibrator Reed Air-Gap Adjustment screw (See Fig. 52). The clamping bolt must be loosened before, and tightened after working on contact adjusting screw. As the contacts wear, the air-gap will increase and cause a slower restoration of voltage on load changes. This is not serious in most cases but can be corrected by adjusting the stationary contacts to give the normal air-gap of 1/32 in. between the vibrator and core of the regulator. Check every 200-300 hours of operation.

Troubles and Their Elimination

In case of voltage irregularity or inability to maintain normal voltage, remove cover of Voltage Regulator and check contacts as previously instructed. When contacts are in proper operation and voltage is still irregular or cannot be maintained, see that generator collector-ring brushes, and exciter commutator brushes are clean and have proper pressure. Also check for possible loss of generator speed or exciter speed due to looseness of belts.

Do not change or tamper with wiring of the Voltage Regulator except to check tightness of connections where necessary, or as instructed below:

Voltage Will Not Build Up

1. If vibrator does not vibrate see that voltage is getting to the coil of the Voltage Regulator. There may be a loose or open connection in the Regulator or potential transformer circuit.
2. Regulator contacts may be excessively dirty and need cleaning up.
3. Check the commutator and brushes on the exciter to make sure contact is good. Clean brushes and commutator of dust or other foreign material. Check brush pressure.
4. Make sure that the exciter rheostat hand-wheel is all the way to the right for automatic operation. Check exciter operation by cutting out rheostat, turning handwheel to the right for a few seconds. (Voltage regulator switch in HAND position.) If voltage builds up, exciter is operating properly.
5. Check for excessive belt slip which will cause a reduction in exciter speed.
6. Check up on generator collector-ring brushes and connections.
7. The Voltage Adjusting Knob may be turned too much in the decrease voltage direction.

Voltage Regulator Has No Control

1. Be sure Regulator switch is in "AUTO" position for automatic operation.
2. Be sure exciter rheostat is turned right (increase excitation) completely.
3. Check large resistors (EM-25618-1 and EM-25606-1, Fig. 52) on back of regulator panel for open circuit.
4. Check relay (EM-25601-1) coil for open circuit or short circuit. If the relay coil has no voltage the regulator will not operate. The normal operating voltage on the relay coil is 40 to 60 volts A.C.
5. Check exciter rheostat (EM-25770, Fig. 50) circuit for an open circuit in the rheostat or its wiring.
6. Contact vibrator may be bent or regulator contacts may be stuck.
7. Voltage adjusting knob (EM-25641) may be turned too much in the increase voltage direction.

Voltage Becomes Erratic

1. The anti-hunt resistor (EM-25606-1) may not be adjusted properly. To increase the anti-hunt effect, increase the resistance of this resistor. CAUTION: In the adjustment of this resistor never cut out more than 50% of the resistance in decreasing the anti-hunt force. After this resistor setting has been changed it will be necessary to re-set the voltage by means of the voltage adjusting knob on the front of the regulator. This resistor is set properly at the factory and should need no further adjustments.
2. The shunt field resistor (EM-25618-1) adjustment will affect the operation of the voltage regulator. This resistor is adjusted at the factory so that the proper resistance is in the circuit for automatic operation.
3. Check for tightness of Regulator connections and other connections in the generator or exciter circuit. Also see that no screws or mechanical parts of the Voltage Regulator Relay are loose.
4. Check for excessive build-up or pitting of the Regulator contacts.
5. Make sure no contact is stuck.
6. In some obstinate cases it is found that exciter brushes are off neutral. Shifting the brushes against the rotation may correct the difficulty. Do not shift more than necessary, since it may cause sparking at the commutator.
7. The relay air-gap will sometimes affect the stability of the regulator. In some cases the erratic or "hunting" (SEE NOTE) condition of the regulator may be corrected by readjustment of the air-gap. In most cases it will be found that the air-gap must be reduced to a smaller value than the recommended setting of 1/32 in. In unusual cases where the "hunting" is produced by too much stabilizing effect, it may be necessary to increase the air-gap to about 1/16 in. This should be done only if items 1 to 6 above fail to correct the trouble.

NOTE: The term "hunting" refers to a periodic variation of generator voltage from normal voltage. The period of variation is usually 1 to 5 times per second.

Voltage Sensitivity is Poor

1. Make sure that the Exciter Rheostat Handwheel is turned all the way to the right, or increase excitation direction.
2. See that no screws or mechanical parts of the Voltage Regulator relay have become loose.
3. Check connections for tightness.
4. Air-gap may be too large or too small. Adjust air-gap to 1/32 in.
5. Contacts may need to be cleaned or refaced.

Voltage Droops Excessively with Increase in Generator Load

1. Regulator switch may not be in the "AUTO" position.
2. Exciter Field Rheostat may not be all the way to the right.
3. The voltage droop is determined by the setting of the shunt field resistor. To decrease the droop increase the resistance slightly.

Contact Sparks Too Much

1. The spark-suppressor condensor (EM-25606-1) may be disconnected, or open-circuited. A contact that does not spark may have a condenser with a short-circuit in it. A contact whose spark is large and shows a yellow flame may have a condenser that is open-circuited. Condensers are easily checked by any standard condenser test set or capacity bridge.
2. A lead may be broken or loose between the contacts and the spark suppressor condenser.
3. A lead may be loose to the hand rheostat, or the rheostat burned out or broken.

Cross Current Compensation

When operating generators in parallel the division of the **kilowatt load** between the generators depends upon the driving power of the diesel engines which is controlled by the engine governors. (Refer to Operating Instructions, Parallel Operation of Generators, Pages 121-122). This division of kw load is practically independent of the field current of the generator as supplied by the exciter. However, certain types of loads (low power factor loads) when connected to the generator, cause the output of the generator to consist partly of current which is not convertable to power. This current is technically called "reactive kva" and generally called "wattless current."

The division of the "wattless current" between generators operating in parallel depends entirely upon the excitation of the generator field. If the excitation of one generator is greater than others with which it is operating in parallel, it will furnish more than its share of the "wattless current." It is therefore necessary to provide a means of correcting the excitation of individual generators which take more or less than their proper share of wattless current. Although the voltage regulators control the field excitation (See General Information, Voltage Regulator, Page 116) it isn't possible to make two voltage regulators exactly the same. That is, it isn't possible to regulate the output of the generator so close that it will not vary a slight bit from that of any other generator. The slightest change will cause unequal division of "wattless current."

To correct this discrepancy, the voltage regulator relay coil (EM-25601-1, Fig. 52) is connected in parallel to the secondary of a current transformer

Cross Current Compensation — (Cont'd)

(EM-25616, Figs. 42 and 43) across a rheostat (EM-25612-1, Fig. 52), as well as across the generator terminals. Thus the vibration of the vibrating reed is effected by the current output as well as by the voltage output of the generator. This is called "Cross-Current Compensation."

As the current output of the generator increases, the energy into the voltage regulator coil increases causing the vibrator to increase the magnitude of its vibrations thus causing the contact to be open more and cut down the excitation. Reduced excitation of course cuts down the generator current output. The voltage however, will reduce only slightly because the generator is connected to the bus on which the voltage is maintained by the other generator or generators. The amount of current shunted through the relay coil can be varied by the Cross-Current Compensation rheostat (EM-25612-1).

The cross current compensation rheostat (EM-25612-1, Fig. 52) is set in the all resistance "out" position when it leaves the factory. This is the proper setting for the rheostat when the generator is not operating in parallel. For parallel operation the cross current compensation rheostat should be turned in the direction of resistance "in" but it should be turned in this direction to give only enough droop in voltage from no load to full load to give stable operation of the generator under reactive kva load conditions. Stable operation is obtained when the generators deliver current in proportion to their kva ratings. Maximum droop from no load to full load is obtained with the resistance of the cross current compensation rheostat all in. Usually sufficient compensation is obtained by use of half of the rheostat.

Remove Generator Line Unit

Remove generator line unit as follows:

1. Remove upper (EM-518206, Fig. 33) and lower (EM-518205, Fig. 33) rear cover plates and the exciter sheave covers (EM-518208, and EM-518209, Fig. 33).
2. Remove back cover plate (EM-28851, Fig. 45) and disconnect each of the cross leads (Fig. 44) from the bus bars (EM-25735, EM-25736, EM-25737, and EM-25738, Fig. 48).
3. Disconnect each lead of the cross cable (EM-25755, Fig. 44) from terminal block (EM-25865, Fig. 45). Also disconnect leads at terminals F_2, F_1, A_2, and A_1 of this terminal block.
4. Disconnect the conduit attachment of the flexible conduit (EM-518139, Fig. 33) from the exciter conduit mounting plate (EM-25862, Fig. 45).
5. Disconnect leads through the Panel Light Conduit mounting plate (EM-25864, Fig. 45).
6. Disconnect all leads to the engine instruments.
7. Remove end cover plates (EM-25714-2, Fig. 45) and remove the two screws (EM-518203, Fig. 33) holding lower part of Line Unit frame to the armature ring (EM-518004-1, Fig. 33).
8. Remove the four screws (EM-518203, Fig. 33) holding the upper part of the Line Unit frame to the armature ring and lift off the Line Unit

PARTS SECTION

ALPHABETICAL INDEX

(Illustrations)

PARTS CATALOG SECTION

On this page is shown a sample spare parts requisition on QMC Form No. 400 which conforms to the latest revisions. The marginal notes give instructions for preparing a requisition for spare parts for Engineer equipment.

The revised QMC Form 400 has new column headings. Until new forms are available use the present form and type or write in corrections in column headings as shown below.

Under revised heading "Nomenclature" and "Unit" list the article and the unit (ea for each; lb for pound; etc.). Under heading "Maximum or Authorized Level" list the authorized organizational allowances or depot stock levels given in ENG 7 and ENG 8 of the ASF Engineer Supply Catalog (superseding Part III, Corps of Engineers Supply Catalog). The total number on hand for each item is listed under "On Hand". In column headed "Due In" enter the total quantity previously requisitioned but not delivered. Column headed "Required" is to be changed to read "Quantity Desired" and column headed "Approved" is to read "Remarks." For "Initial" and "Replenishment" requisitions, the sum of "Quantity Desired", "Due In", and "On Hand" should equal "Maximum or Authorized Level."

(Additional details on this subject are covered in ENG 1 of the ASF Engineer Supply Catalog which incorporates information formerly contained in Section AA-1, Part III, Engineer Supply Catalog.)

State PERIOD designation by use of one of the following terms:
(1) "INITIAL"—first requisition of authorized allowances.
(2) "REPLENISHMENT"-subsequent requisitions to maintain authorized allowances.
(3) "SPECIAL"—requisitions for necessary repairs not covered by allowances.

Type "SPARE PARTS" in upper right hand corner of requisition.

Address requisitions to Engineer Field Maintenance Office, P. O. Box 1679, Columbus, Ohio (except for spare parts for searchlights and barrage balloons which are addressed to Schenectady, N. Y. or Ogden, Utah ASF depots).

Give complete shipping instructions. Special instructions for packing, marking, routing, etc., should be given at bottom of requisition.

State proper nomenclature of machine, also make, model, machine serial number and U. S. A. registration number.

Prepare a separate requisition for each different machine.

State basis or authority and date delivery is required, immediately below description of machine.

Double space between items.

Group parts required under group headings as shown in manufacturers' parts catalogs (Technical Manuals).

State OCE stock numbers, manufacturers' parts numbers and nomenclature accurately and completely. Do not use abbreviations.

WAR DEPARTMENT
Q. M. C. Form No. 400
(Revised 10 Aug 1942)

(SAMPLE)
REQUISITION

SPARE PARTS

To: Engineer Supply Officer
Columbus Army Forces, Depot, Columbus, Ohio
No. of Sheets 1 Sheet No. 1

Requisition No. E-531-3-44 Date July 5, 1943 Period Replenishment

SHIP TO Engineer Property Officer, Pine Camp, New York

MARKED FOR: Engineer Supply Officer, 802nd Eng. Battalion, Pine Camp, N.Y.

Requisitioned By (show Signature, Rank, Organization, Destination. If different from "ship to" include address):

Robert E Roe
Robert E. Roe
Major, C.E.
Engineer Property Officer

Approval: For: the Commanding Officer:

John F Doe
John F.Doe
Col. C.E.,
Executive Officer

Stock No.	Nomenclature and Unit	Auth or Max Level	On Hand	Due In	Quantity Desired	Remarks
PARTS FOR GENERATOR SET, PORTABLE, DIESEL, SKID MOUNTED, 100-KW, 127/220-Volt, 3-Phase, 60-Cycle, or 230/400-Volt, 3-Phase, 50-Cycle, Murphy, Model ME-650, Engine Number #11236B.						
	Basis: Repair of Disabled Equipment					
	Delivery is requested by July 20, 1943					
	ME-650 MURPHY ENGINE GROUP					
	WATER PUMP					
AD 3275	Water Pump Packing	0	0	0	2	
	BLOWER					
MC-40112	Rotor Housing	0	0	0	1	
	DELCO REMY GENERATOR					
DR-1850768	Brush 3rd	0	0	0	1	
DR-1856494	Brush Main	0	0	0	2	
	ELECTRIC MACHINERY COMPANY GENERATOR GROUP					
	GENERATOR					
EM-518031	Brush Holder with Spring	0	0	0	1	
	EXITER					
EM-518101	Armature Complete	0	0	0	1	
	VOLTAGE REGULATOR					
EM-25615	Regulator Contacts	0	0	0	1	
	*					

*Nonexpendable items such as tools must be accounted for, when requisitioned, by a statement that they have been placed on REPORT OF SURVEY or STATEMENT OF CHARGES.

Emergency requisitions sent by telephone, teletype, cablegram, telegraph or radio must be confirmed immediately with requisition marked: "Confirming (state identifying data)."

PREPARATION OF REQUISITIONS

A Sample requisition in the correct form for submission by the Engineer Property Officer is shown on the opposite page.

THIS SHALL BE FOLLOWED IN MAKING OUT REQUISITIONS.

In order to eliminate duplication of work, Property Officers may authorize organizations to prepare requisitions in final form, leaving requisition number space blank for completion by Property Officer.

THE FOLLOWING RULES WILL BE OBSERVED CAREFULLY IN PREPARING REQUISITIONS FOR SPARE PARTS:

a. Prepare a separate requisition for each different machine.

b. Type "SPARE PARTS" in upper right hand corner of requisition form.

c. State PERIOD designation by use of one of the following terms:

(1) "INITIAL"—first requisition of authorized allowances.

(2) "REPLENISHMENT"—subsequent requisitions to maintain authorized allowances.

(3) "SPECIAL"—requisitions for necessary repairs not covered by allowances.

d. Give complete shipping instructions.

e. State proper nomenclature of machine, and make, model, serial number and registration number.

f. State basis or authority, and date delivery is required, immediately below description of machine.

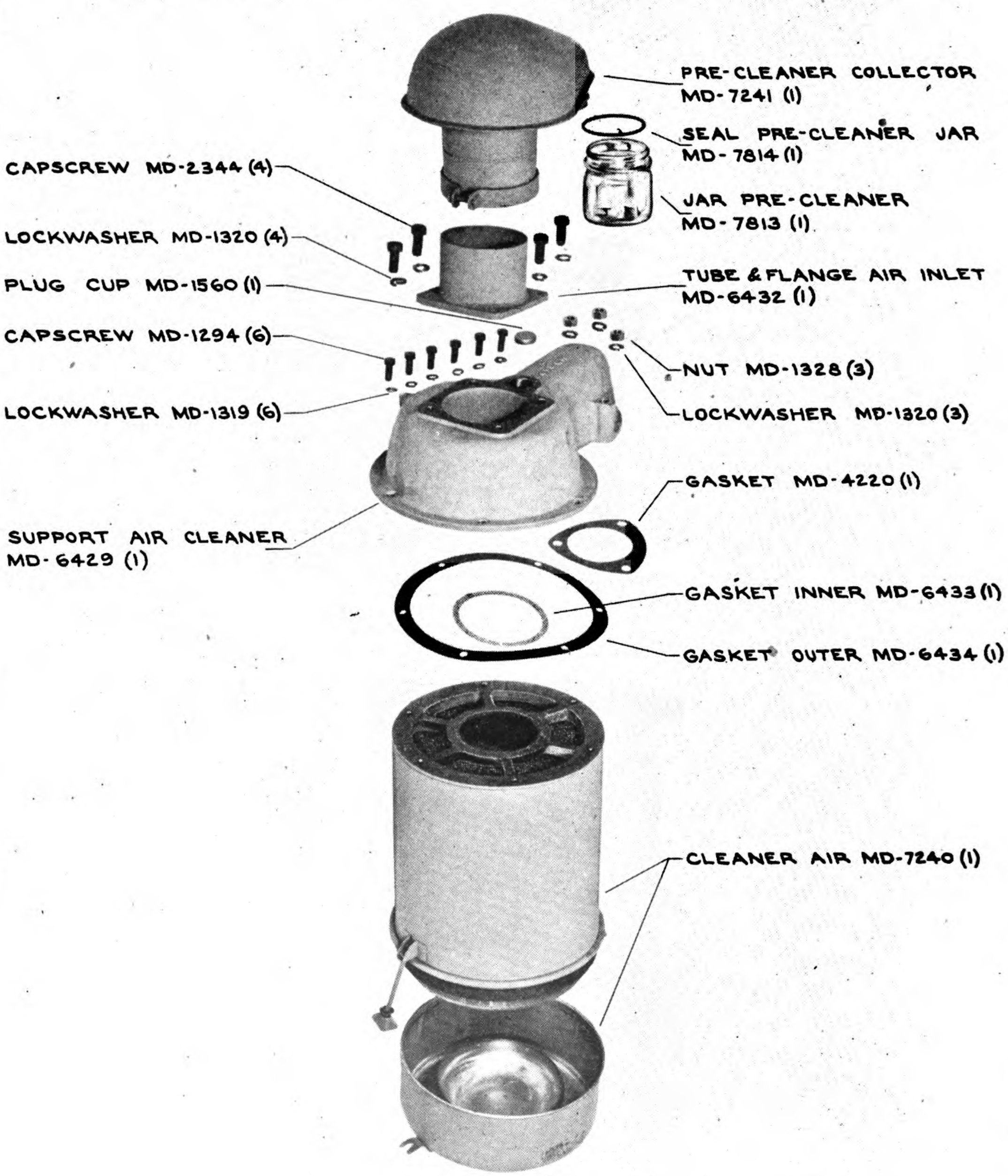
g. Group parts required under group headings as shown in manufacturers' parts catalogs.

h. State manufacturers' parts numbers and nomenclature descriptions accurately and completely. Do not use abbreviations.

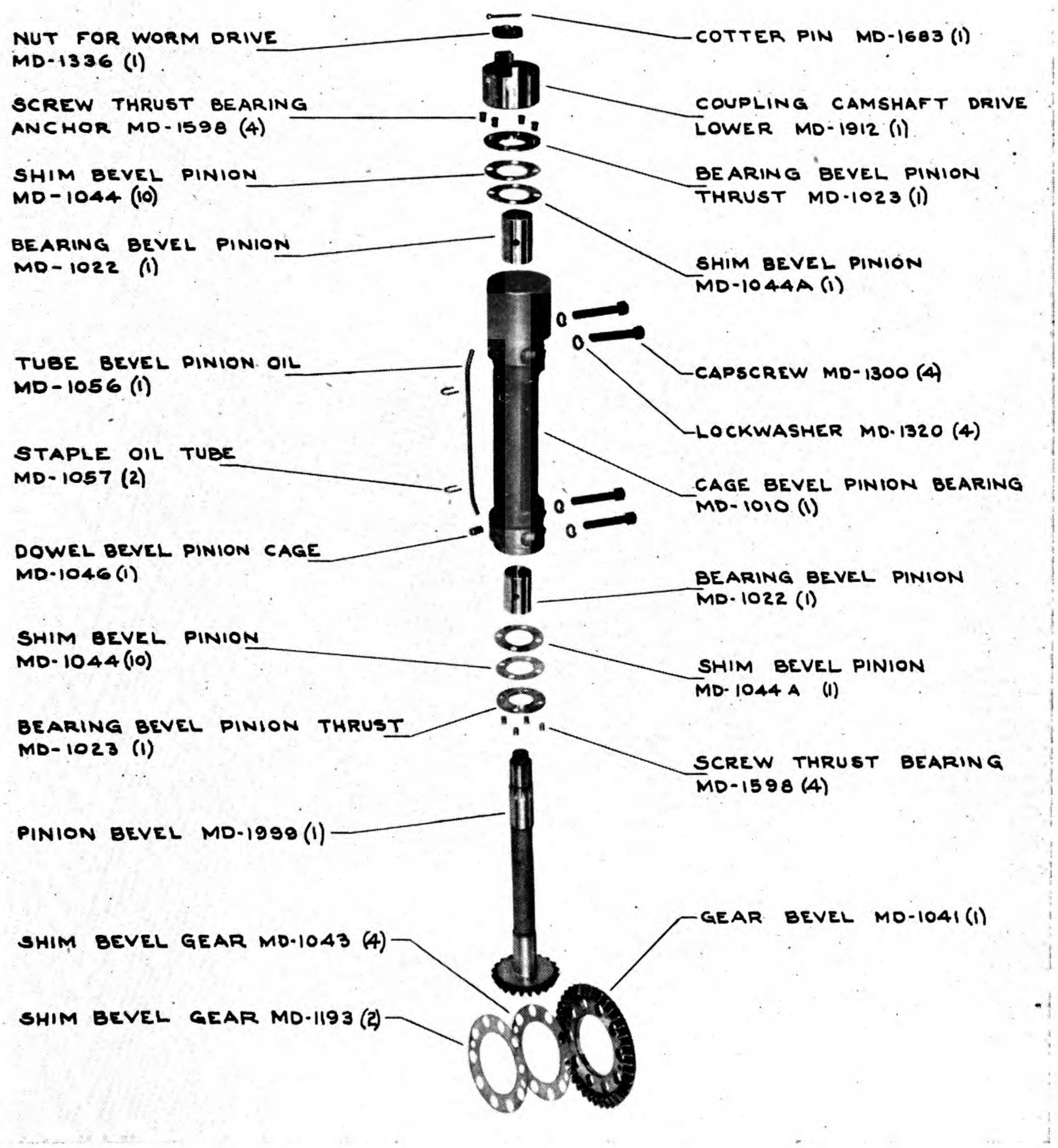
i. Double space between lines.

j. Emergency requisitions sent by telephone, telegraph, or radio must always be confirmed immediately with requistion marked: **"Confirming** (state identifying data)."

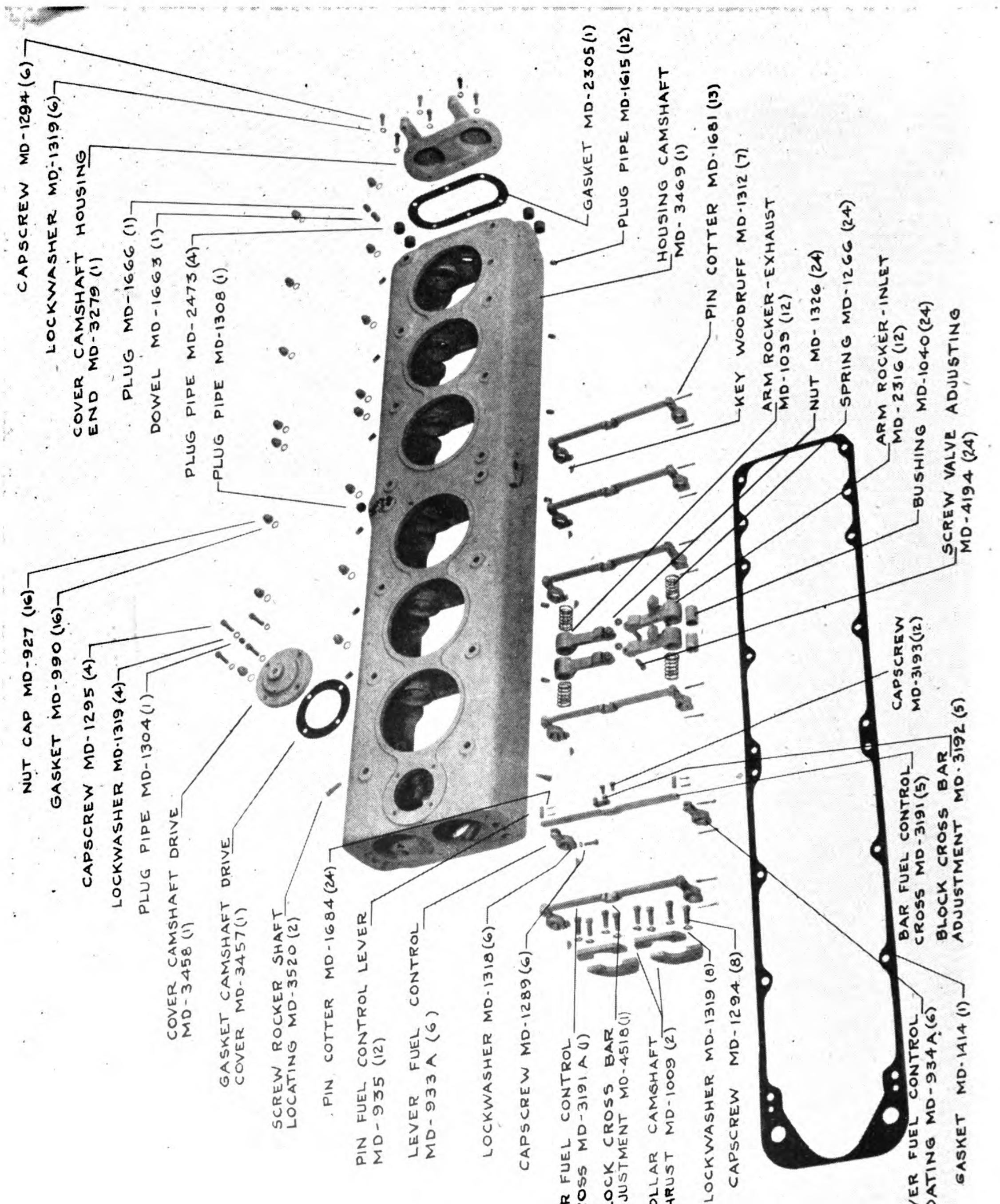
k. Nonexpendable items must be accounted for.



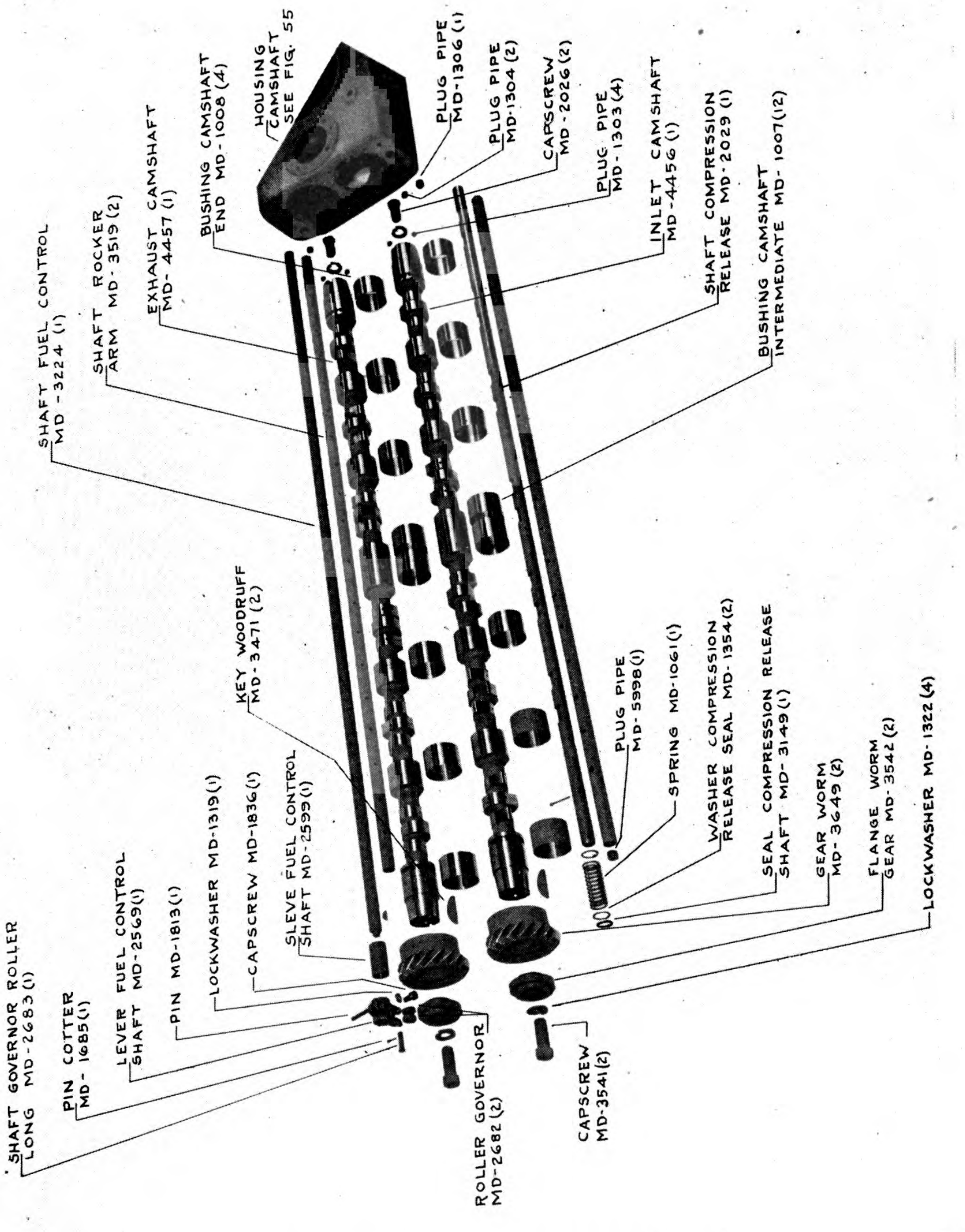
AIR CLEANER AND PRE-CLEANER ASSEMBLY
MD-7242
FIG. 53



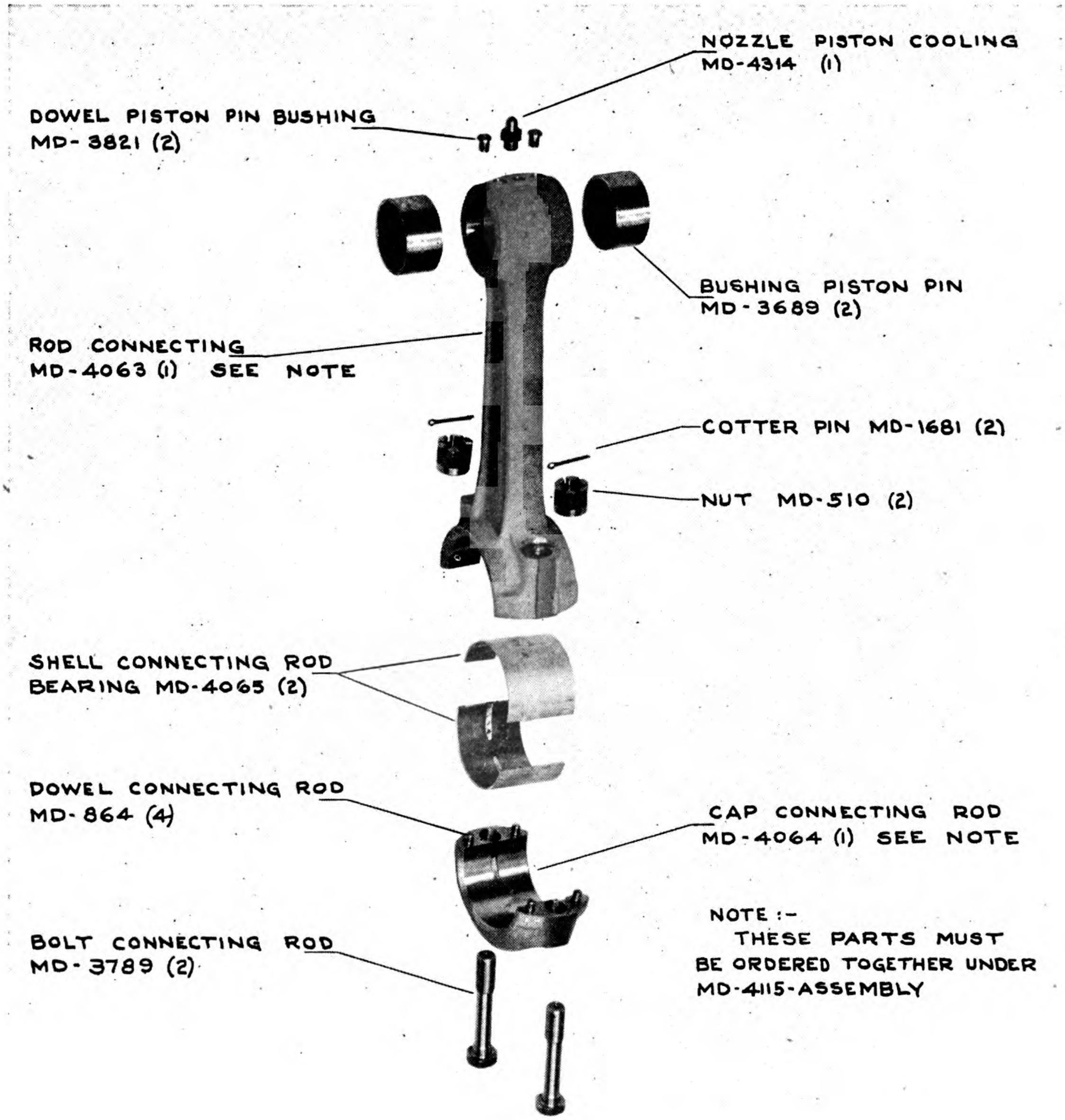
BEVEL GEAR AND PINION ASSEMBLY
MD-6315
FIG. 54



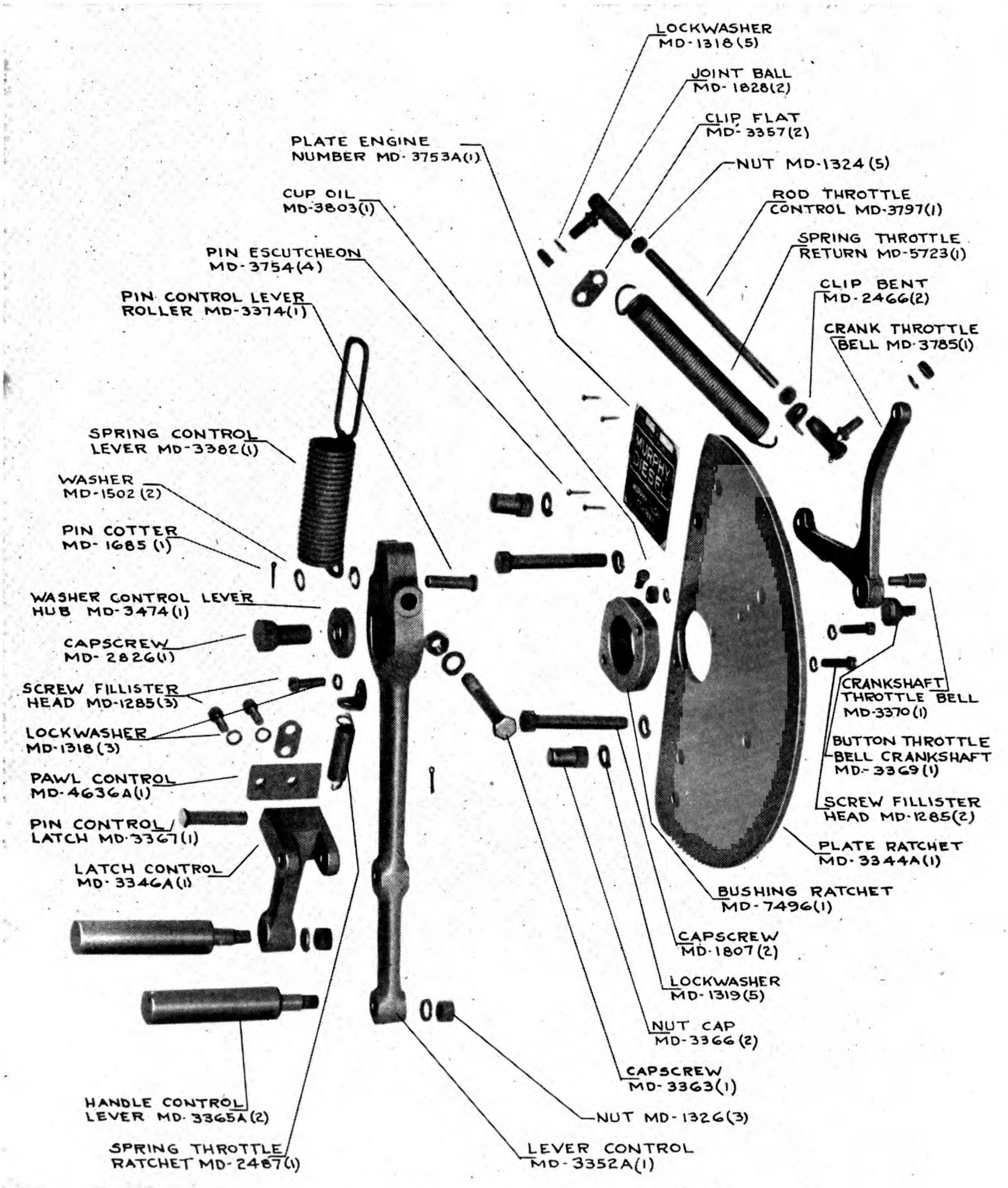
CAMSHAFT HOUSING ASSEMBLY
MD-6041
FIG. 55



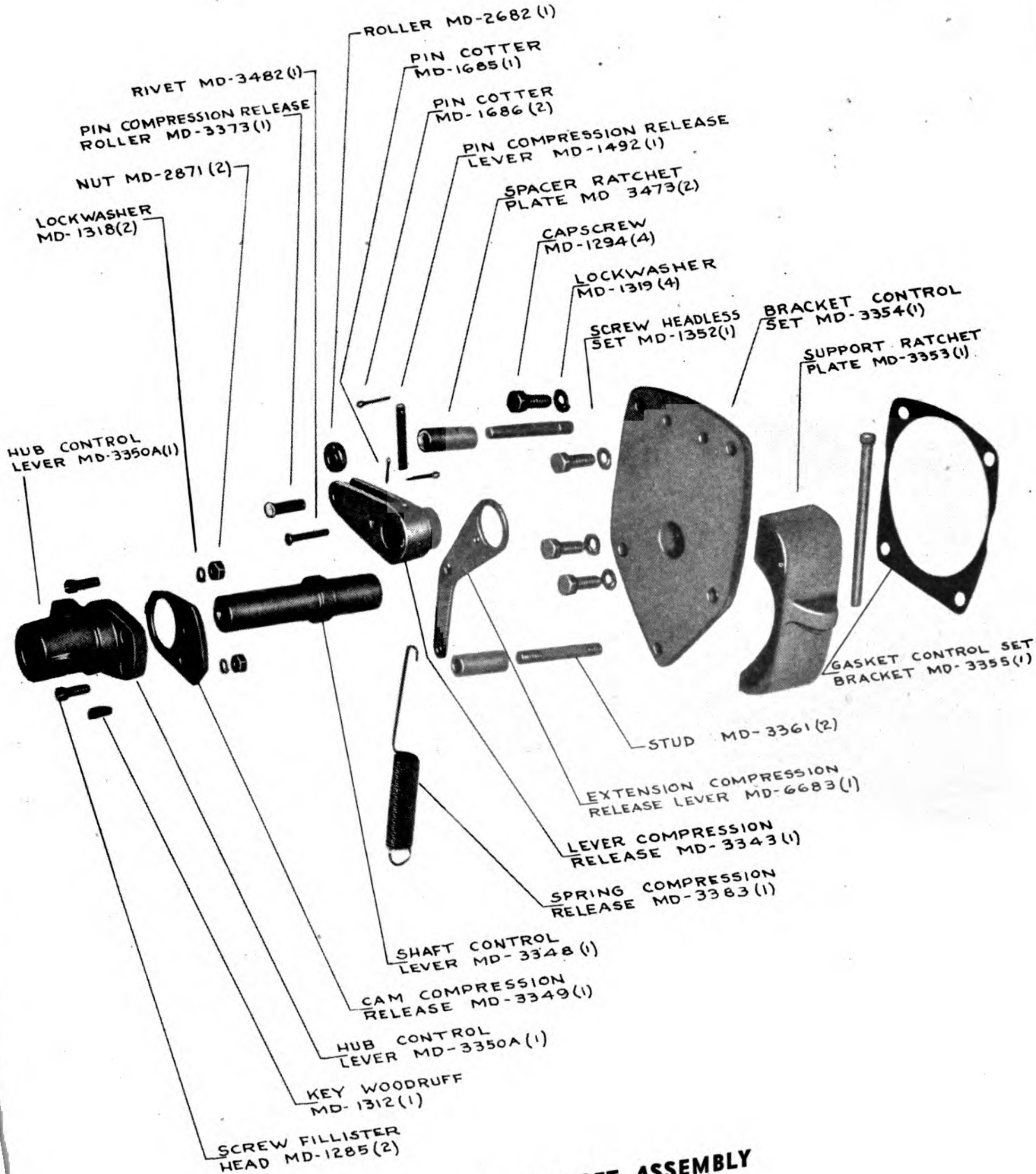
CAMSHAFT HOUSING ASSEMBLY
MD-6041
FIG. 55A



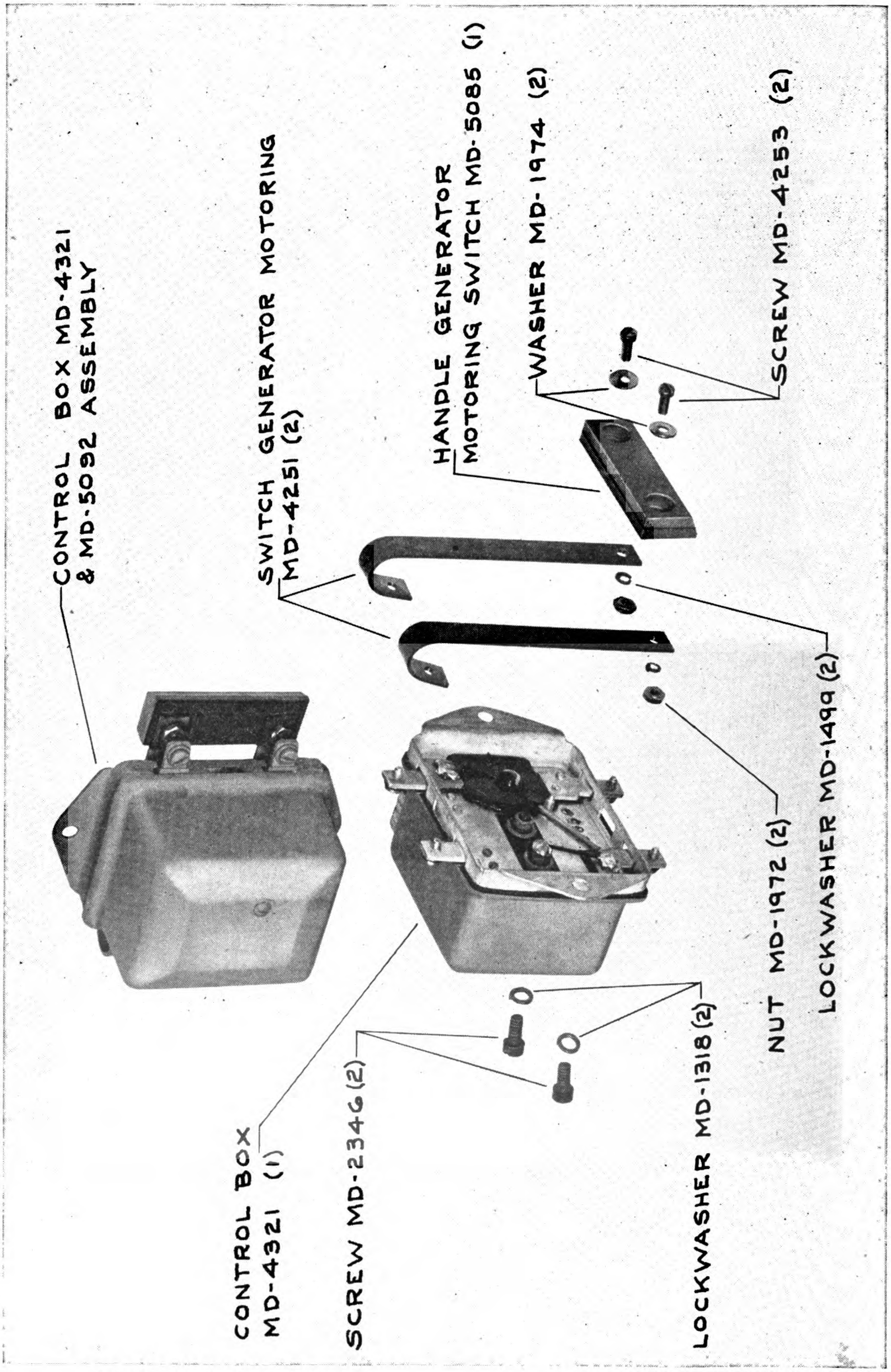
CONNECTING ROD ASSEMBLY
MD-4315
FIG. 56



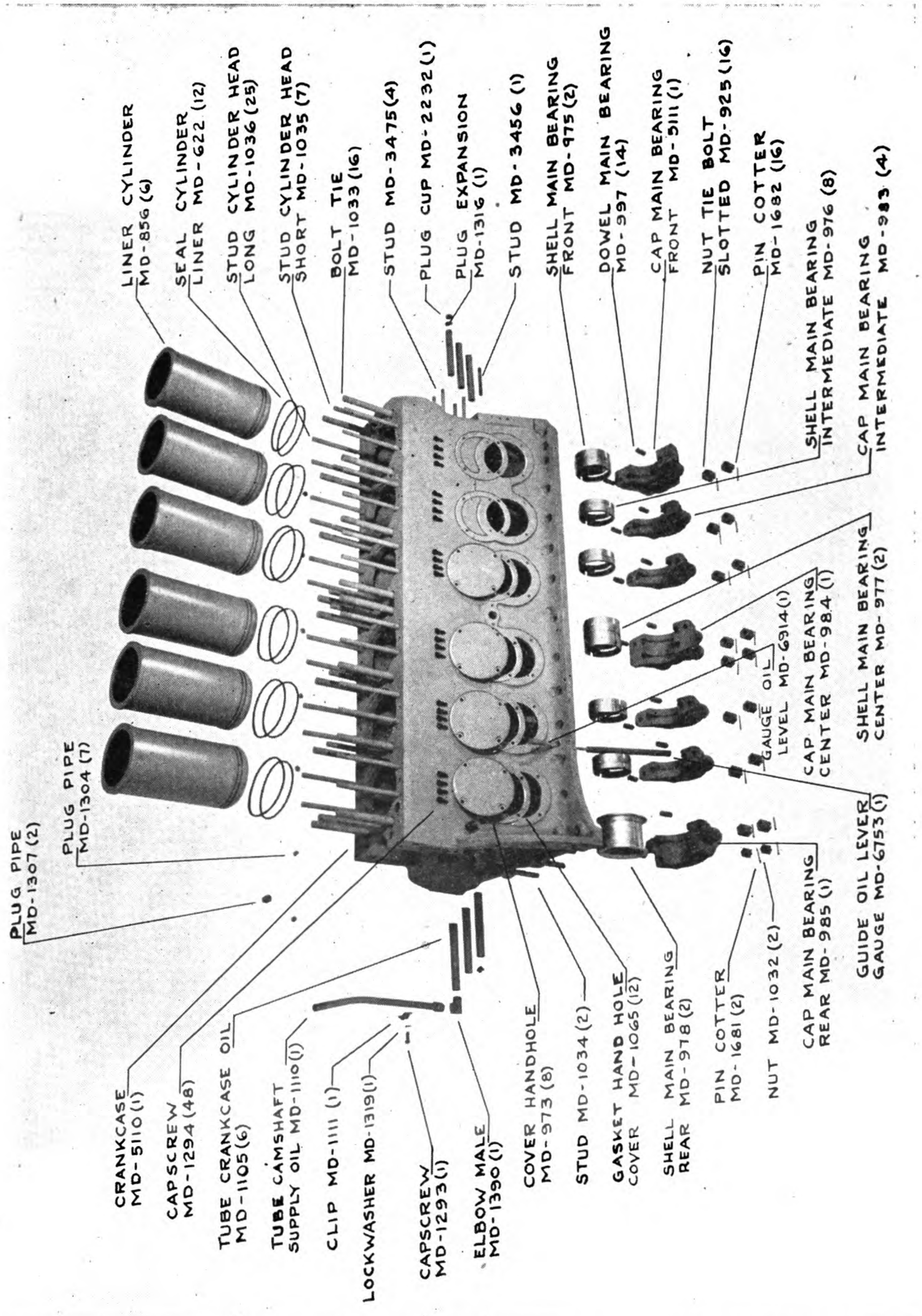
CONTROL SET ASSEMBLY
MD-6125A
FIG. 57A



CONTROL SET ASSEMBLY
MD-6125A
FIG. 57



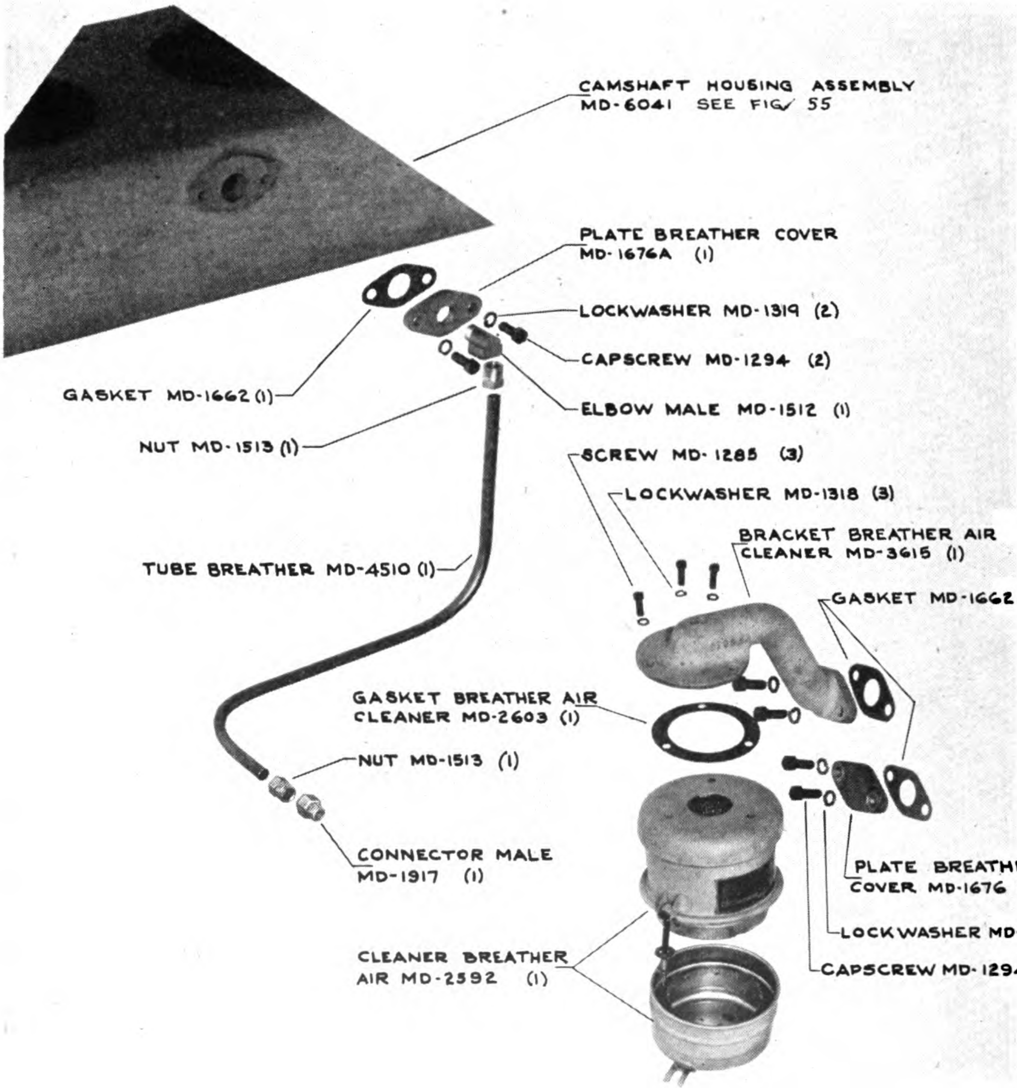
CONTROL BOX ASSEMBLY DR-5859 **FIG. 58** **CONTROL BOX MTG. ASS'Y MD-5092**



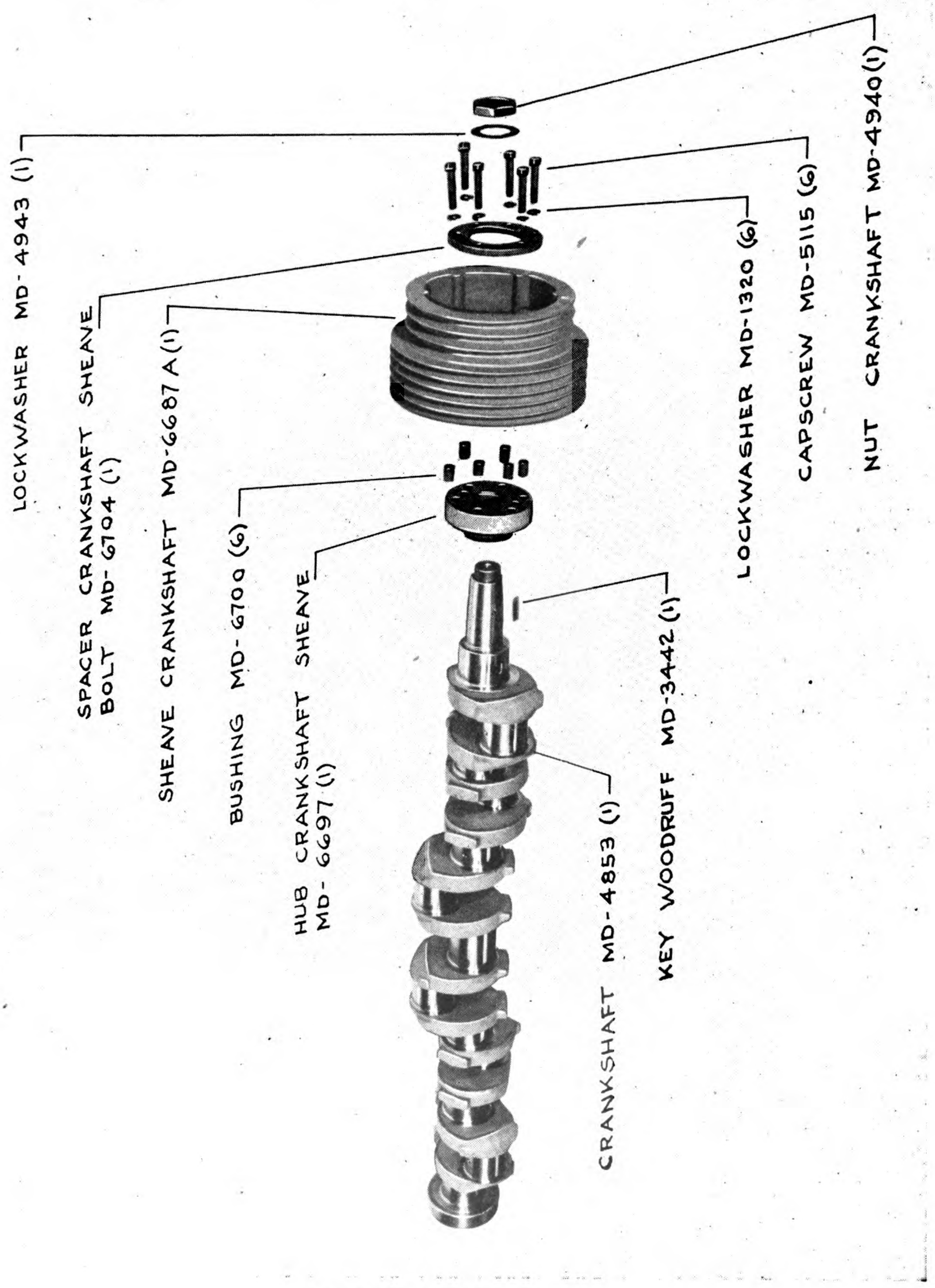
CRANKCASE ASSEMBLY

MD-6758

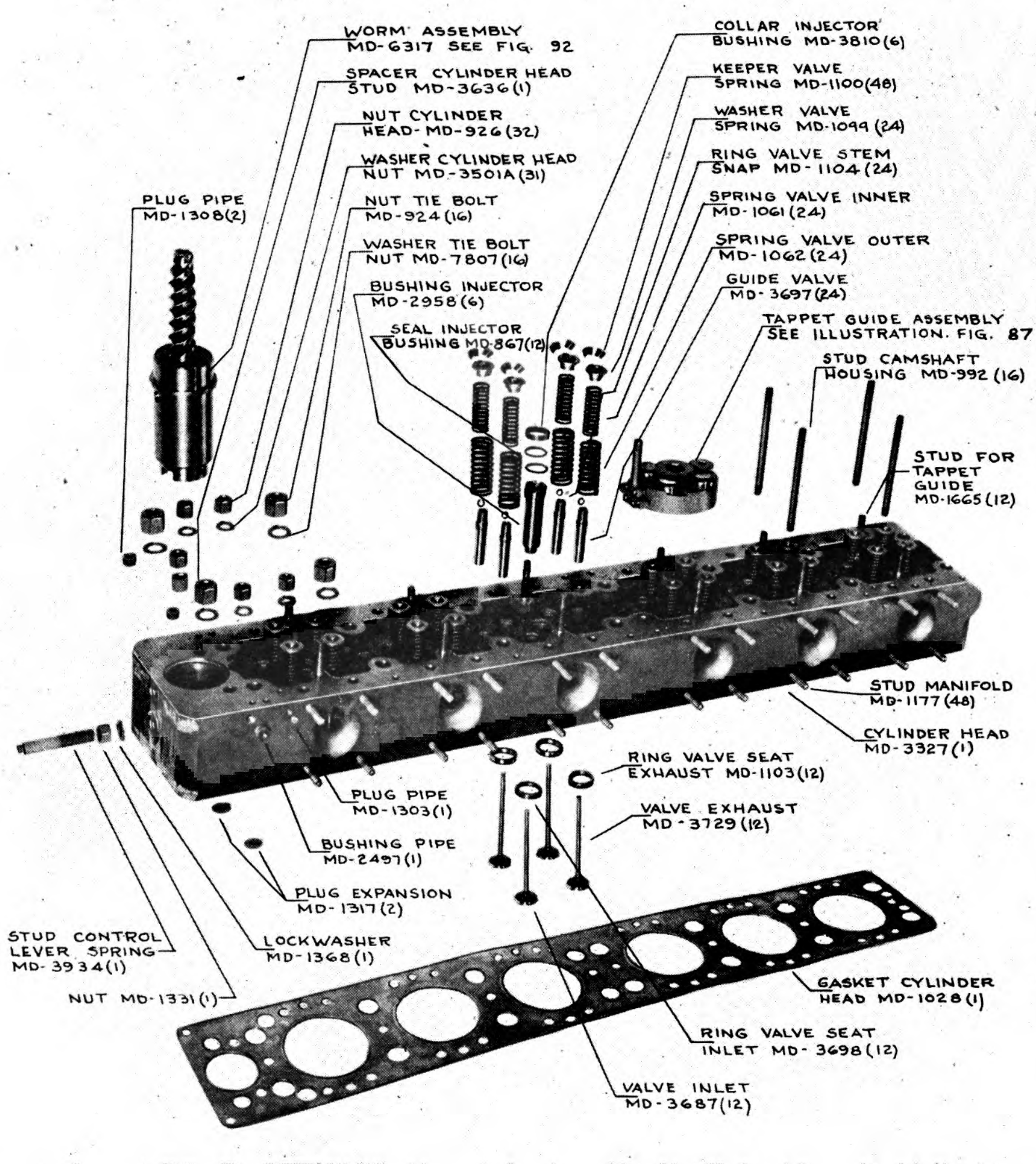
FIG. 59



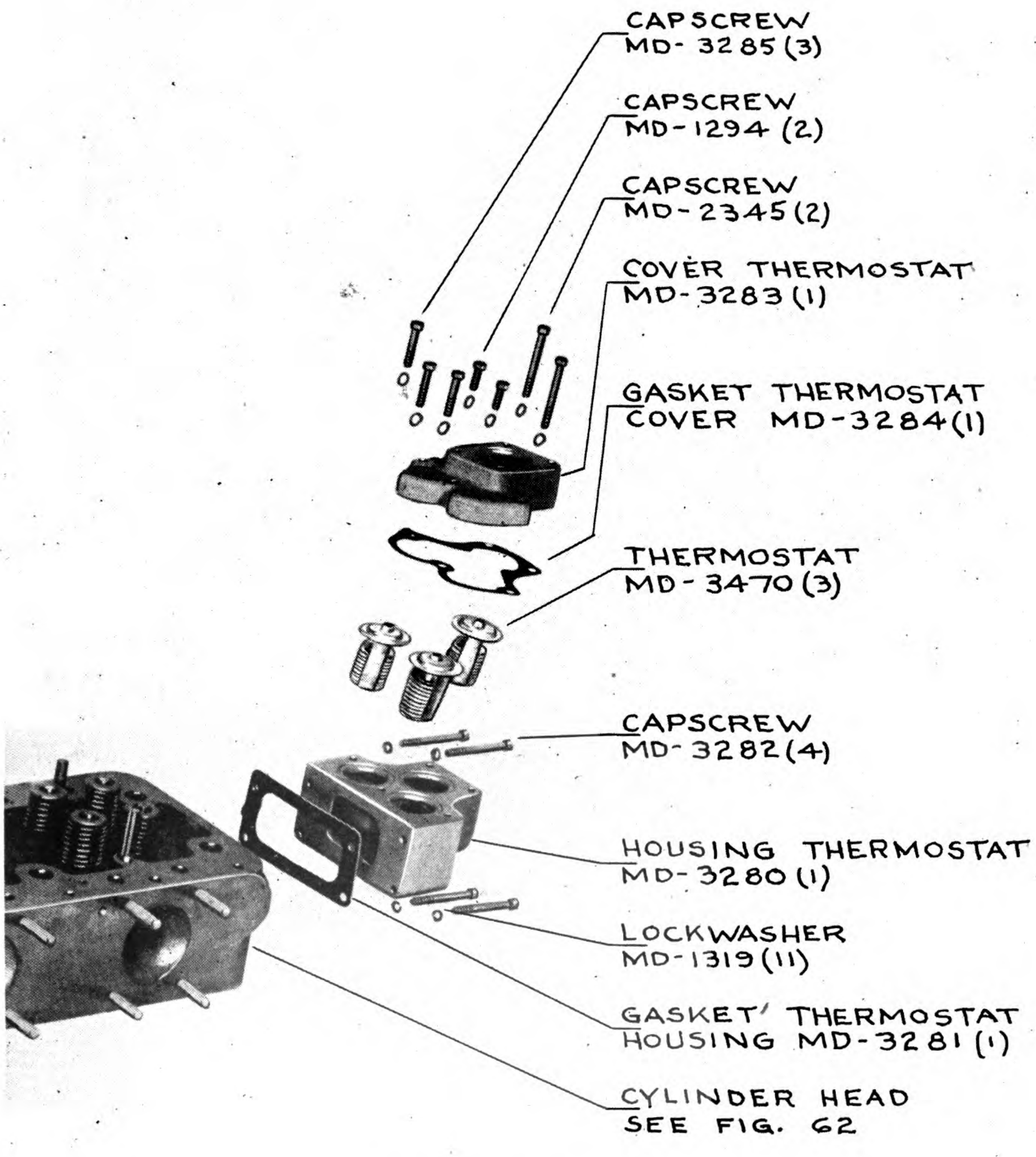
CRANKCASE BREATHER ASSEMBLY
MD-4326
FIG. 60



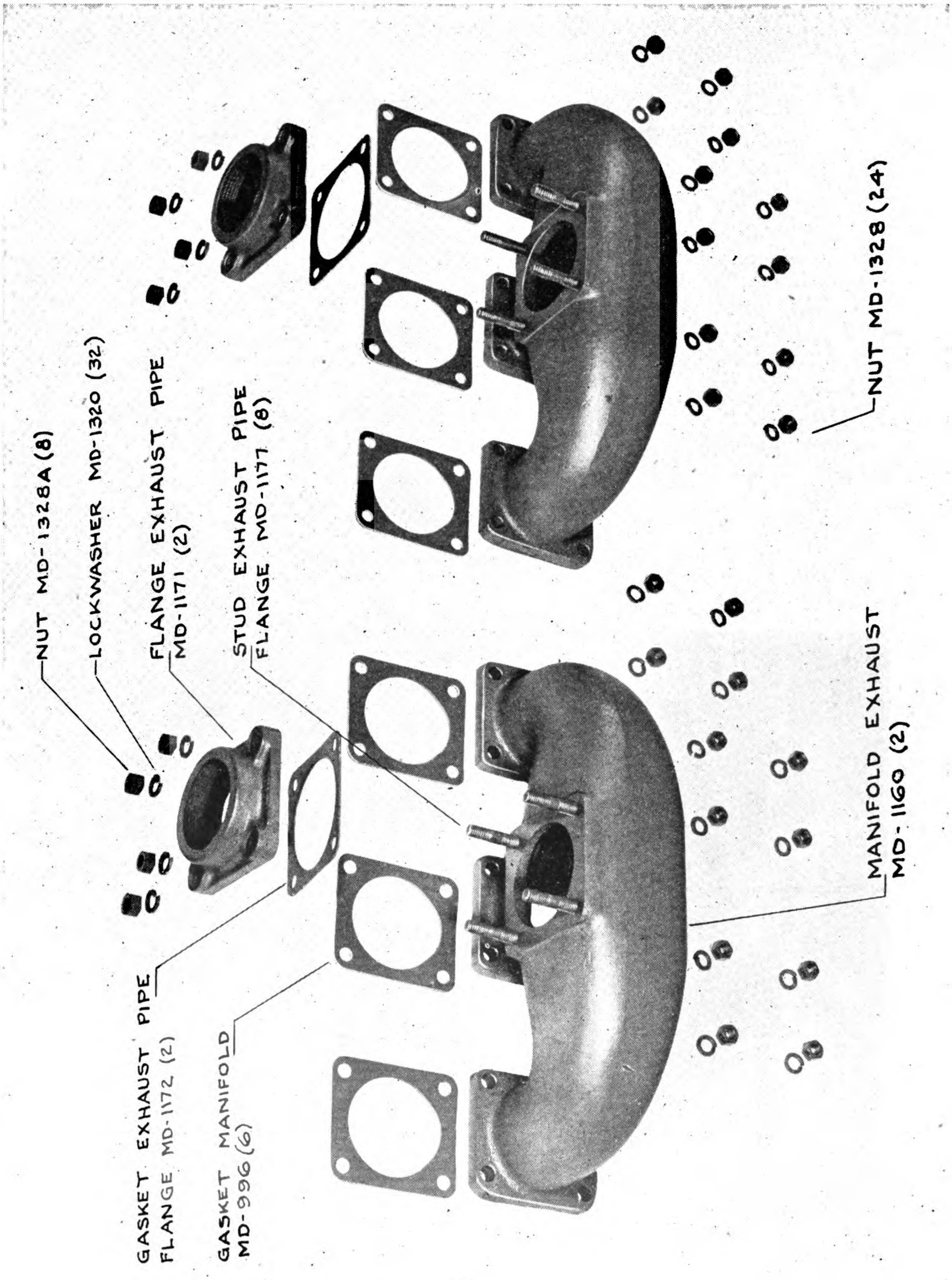
CRANKSHAFT ASSEMBLY
MD-6768A
FIG. 61



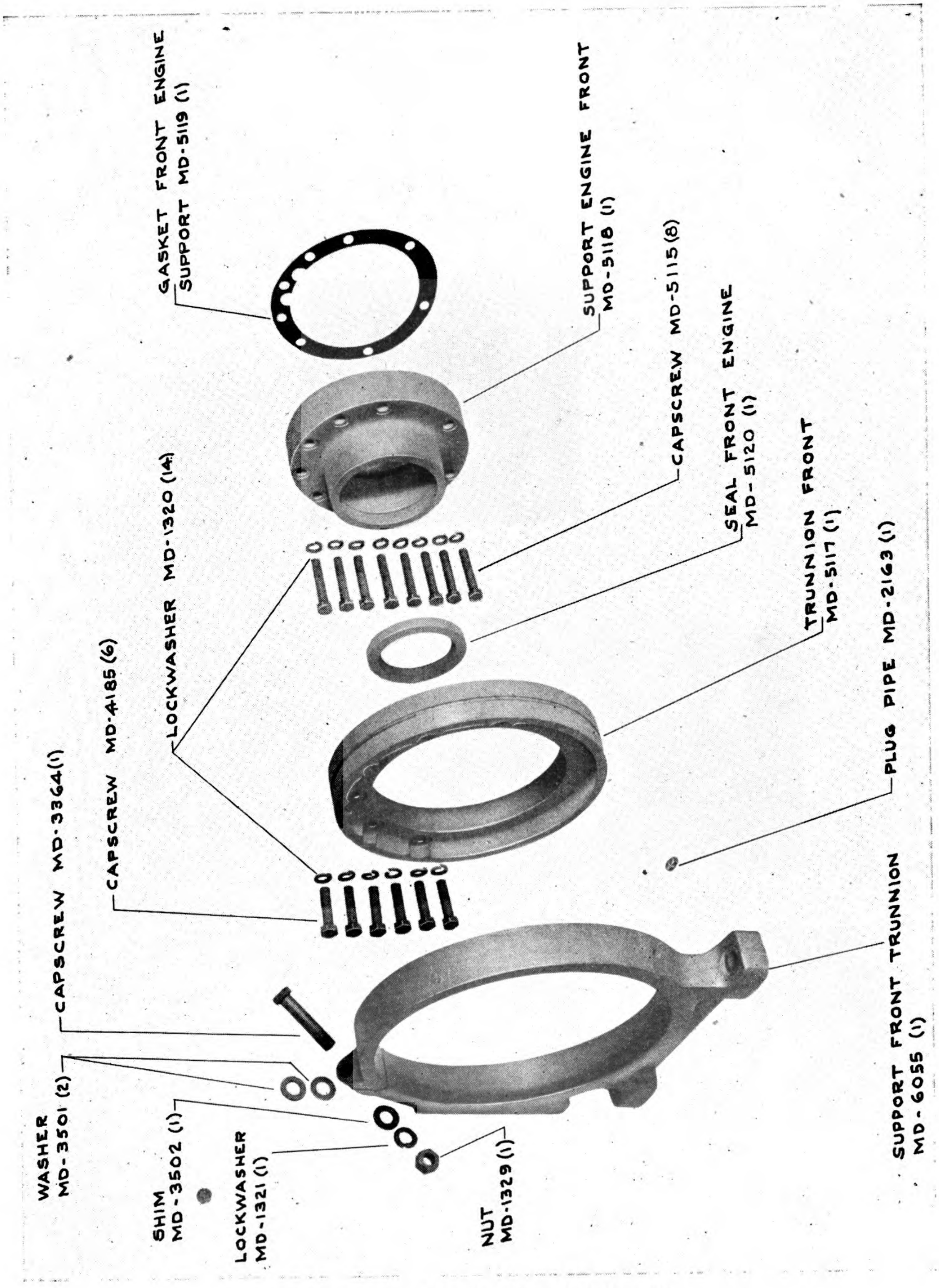
CYLINDER HEAD ASSEMBLY
MD-3498
FIG. 62



CYLINDER HEAD ASSEMBLY
MD-3498
FIG. 62A



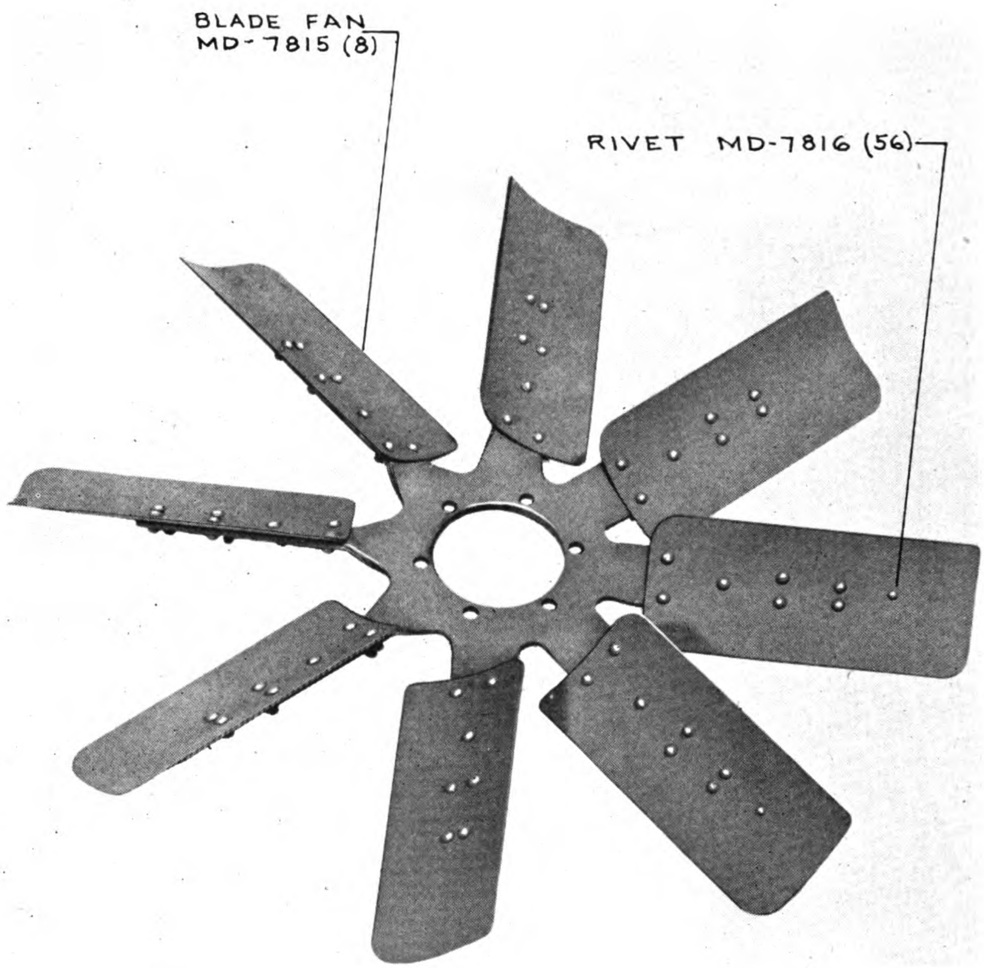
EXHAUST MANIFOLD ASSEMBLY
MD-5889
FIG. 63



FRONT ENGINE SUPPORT ASSEMBLY

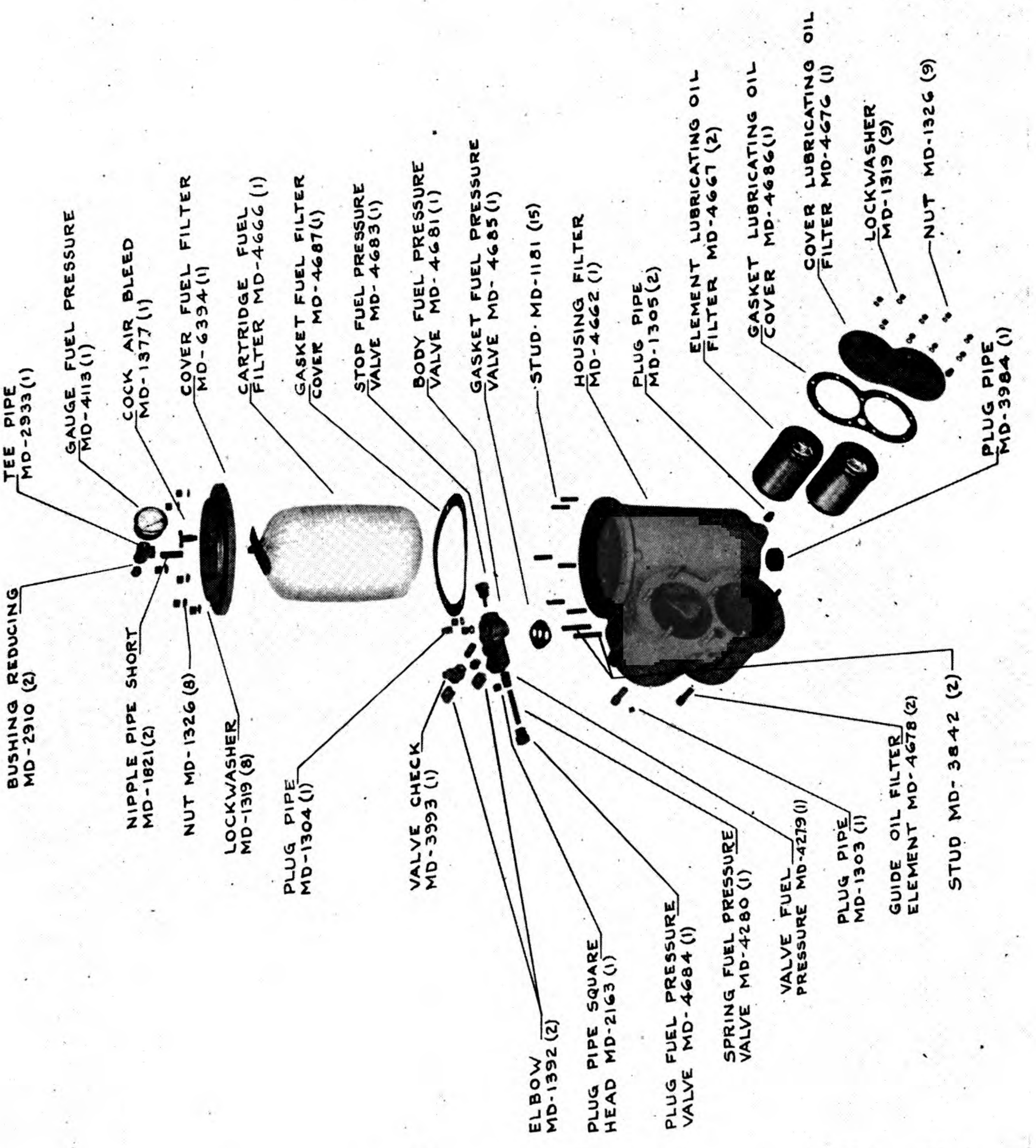
MD-6392

FIG. 64



NOTE:-
IF FAN SPIDER IS REQUIRED
ORDER COMPLETE FAN
MD-7570 FAN ASSEMBLY

FAN ASSEMBLY
MD-7570
FIG. 65

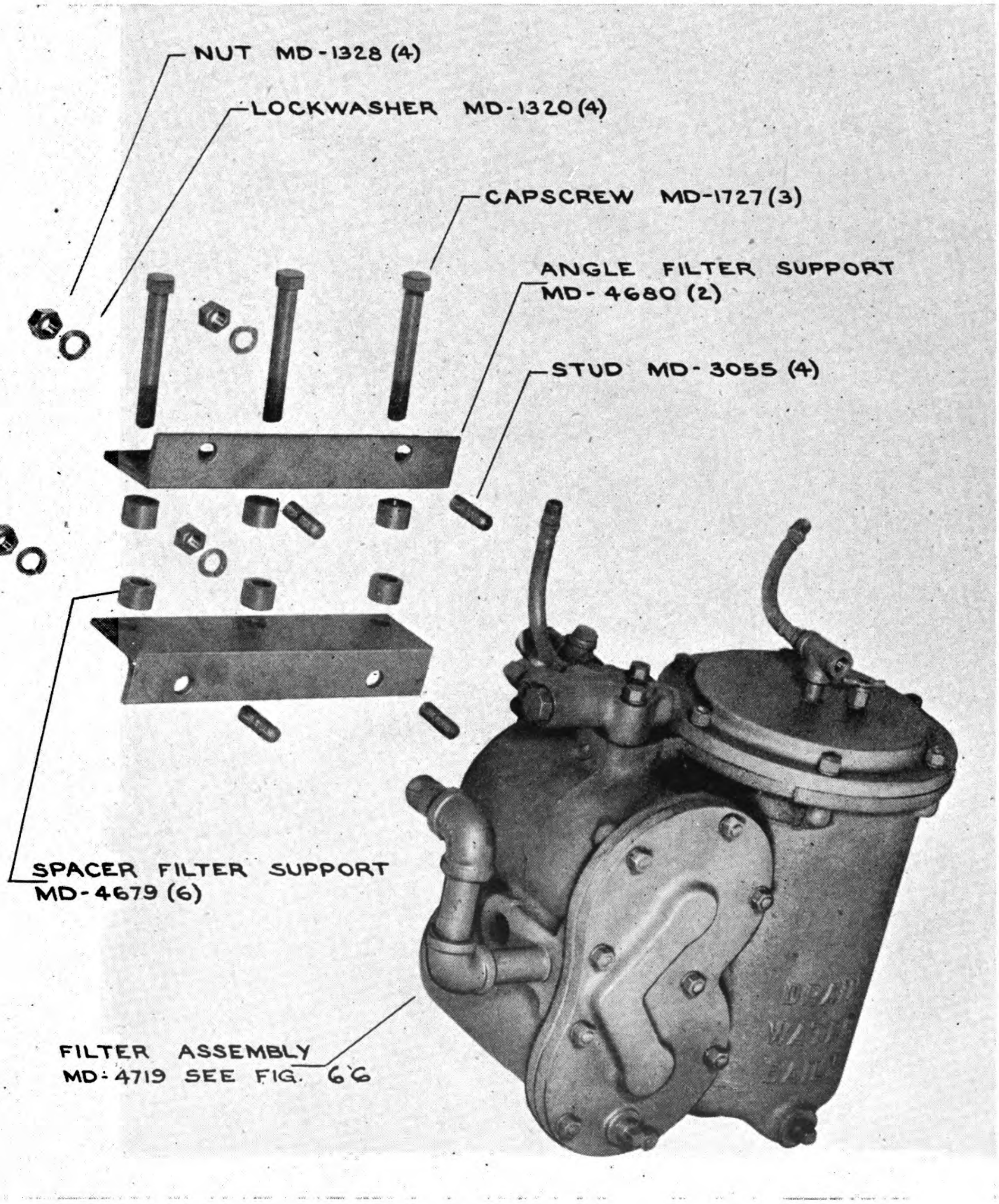


FUEL FILTER ASSEMBLY
MD-4719
FIG. 66

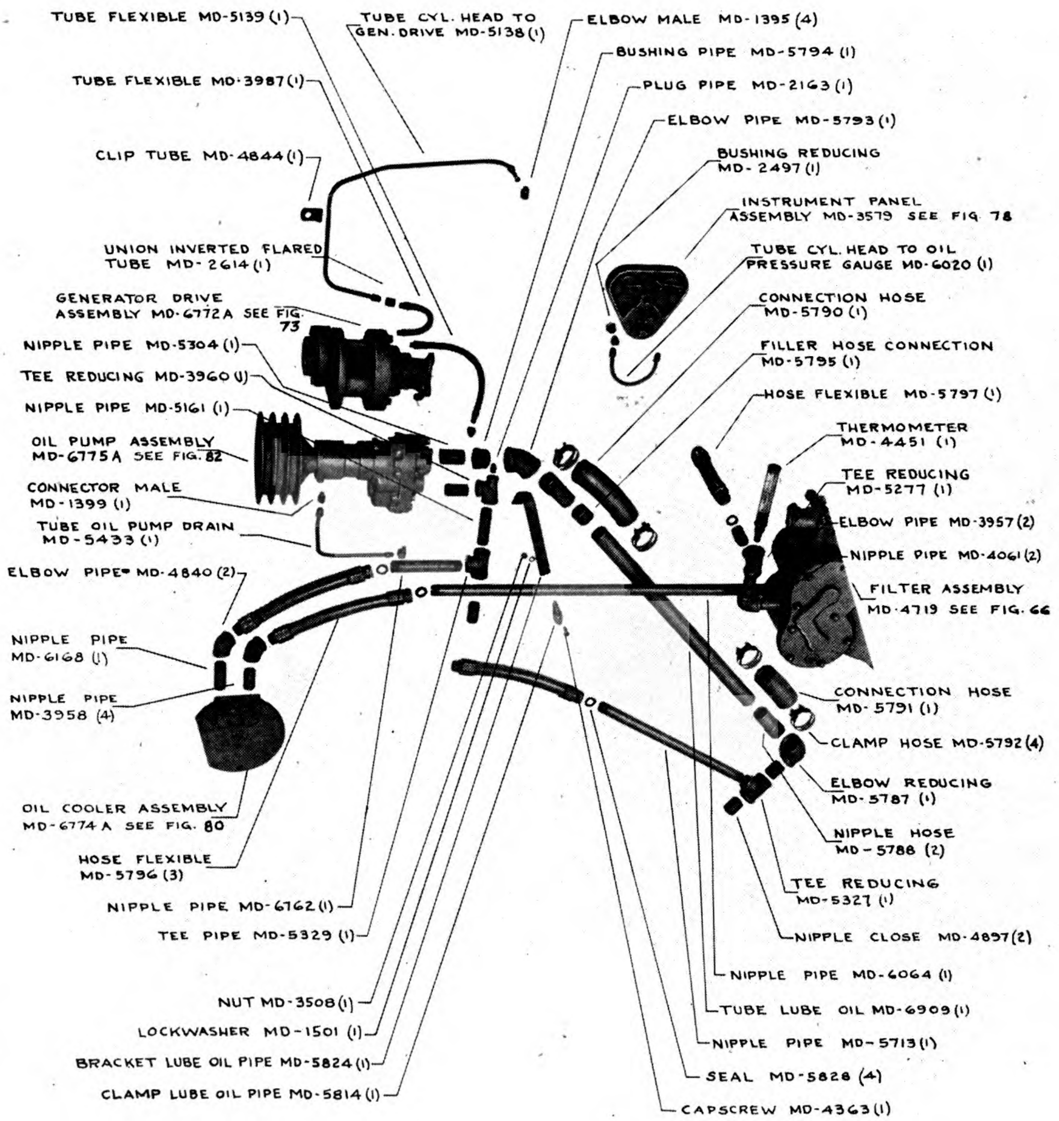
NOTE

This assembly is identical to MD-4719 fuel filter assembly (Fig. 66, Page 163) except MD-4113 gauge fuel pressure is not used. Order all other parts from MD-4719 fuel filter assembly.

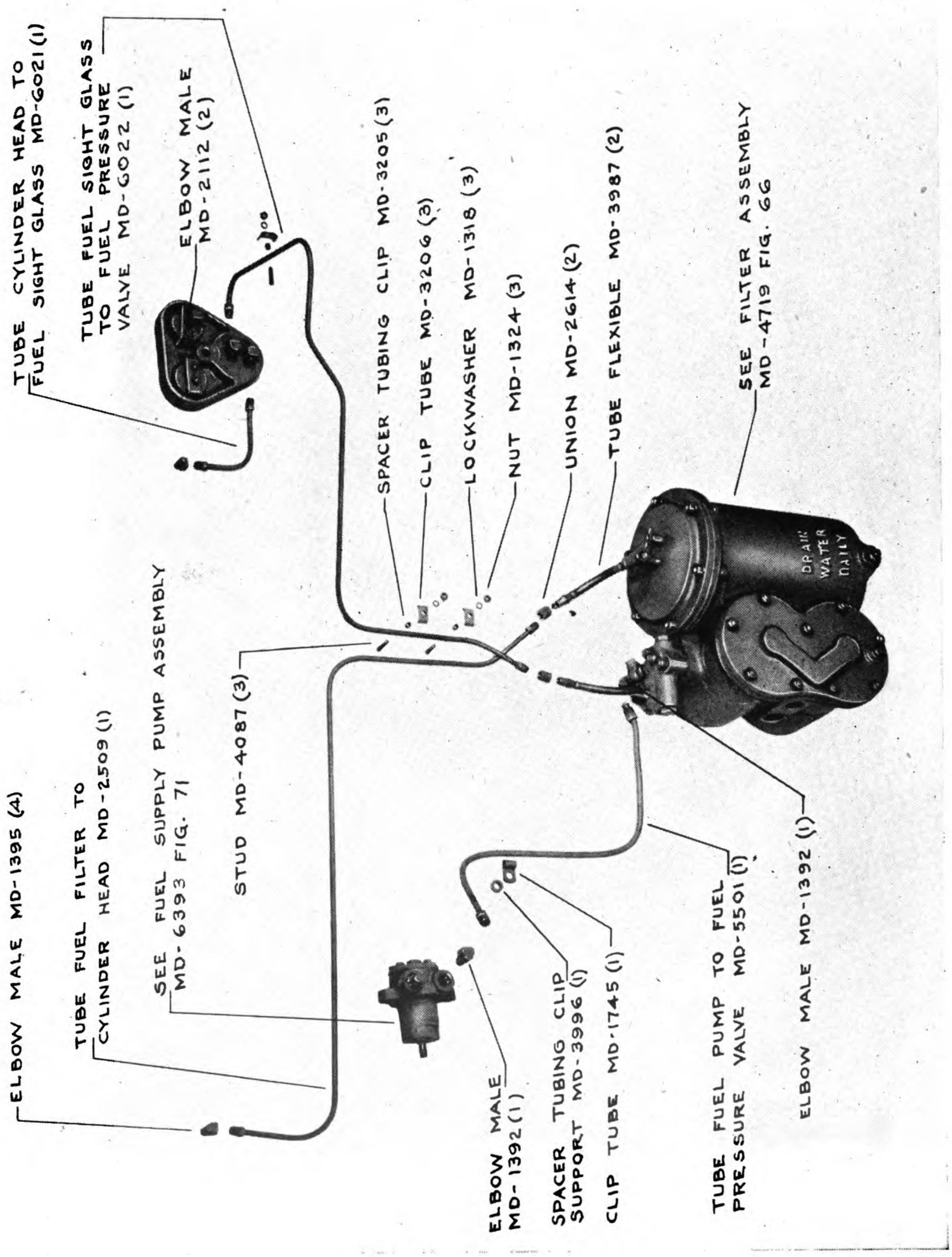
FUEL FILTER ASSEMBLY
MD-4719A
FIG. 66A



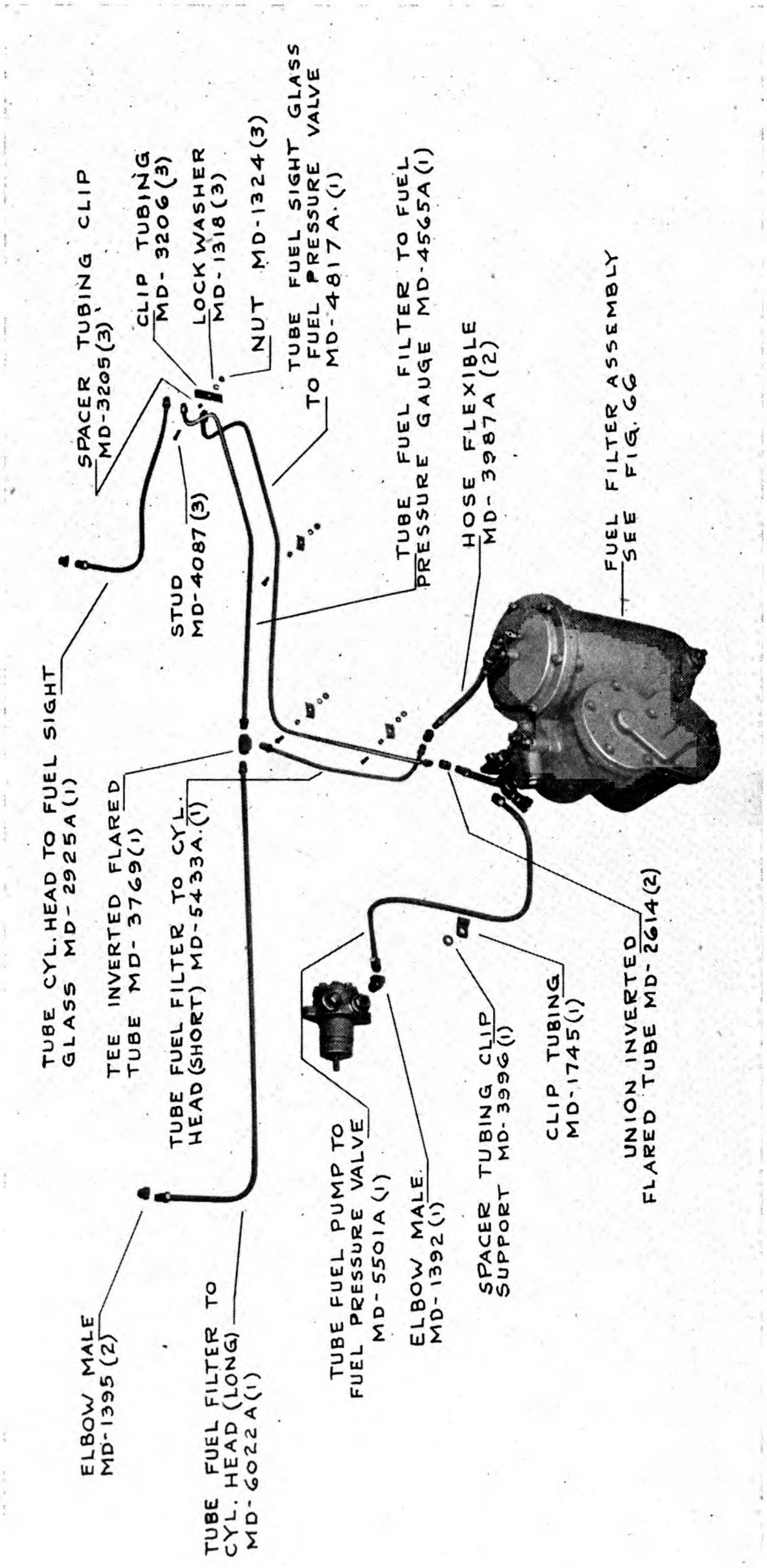
FUEL FILTER SUPPORT ASSEMBLY
MD-4809
FIG. 67



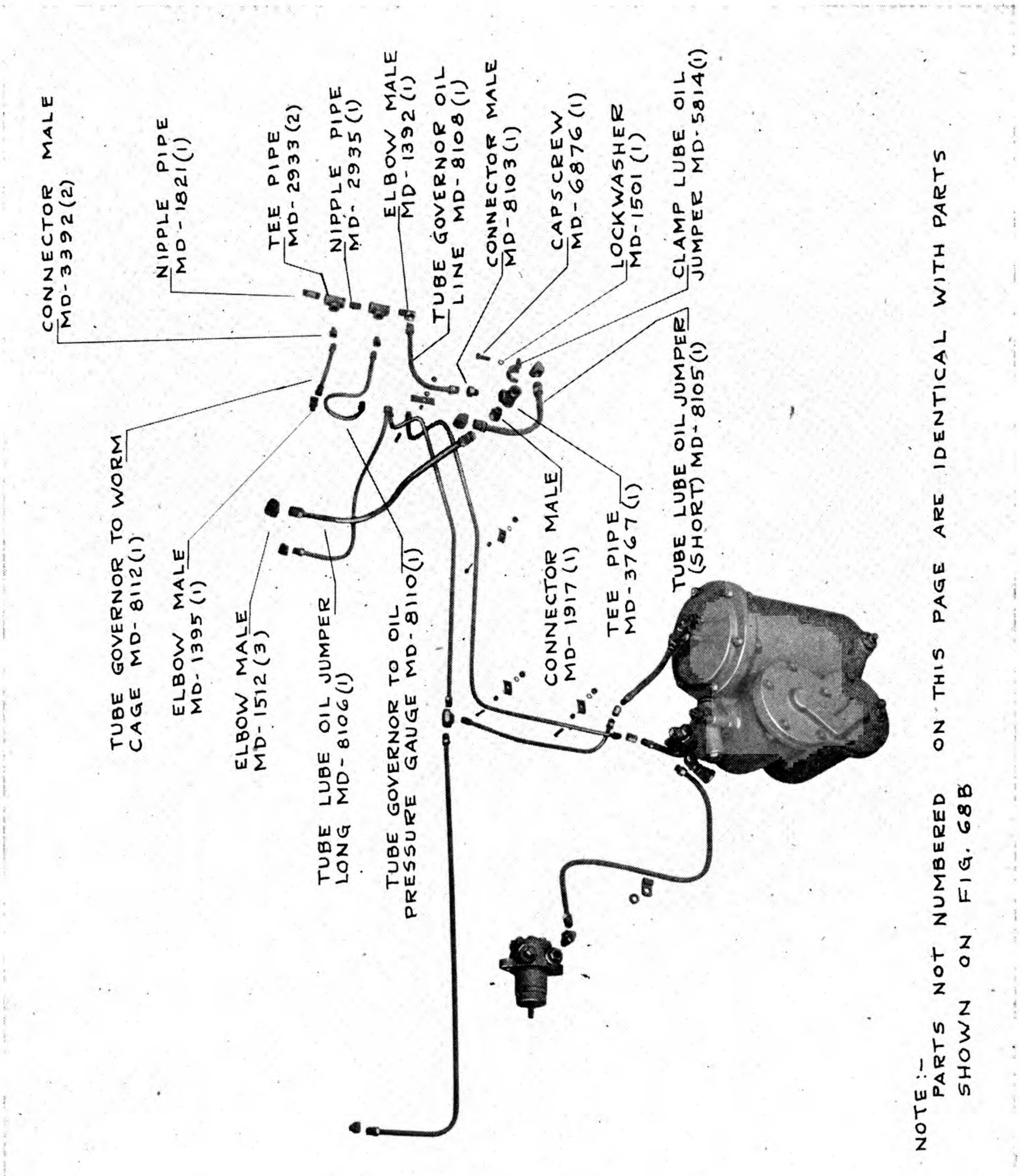
FILTER TUBING ASSEMBLY
MD-7580
FIG. 68



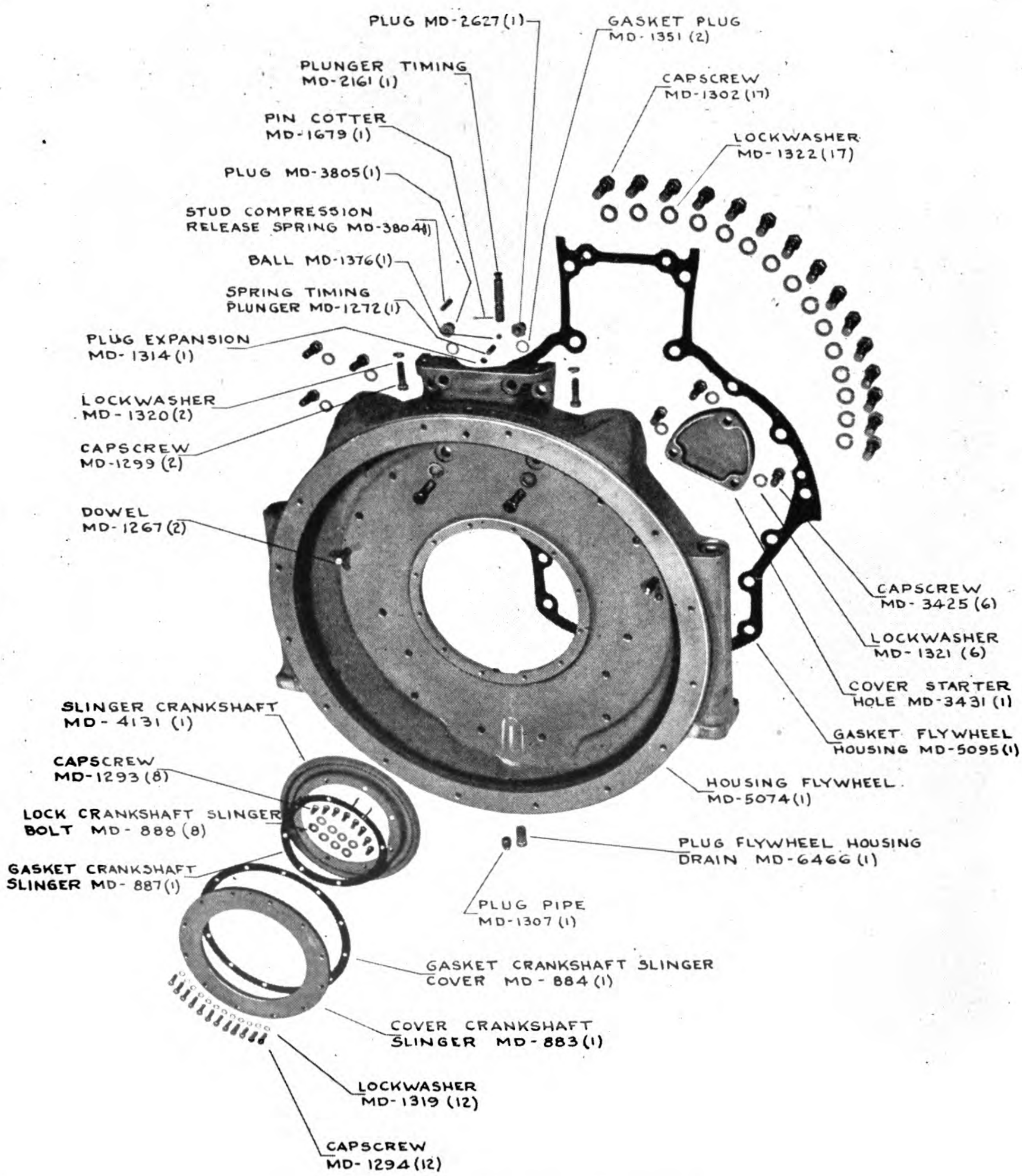
FILTER TUBING ASSEMBLY
MD-7580
FIG. 68A



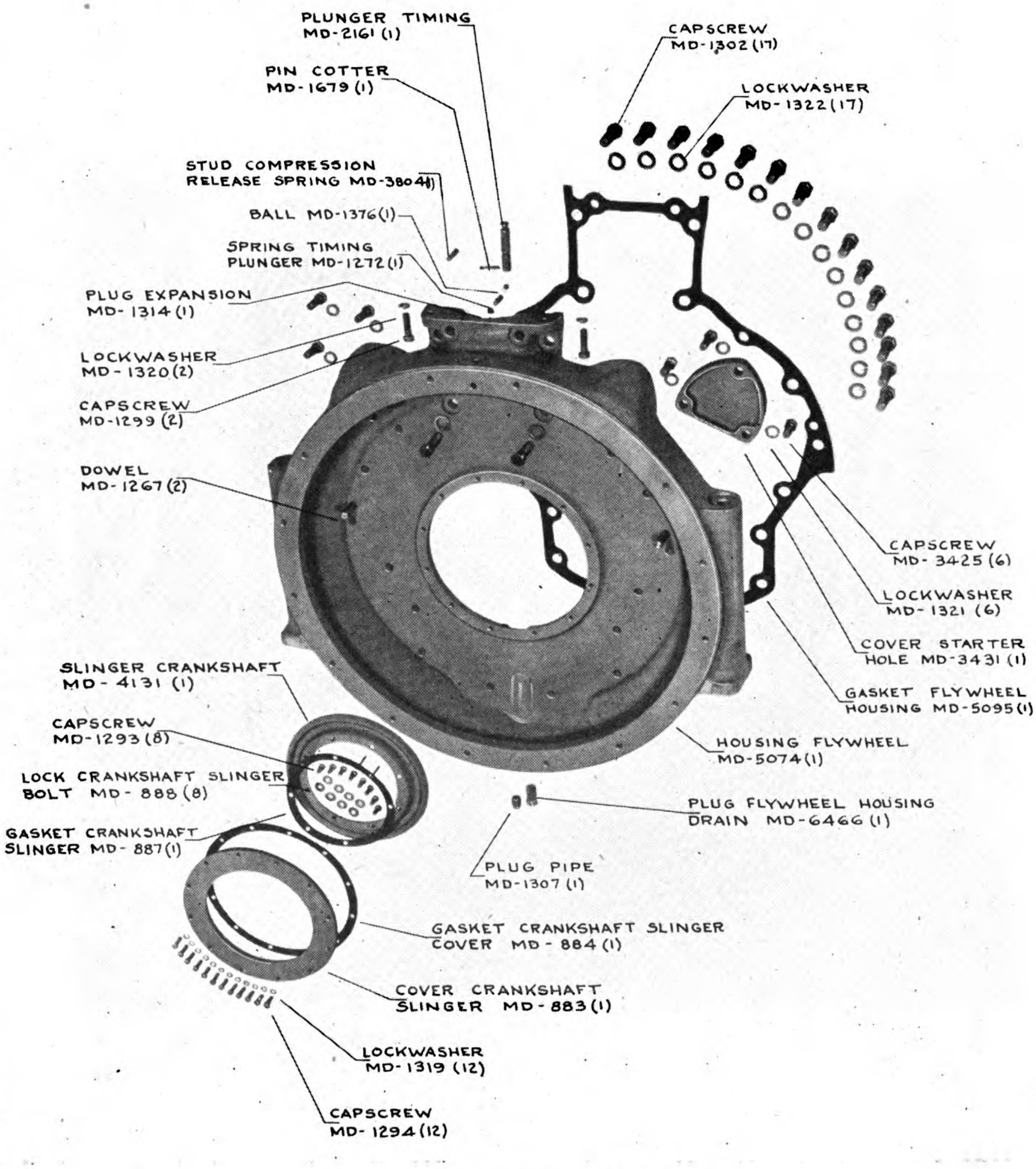
FILTER TUBING ASSEMBLY
MD-7580B
For balance of this assembly see Fig. 68
FIG. 68B



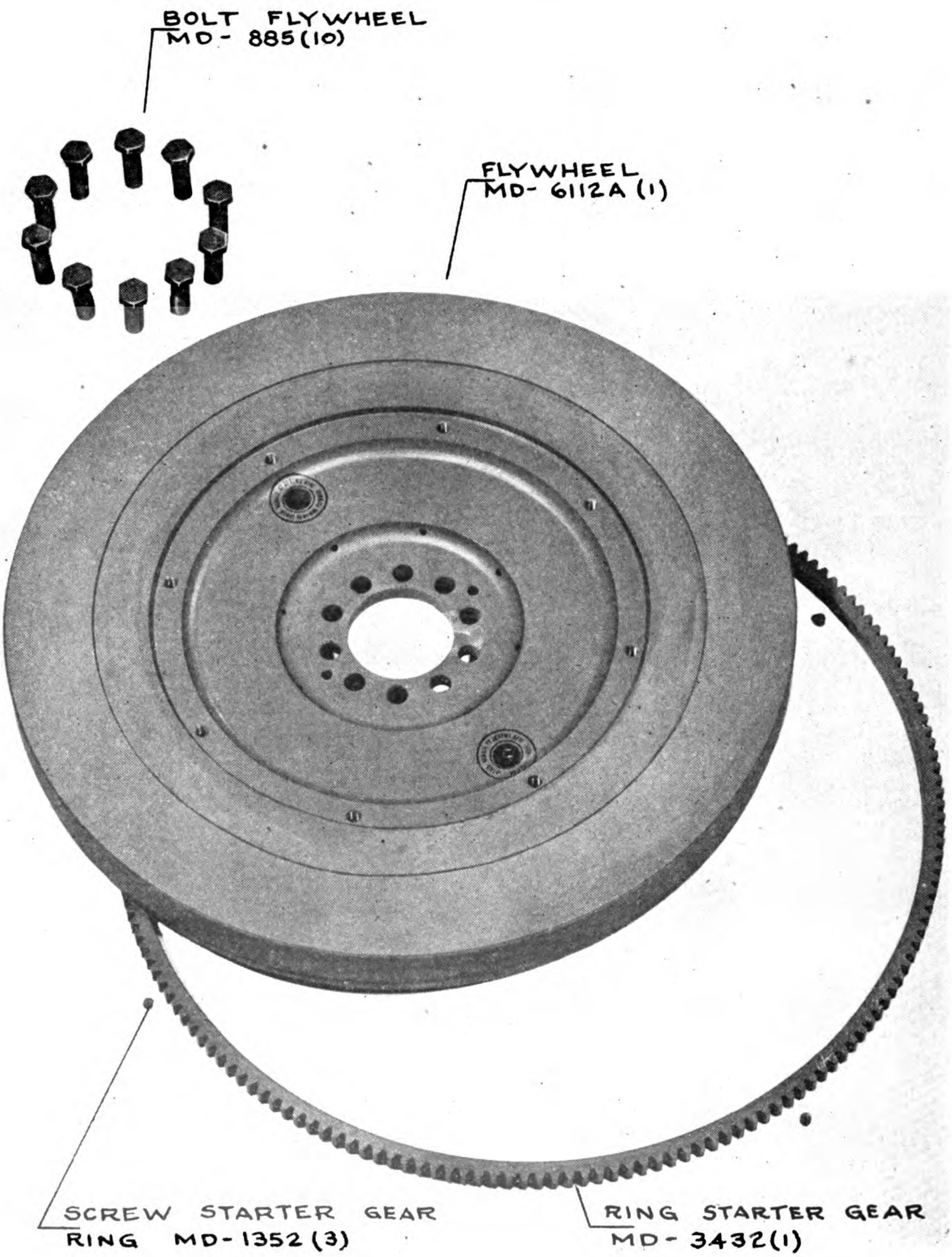
FILTER TUBING ASSEMBLY
MD-7580C
For balance of this assembly see Fig. 68 and Fig. 68B
FIG. 68C



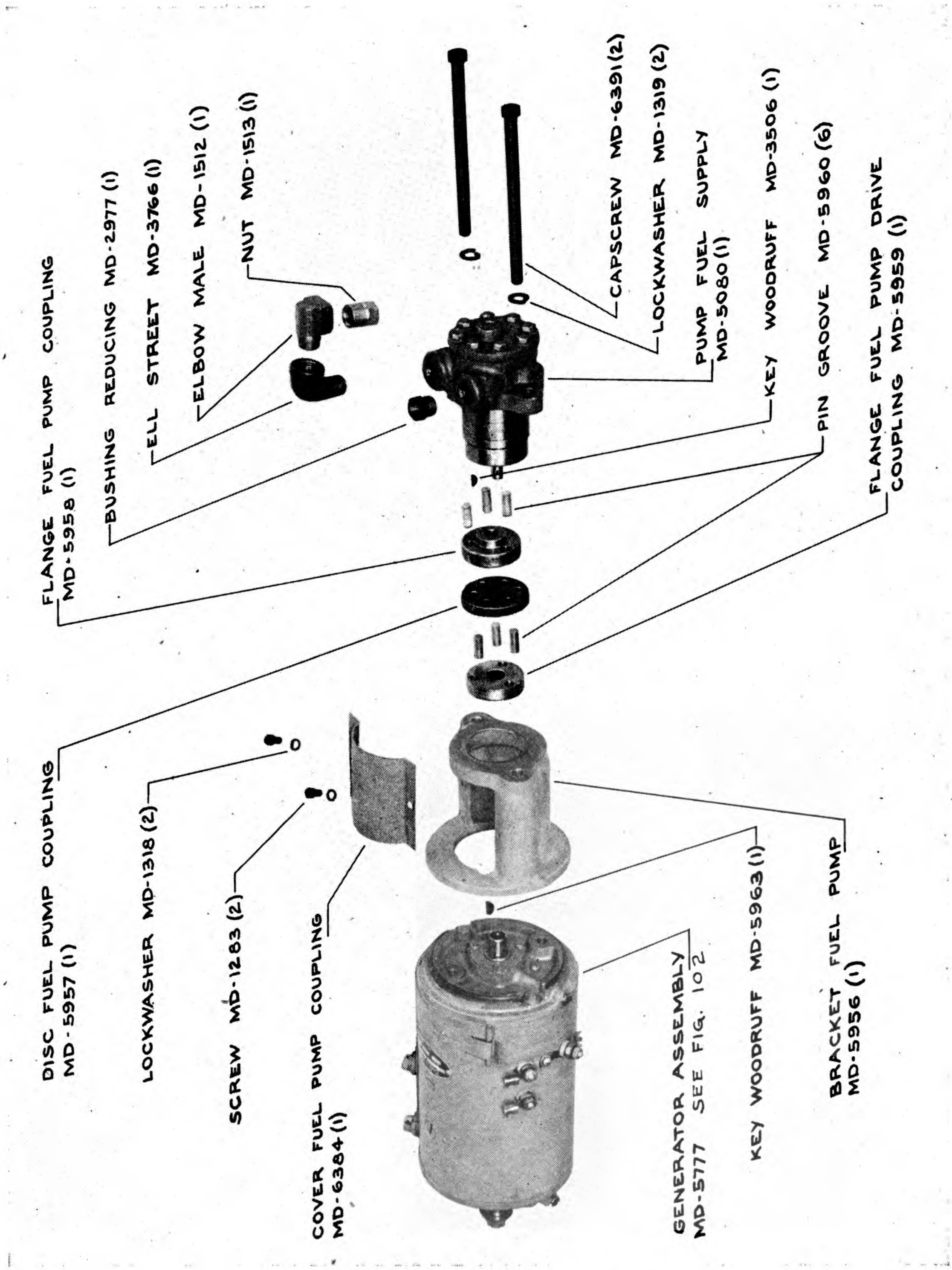
FLYWHEEL HOUSING ASSEMBLY
MD-5447
FIG. 69



FLYWHEEL HOUSING ASSEMBLY
MD-5447A
FIG. 69A



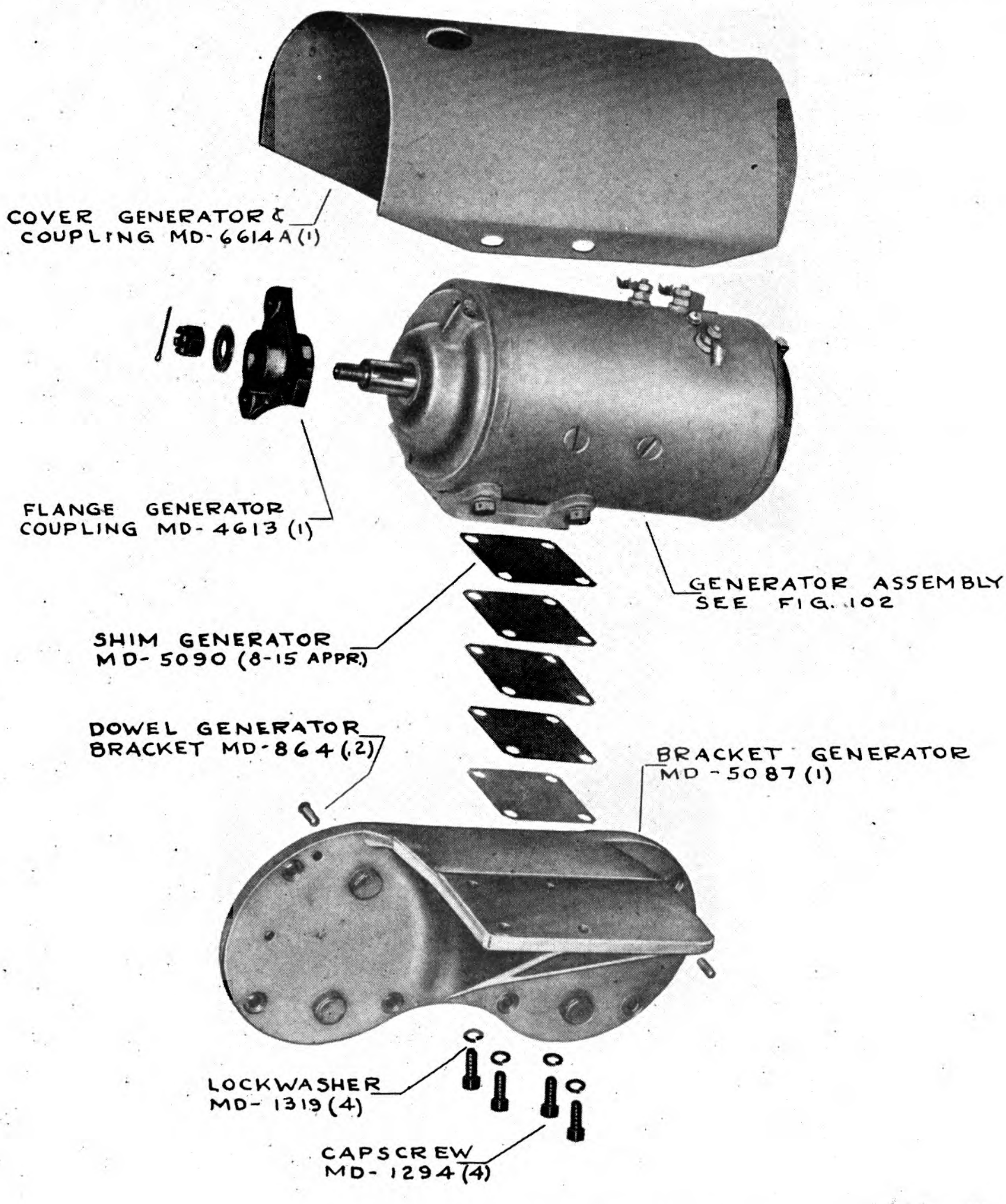
FLYWHEEL AND GEAR RING ASSEMBLY
MD-6575A
FIG. 70



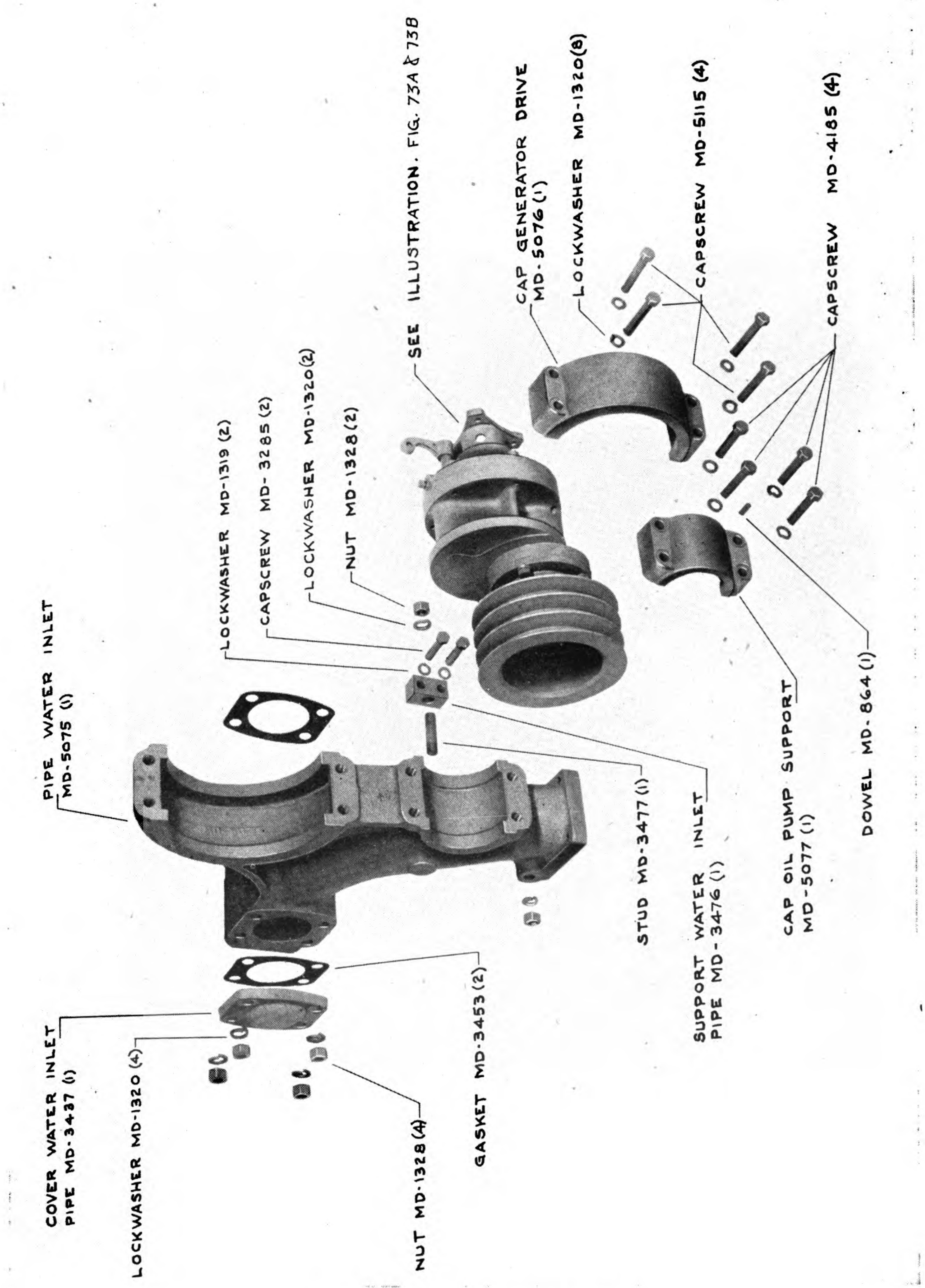
FUEL SUPPLY PUMP ASSEMBLY

MD-6393

FIG. 71



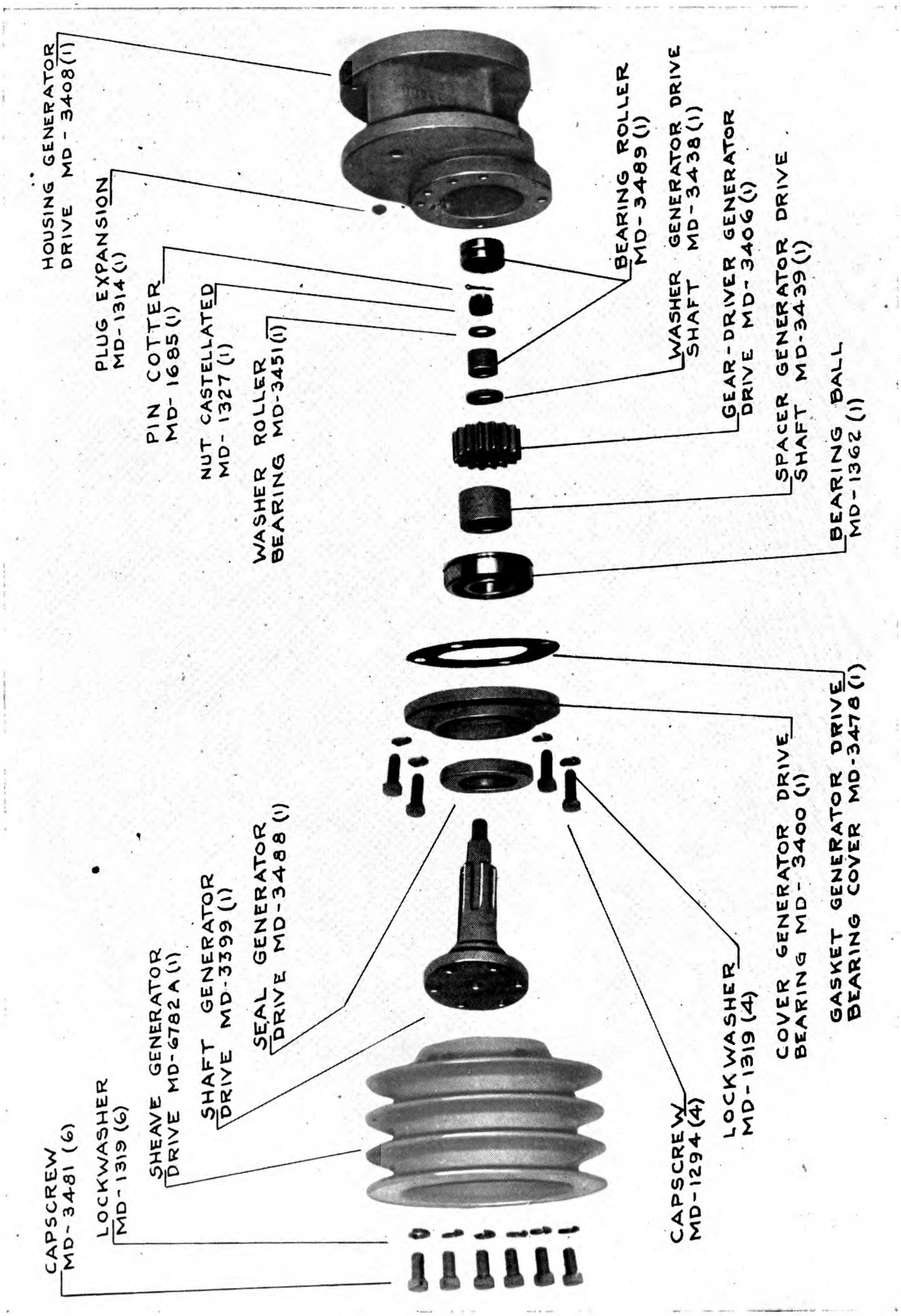
GENERATOR MOUNTING ASSEMBLY
MD-5091A
FIG. 72



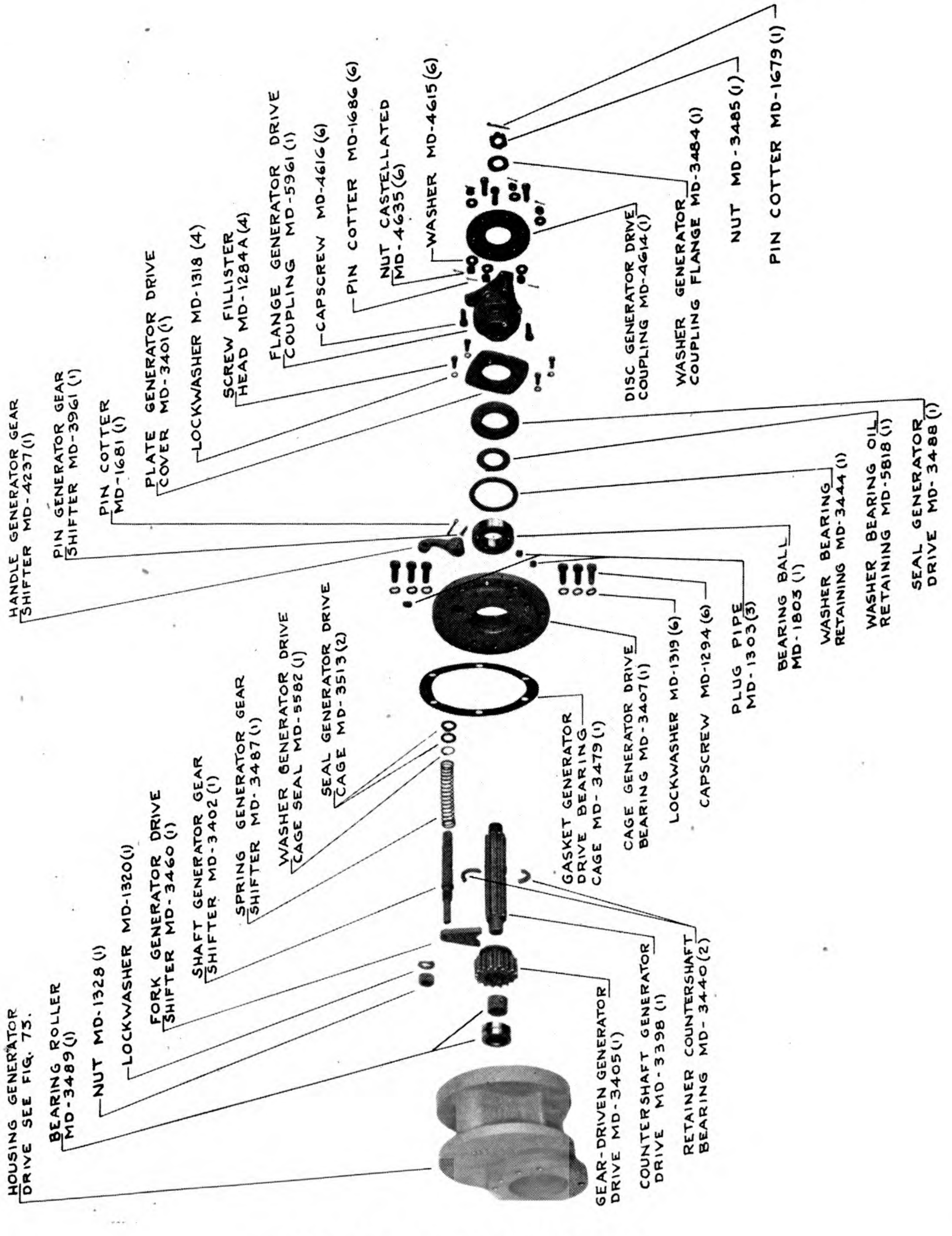
GENERATOR DRIVE ASSEMBLY

MD-6772A

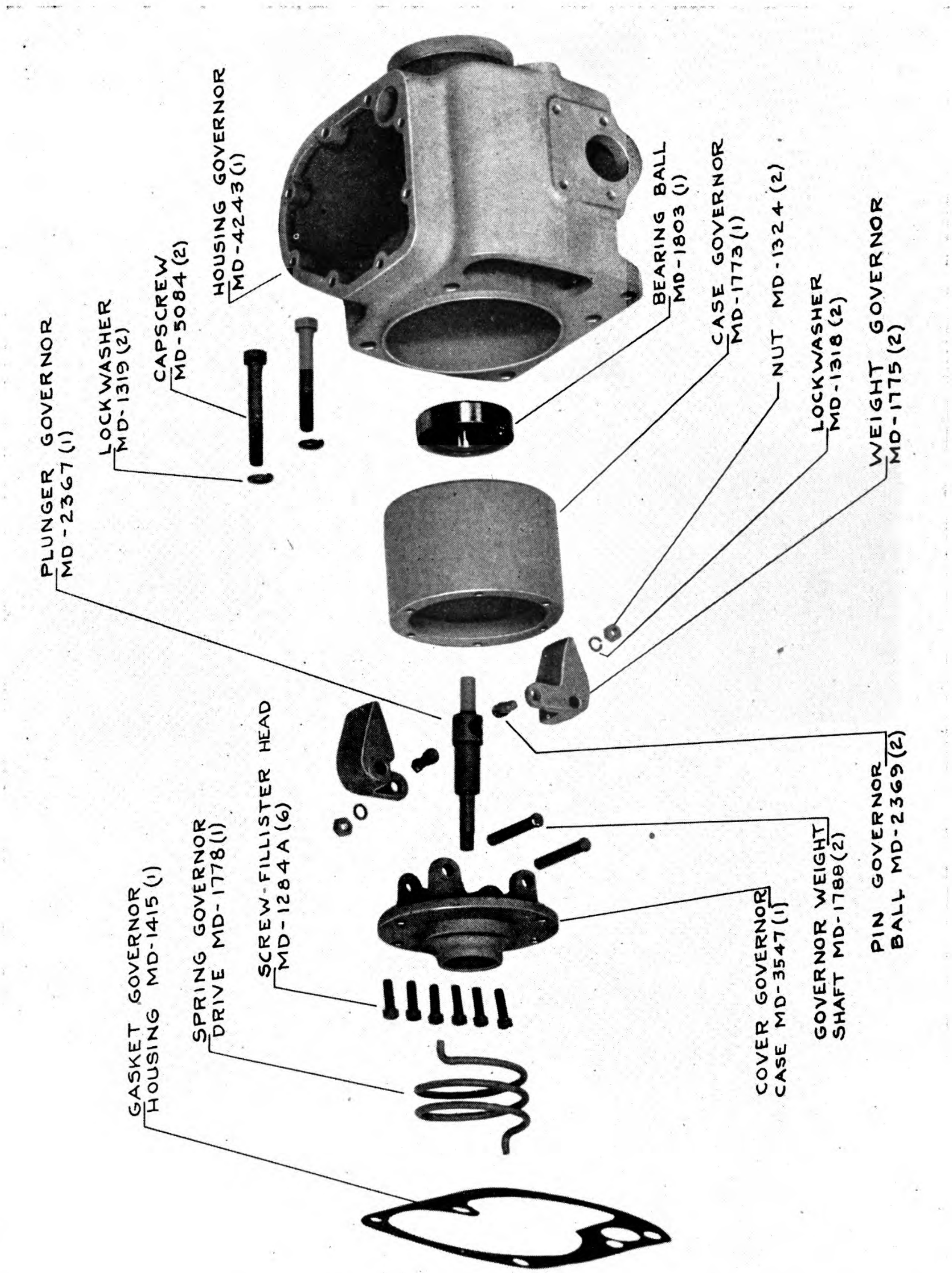
FIG. 73



GENERATOR DRIVE ASSEMBLY
MD-6772A
FIG. 73A

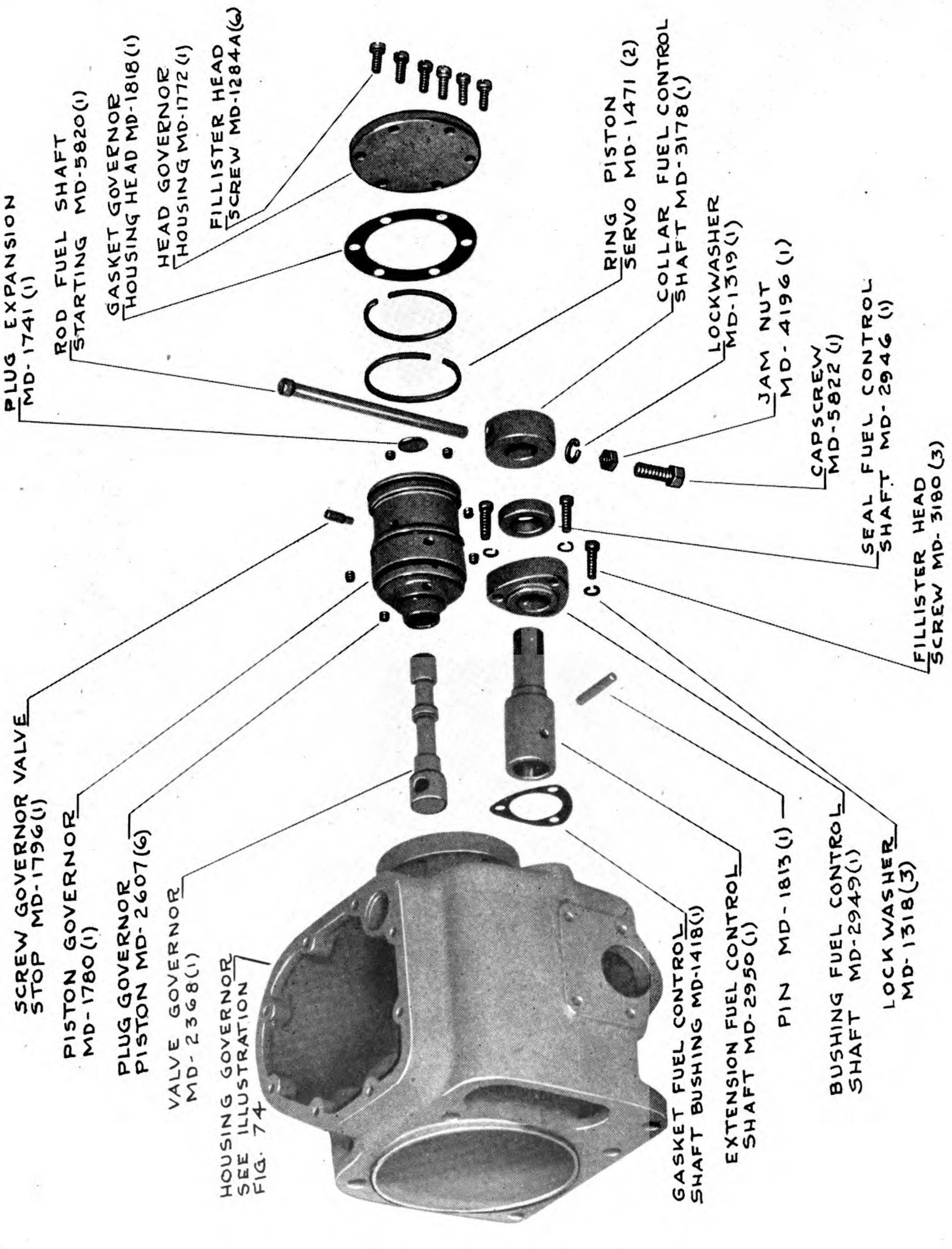


GENERATOR DRIVE ASSEMBLY
MD-6772A
FIG. 73B



If complete governor case assembly (case, cover, bearing, weights, plunger and pins assembled) is desired order MD-3886 assembly.

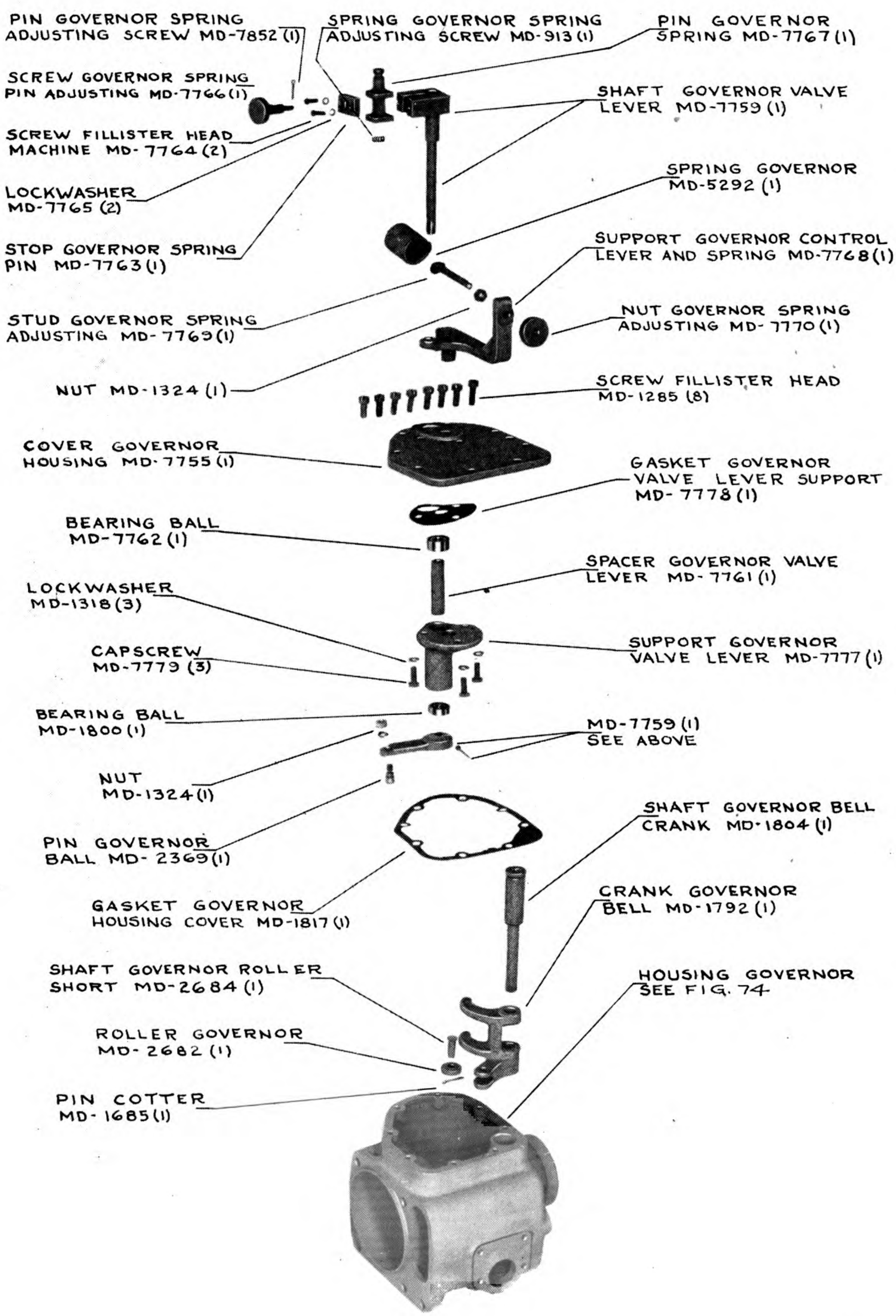
GOVERNOR ASSEMBLY
MD-5823A
FIG. 74



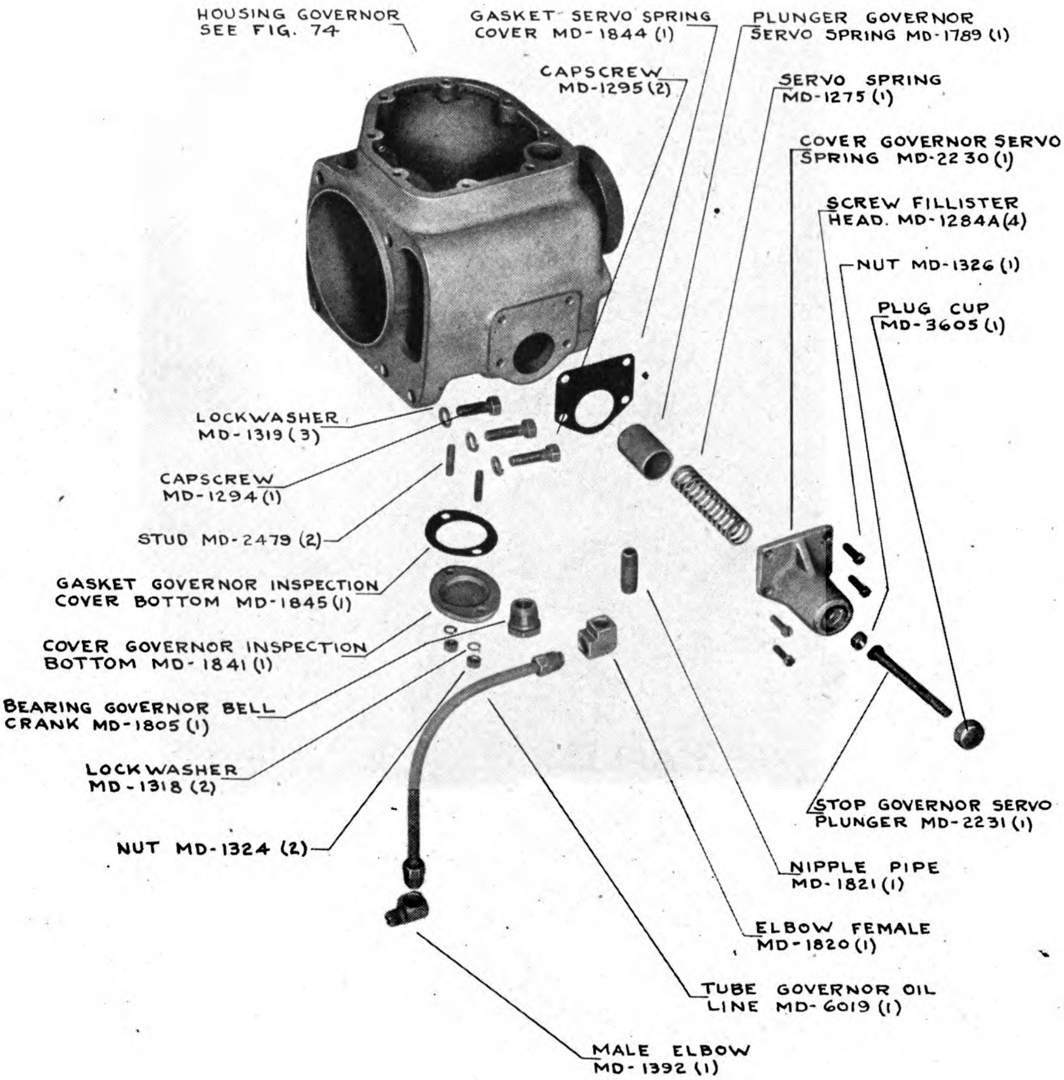
GOVERNOR ASSEMBLY
MD-5823A

If complete governor piston assembly (valve piston, rings, plugs, and stop screw assembled) is desired order MD-2995 assembly

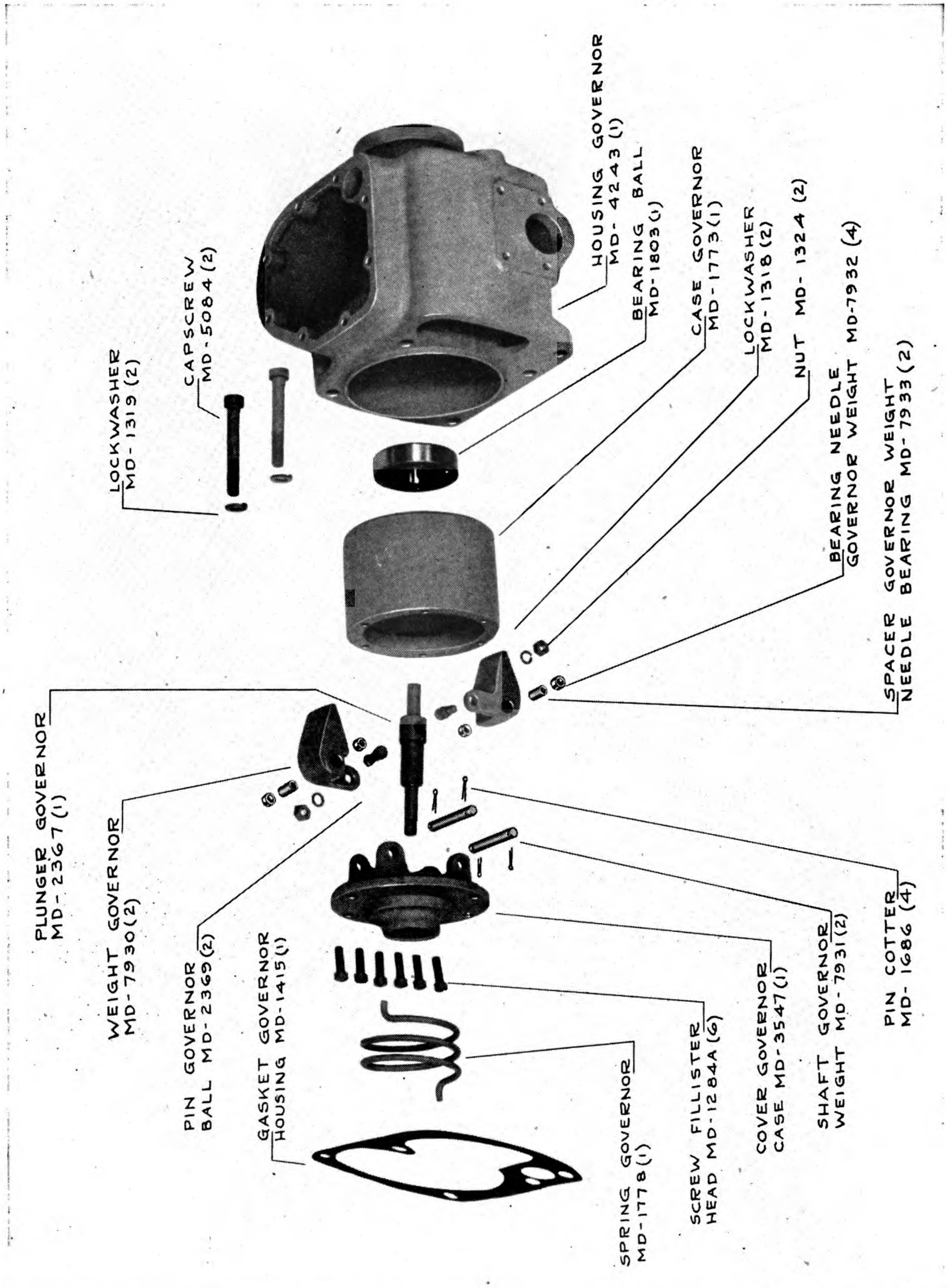
FIG. 74A



GOVERNOR ASSEMBLY
MD-5823A
FIG. 74B



GOVERNOR ASSEMBLY
MD-5823A
FIG. 74C

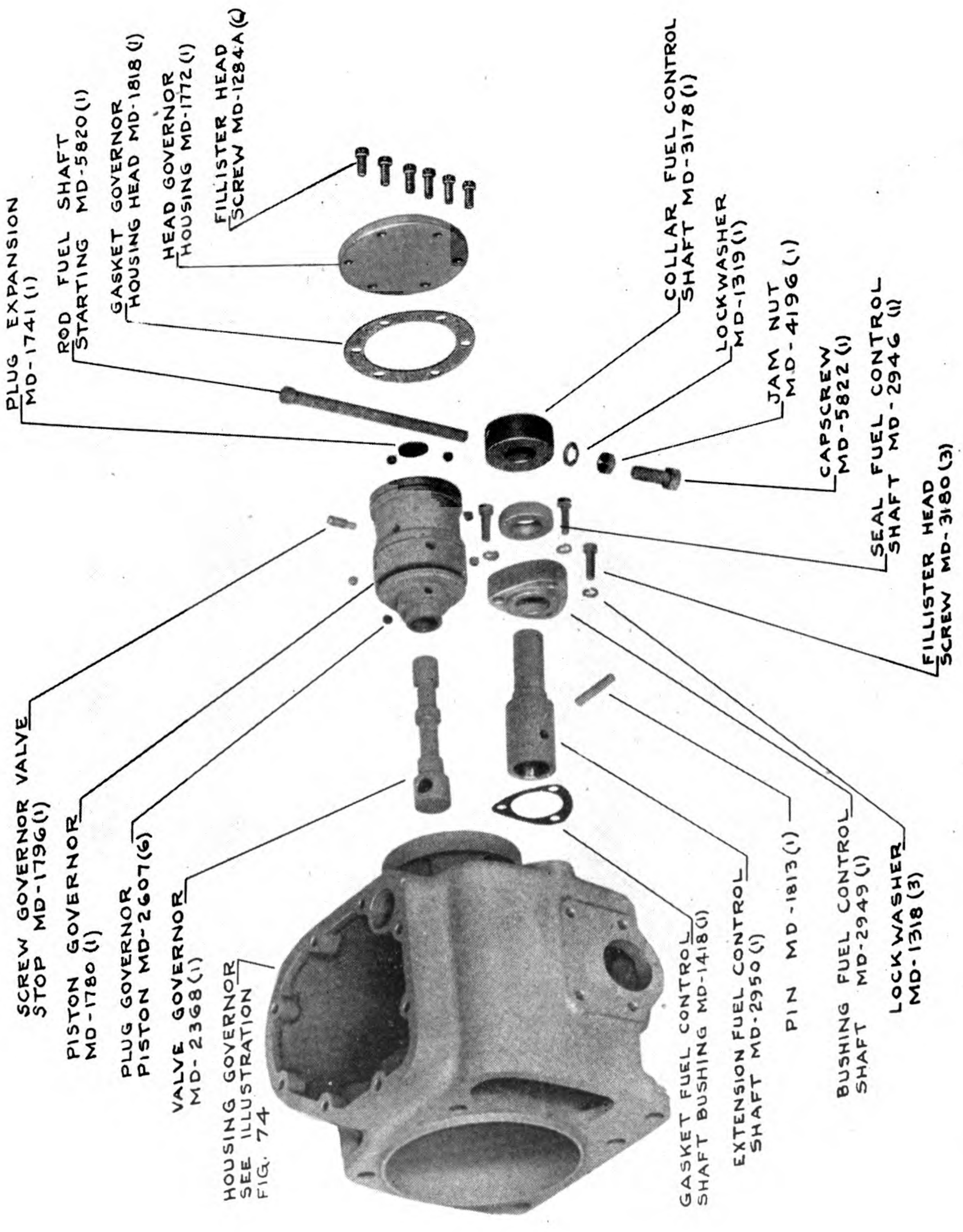


GOVERNOR ASSEMBLY
MD-5823B

If complete governor case assembly (case cover, bearings, weights, spacers, plunger and pins assembled) is desired order MD-3886A assembly

For parts not shown on this page or on Fig. 75A refer to Fig. 74B and Fig. 74A

FIG. 75



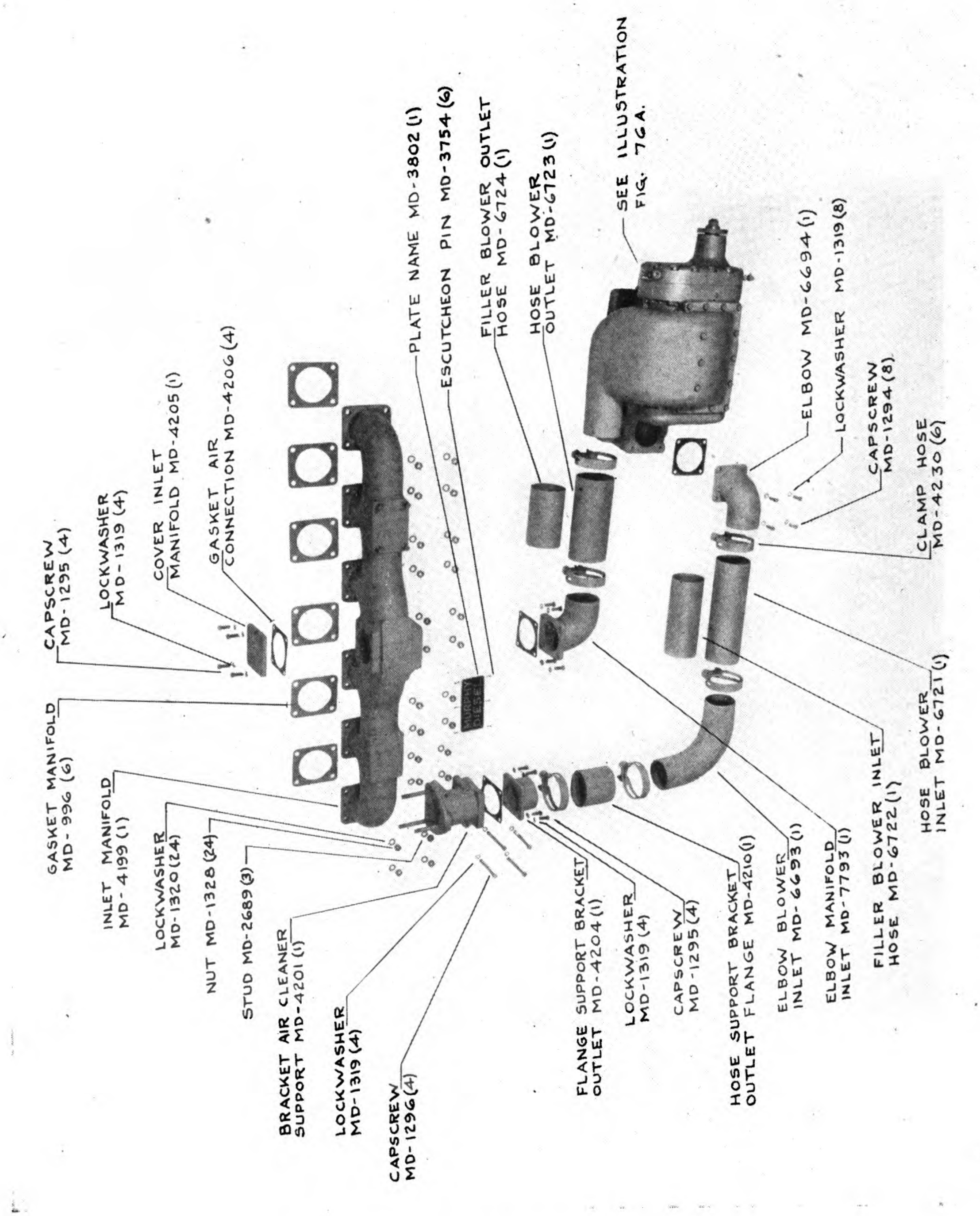
GOVERNOR ASSEMBLY

For parts not shown on this page or on Fig. 75 refer to Fig. 74A and Fig. 74B

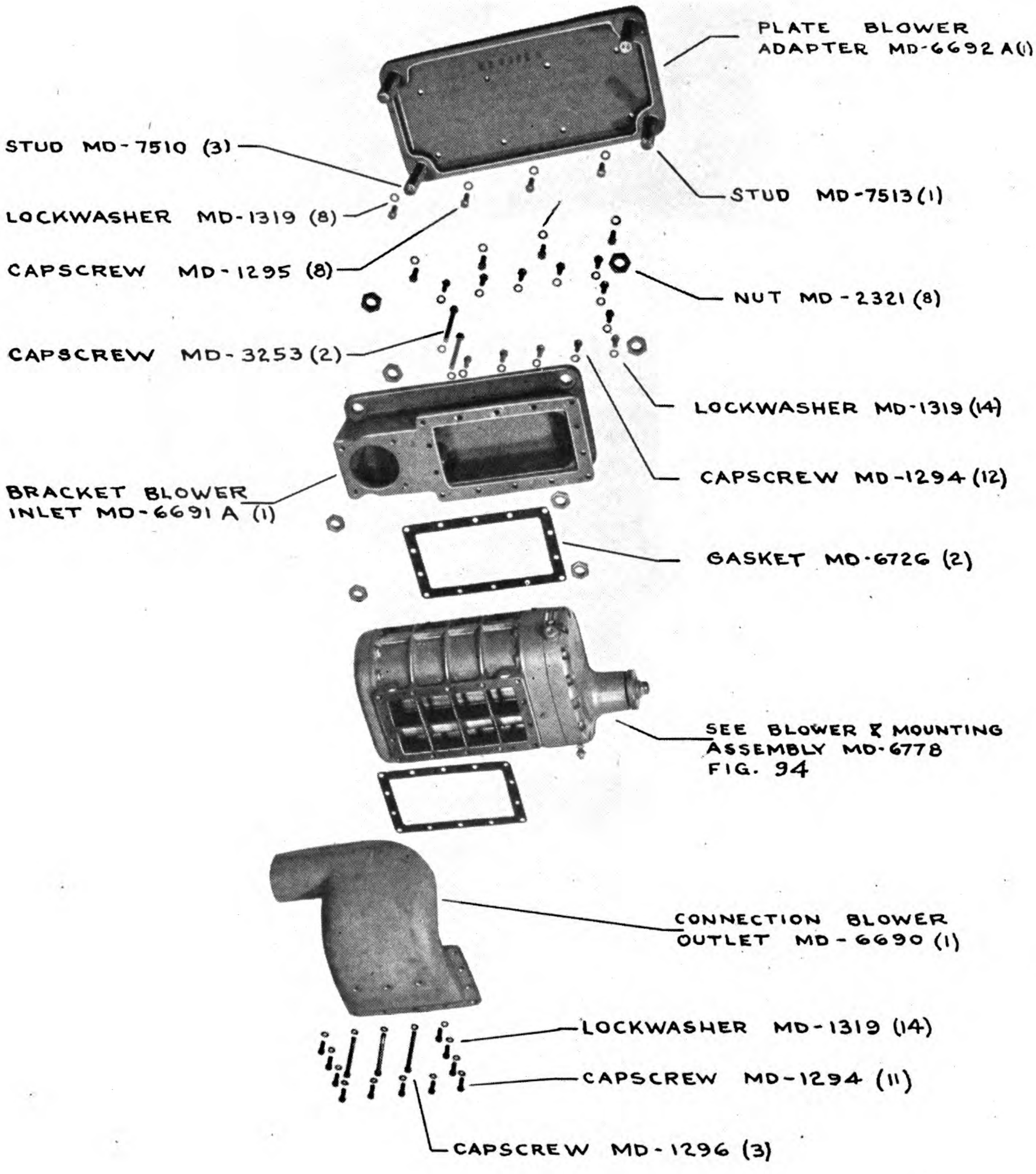
If complete governor piston assembly (valve, piston, plugs, and stop screw assembled) is desired order MD-2995A assembly

MD-5823B

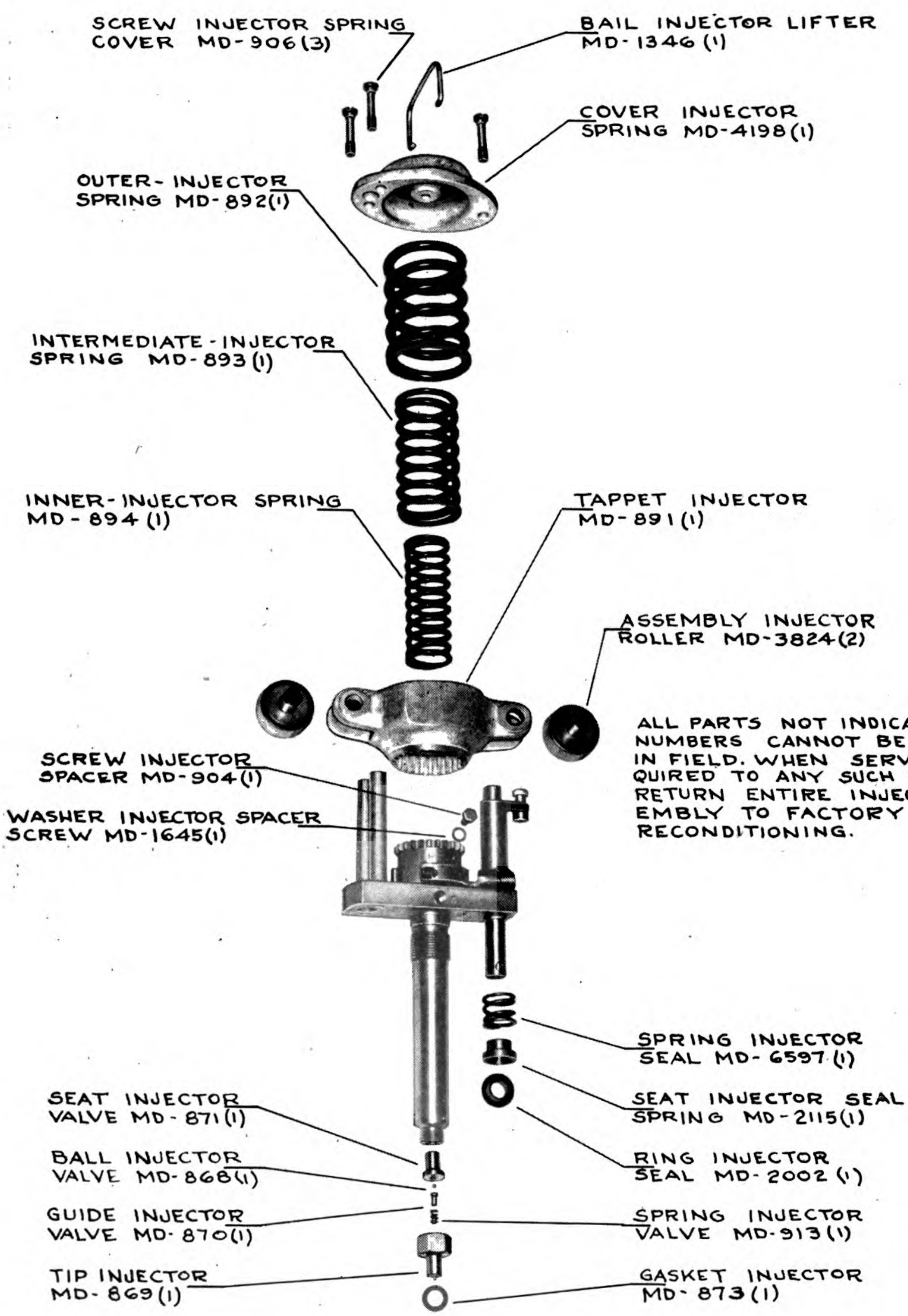
FIG. 75A



INLET MANIFOLD AND PIPING ASSEMBLY
MD-7243A
FIG. 76



INLET MANIFOLD AND PIPING ASSEMBLY
MD-7243A
FIG. 76A

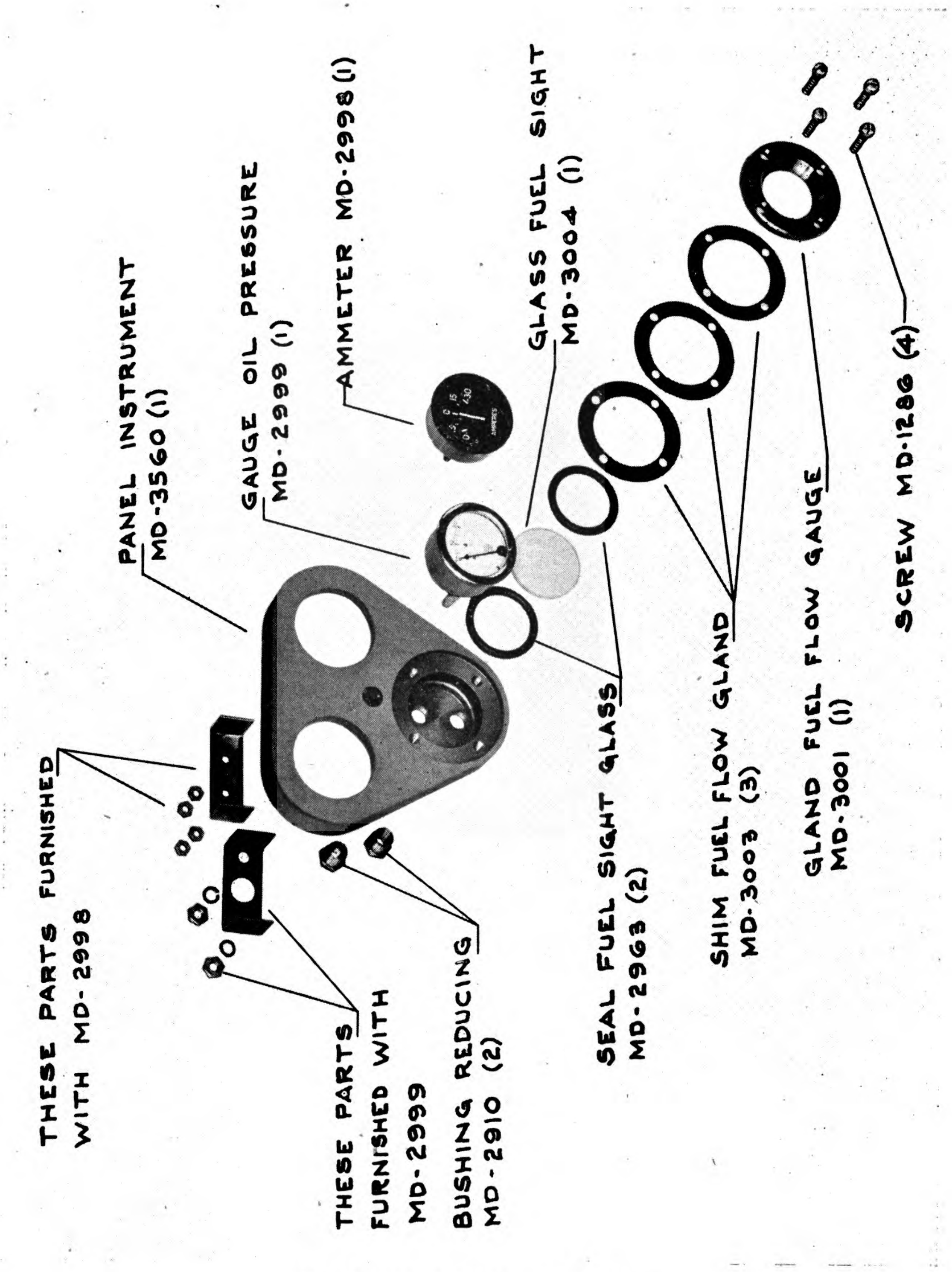


ALL PARTS NOT INDICATED BY NUMBERS CANNOT BE SERVICED IN FIELD. WHEN SERVICE IS REQUIRED TO ANY SUCH PARTS RETURN ENTIRE INJECTOR ASSEMBLY TO FACTORY FOR RECONDITIONING.

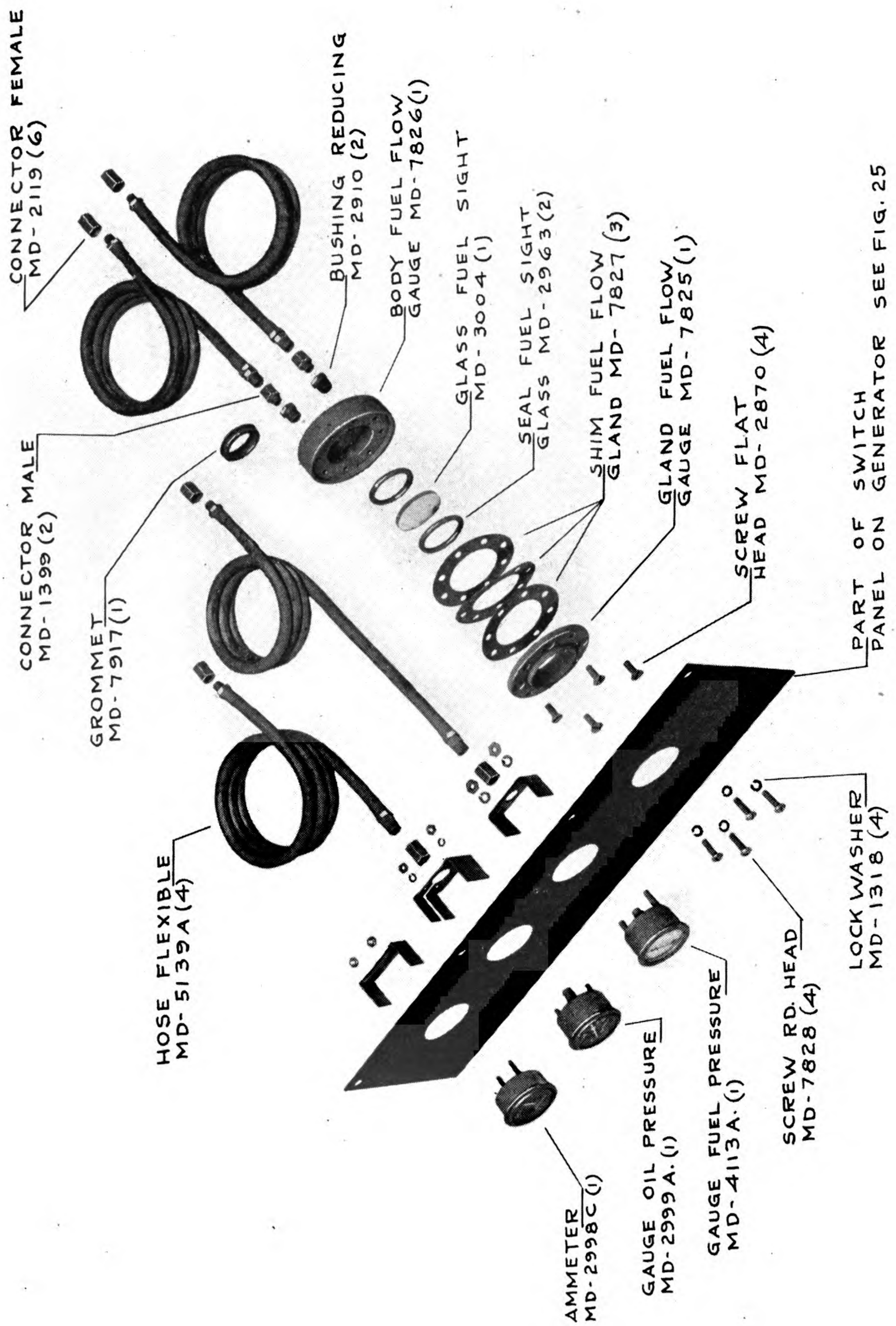
INJECTOR ASSEMBLY

MD-6495

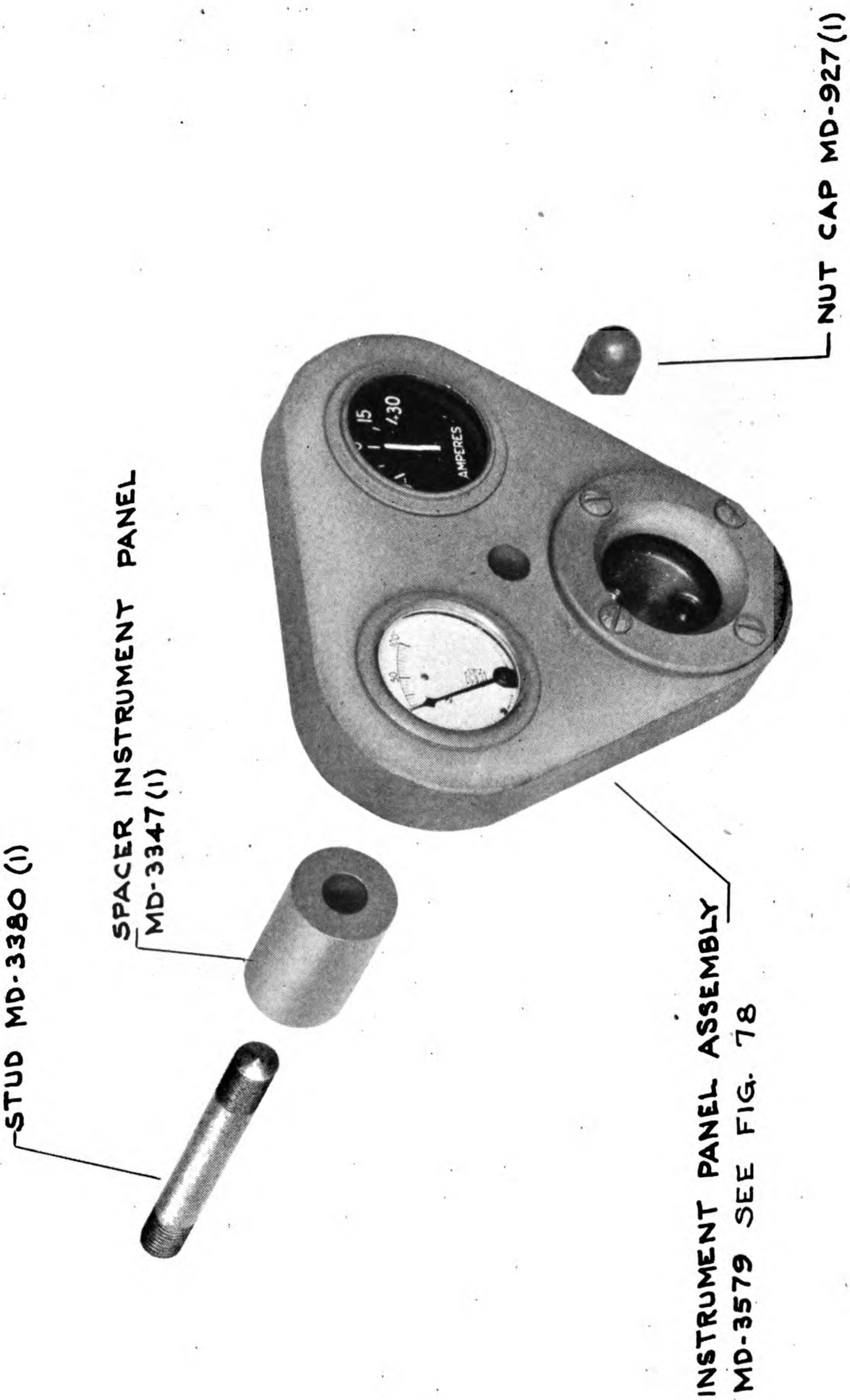
FIG. 77



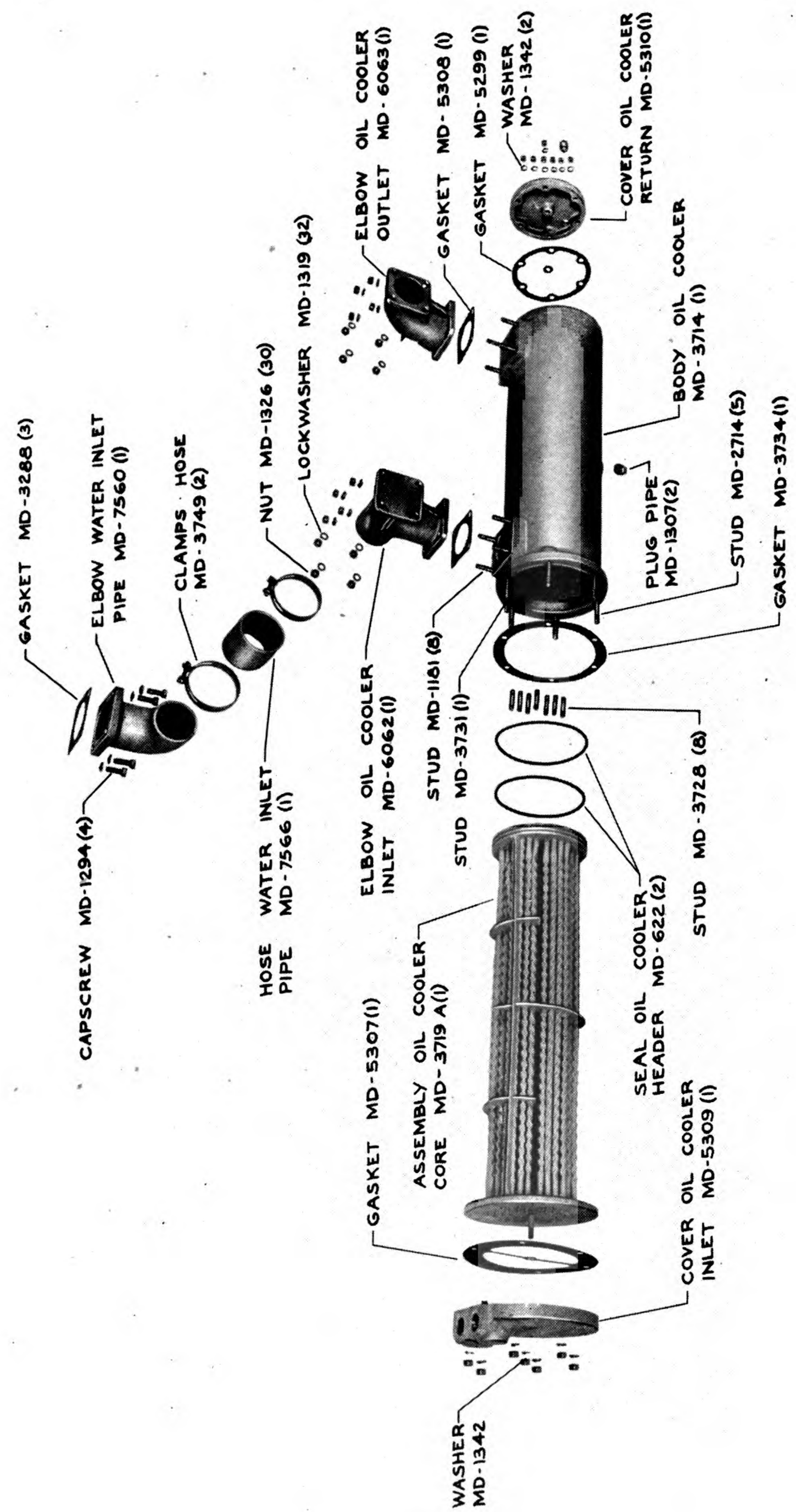
INSTRUMENT PANEL ASSEMBLY
MD-3579
FIG. 78



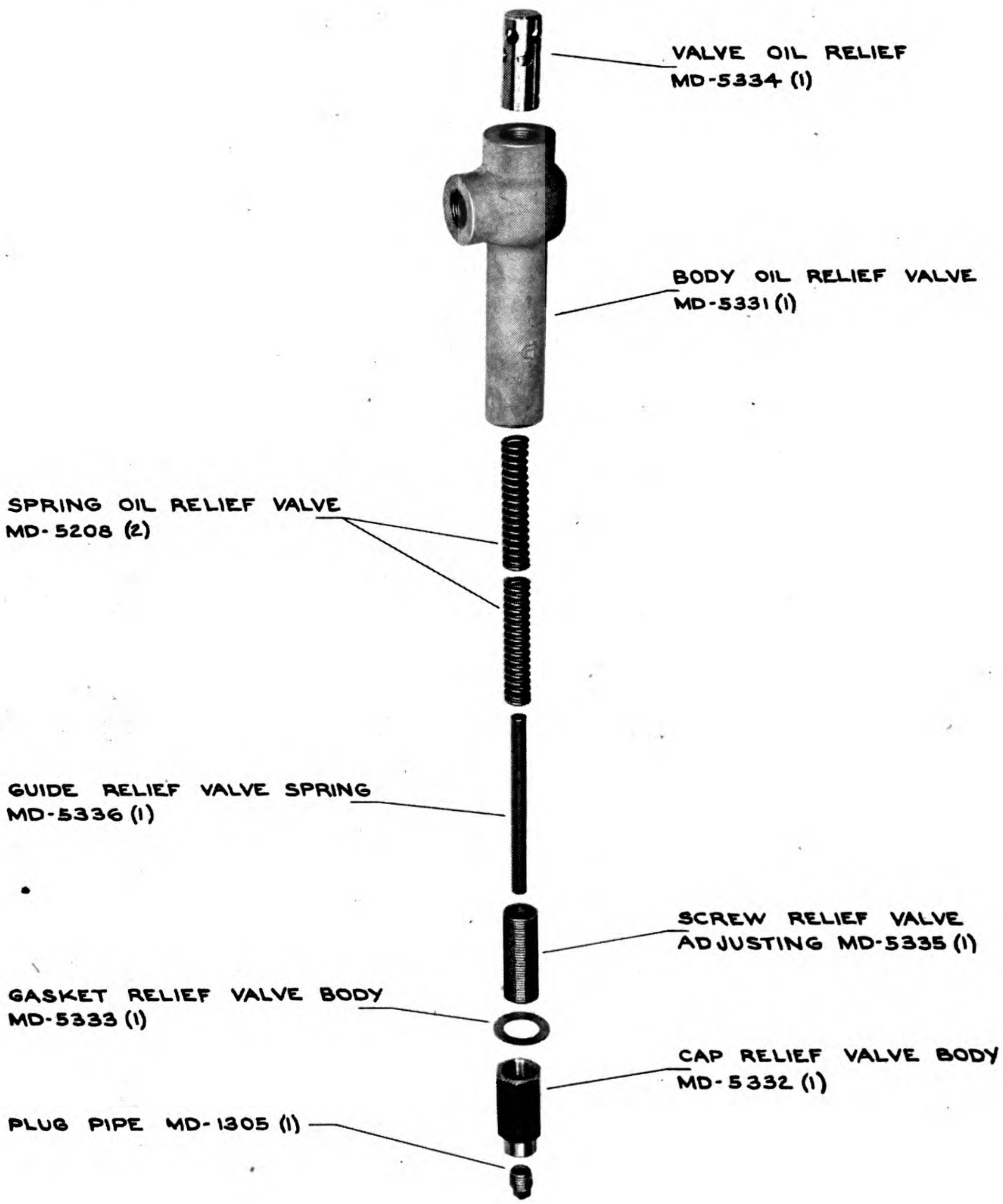
INSTRUMENT PANEL ASSEMBLY
MD-7918
FIG. 78A



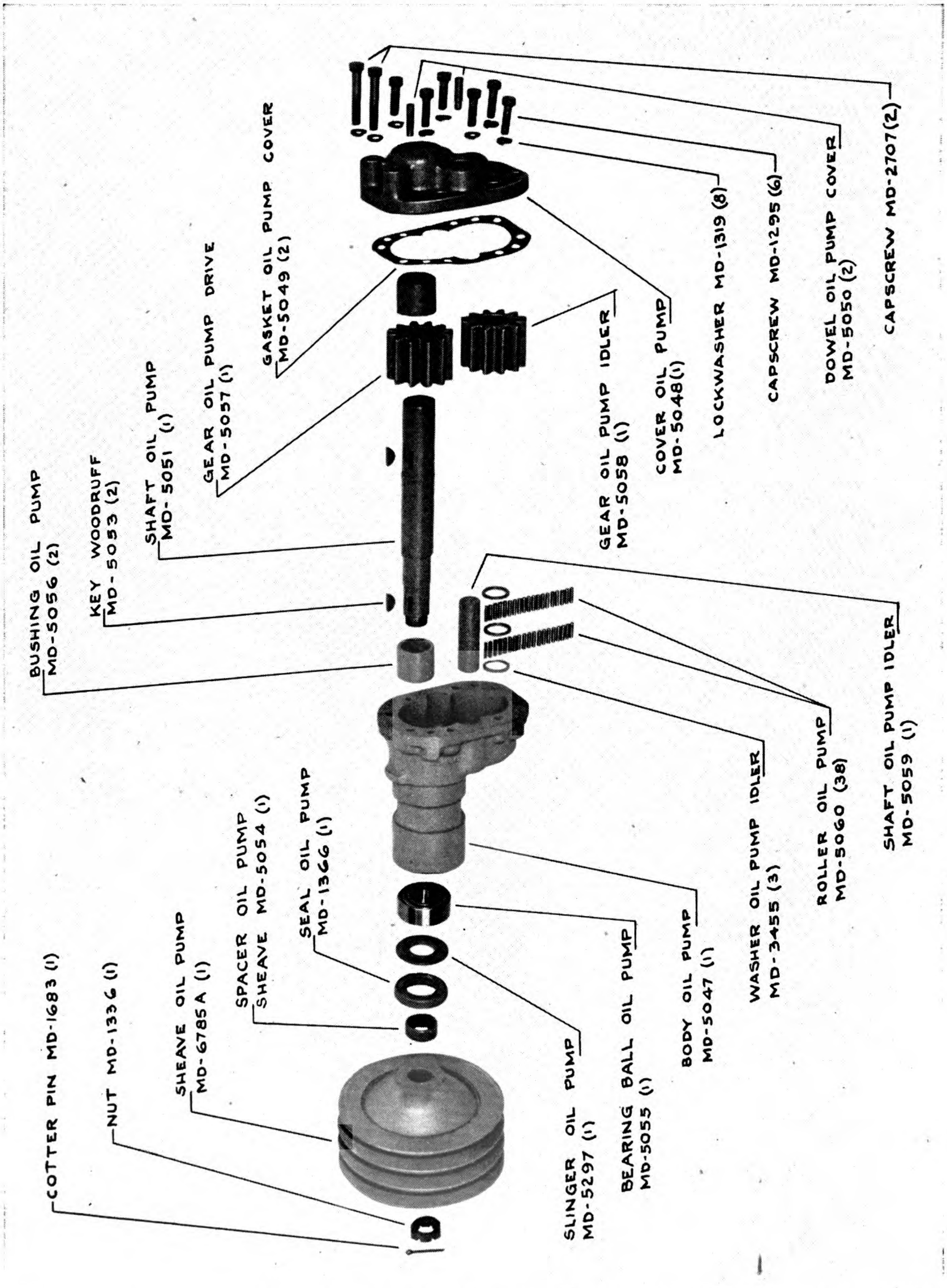
INSTRUMENT PANEL MOUNTING ASSEMBLY
MD-3840
FIG. 79



OIL COOLER ASSEMBLY
MD-6774A
FIG. 80



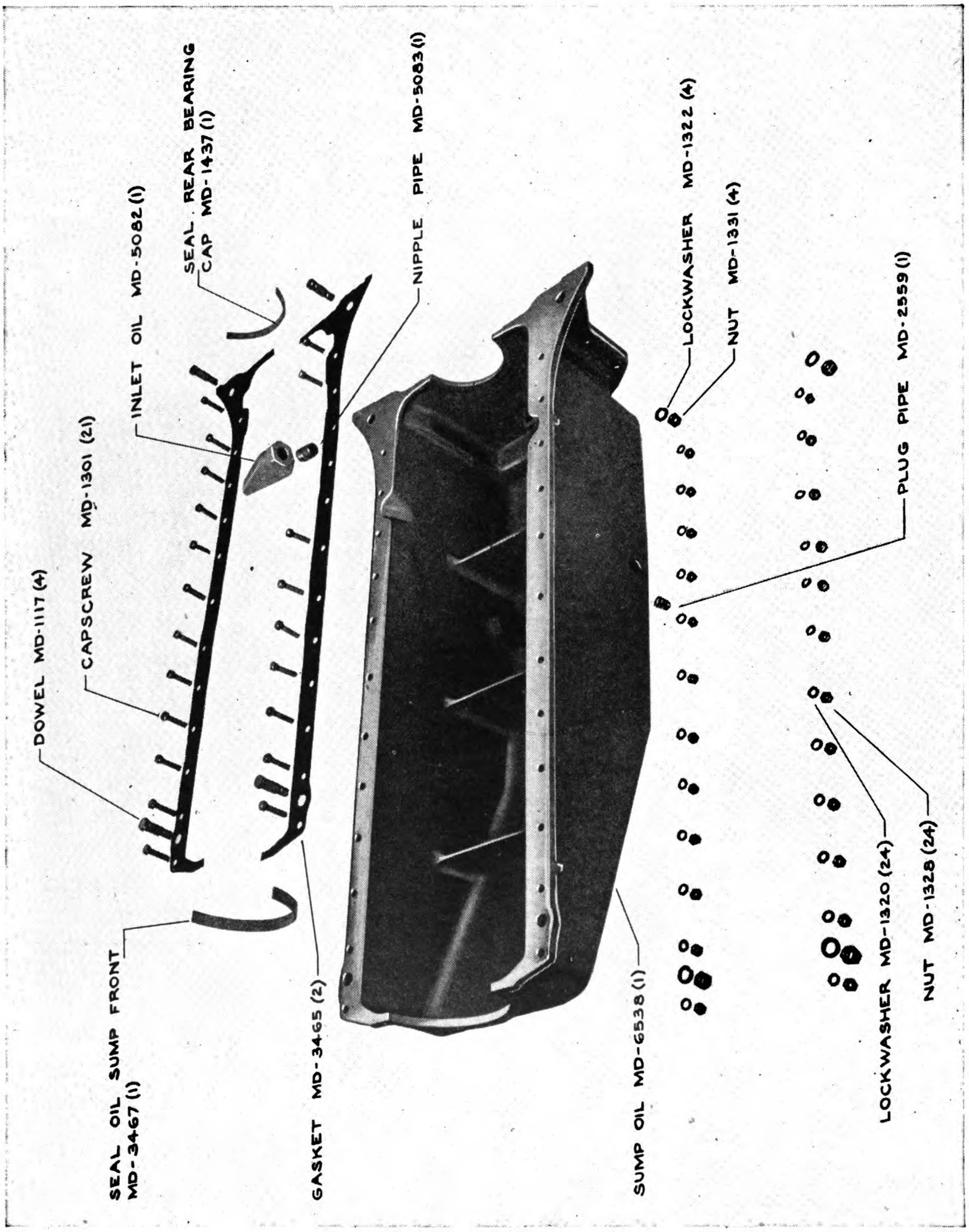
OIL PRESSURE RELIEF VALVE ASSEMBLY
MD-5337
FIG. 81



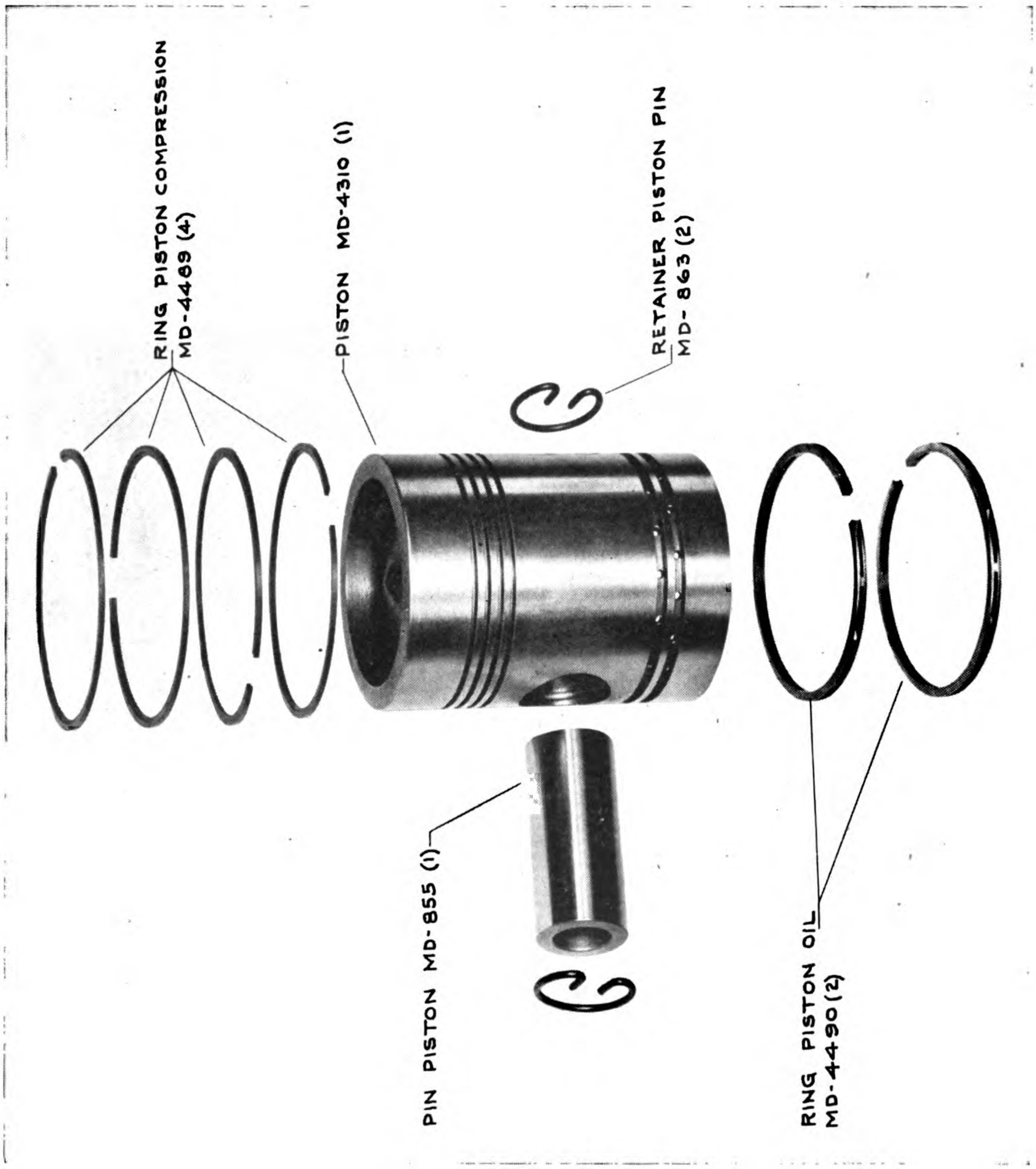
OIL PUMP ASSEMBLY

MD-6775A

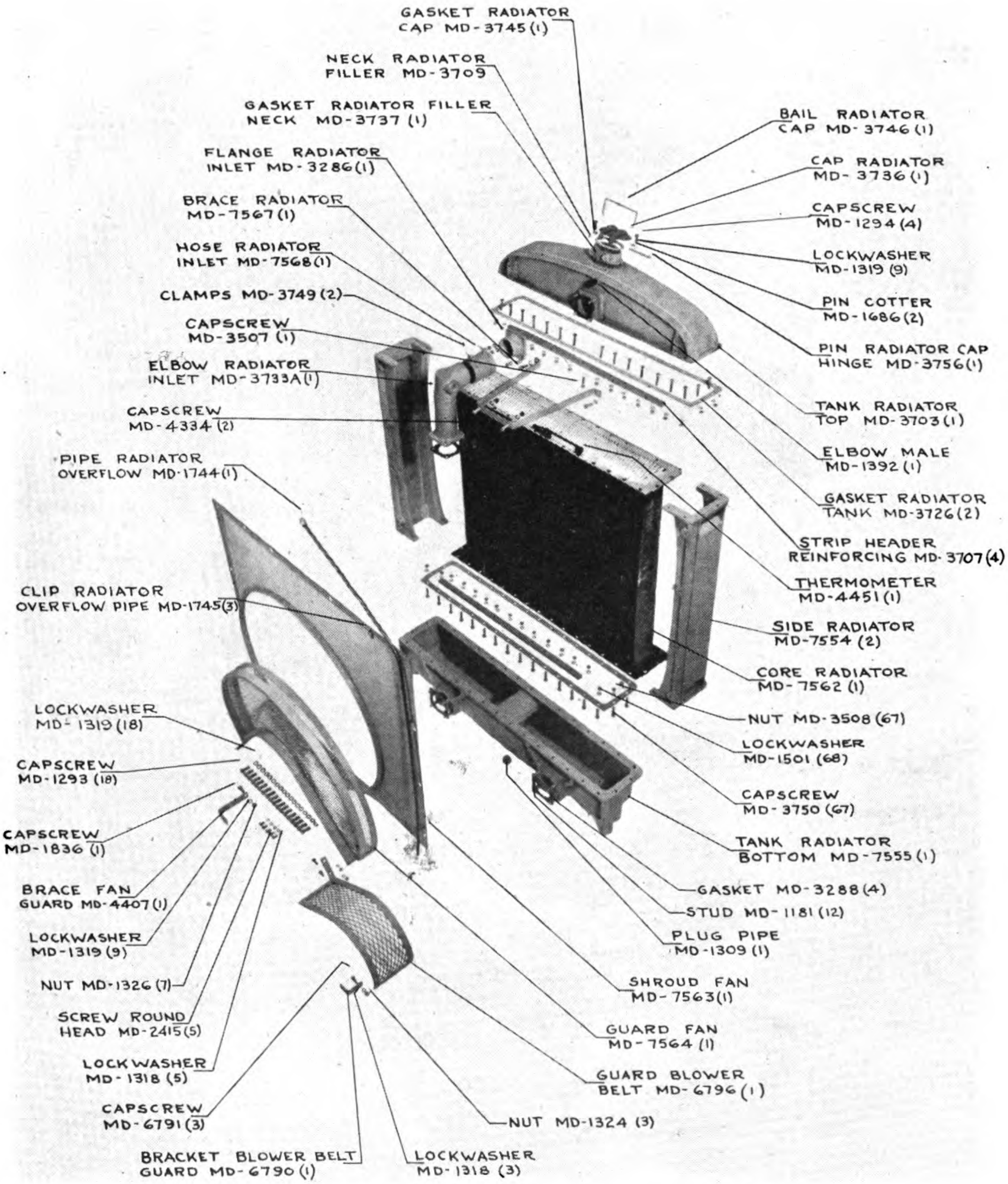
FIG. 82



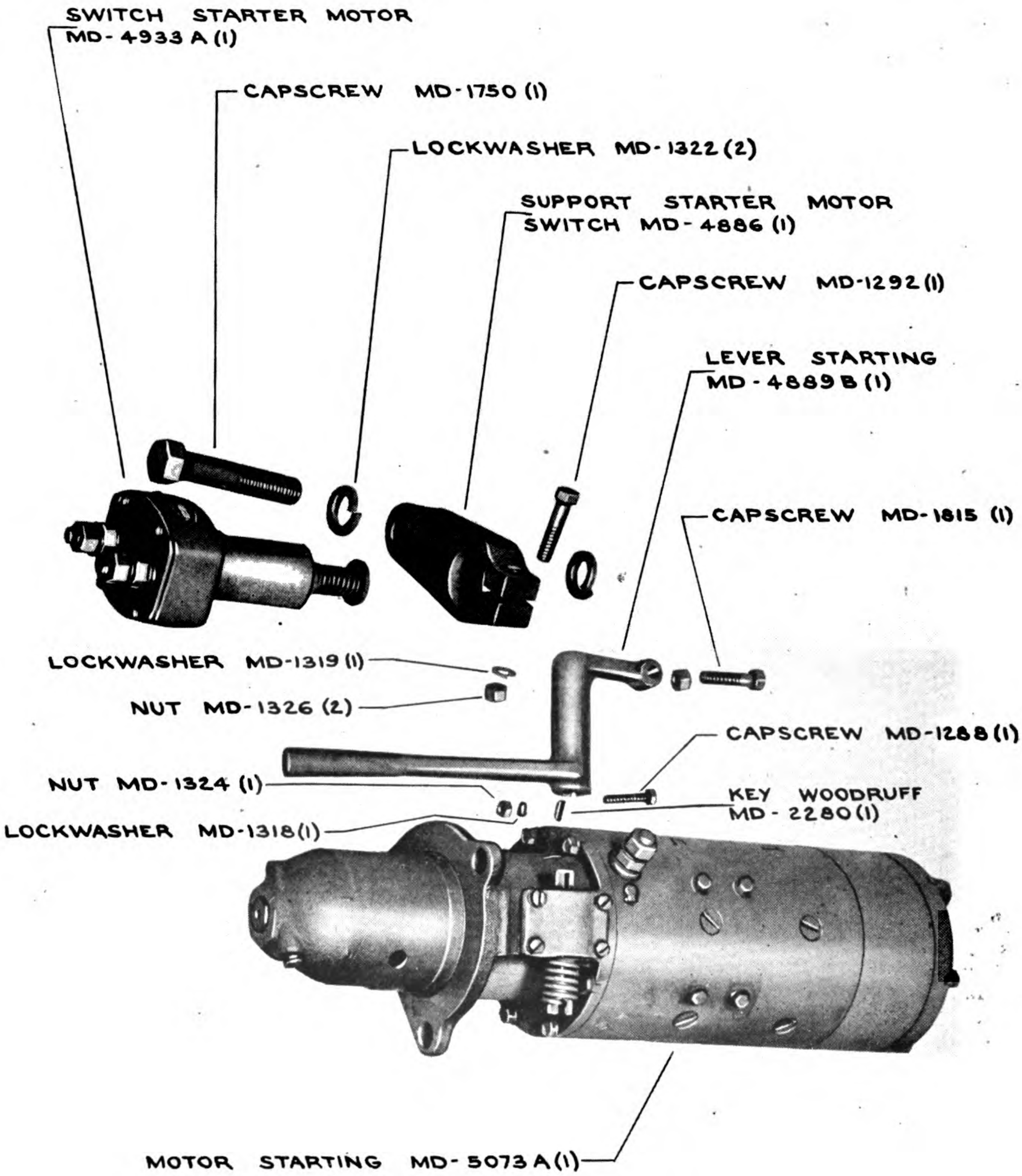
OIL SUMP ASSEMBLY
MD-6566
FIG. 83



PISTON ASSEMBLY
MD-4765
FIG. 84

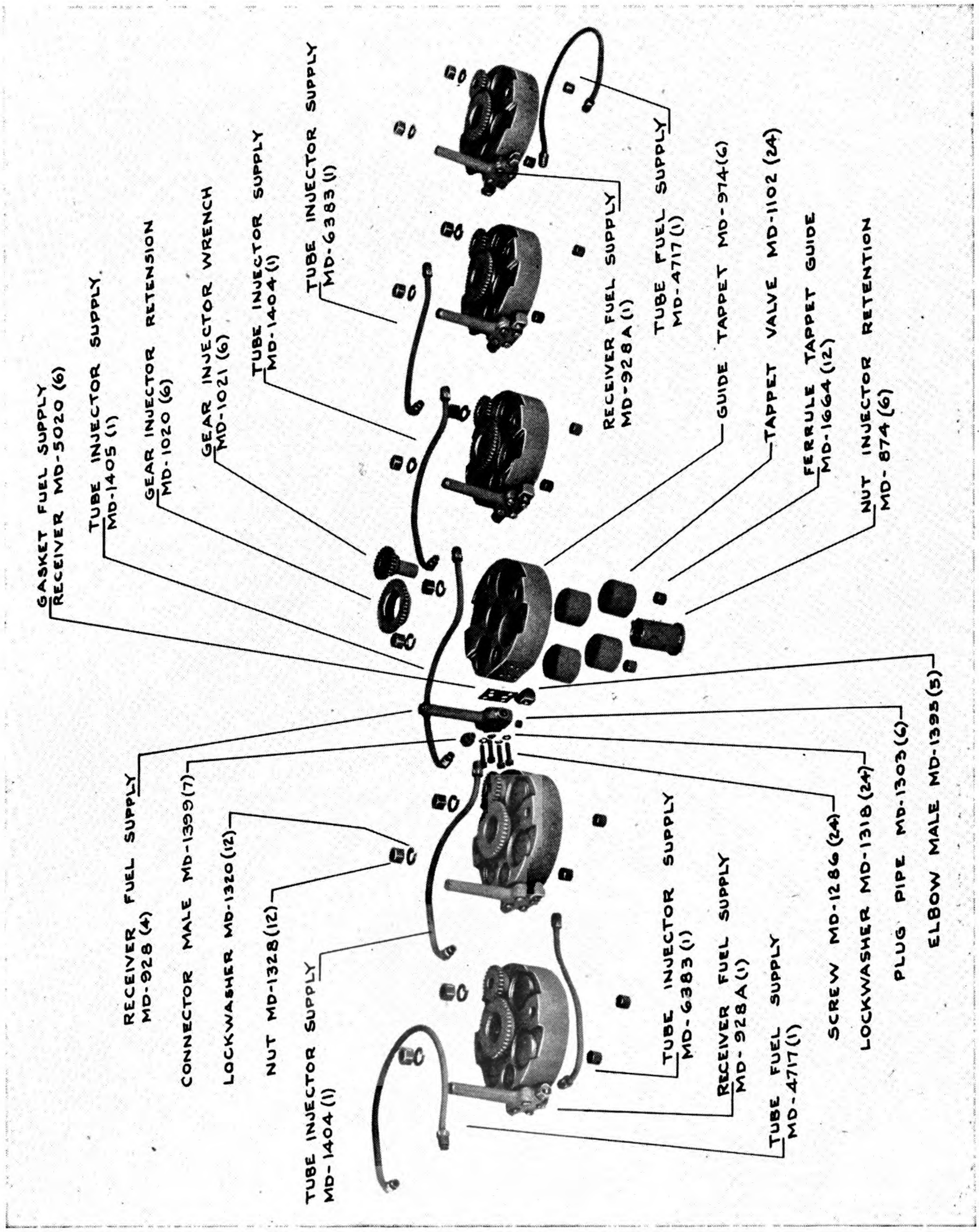


RADIATOR ASSEMBLY
MD-7559
FIG. 85

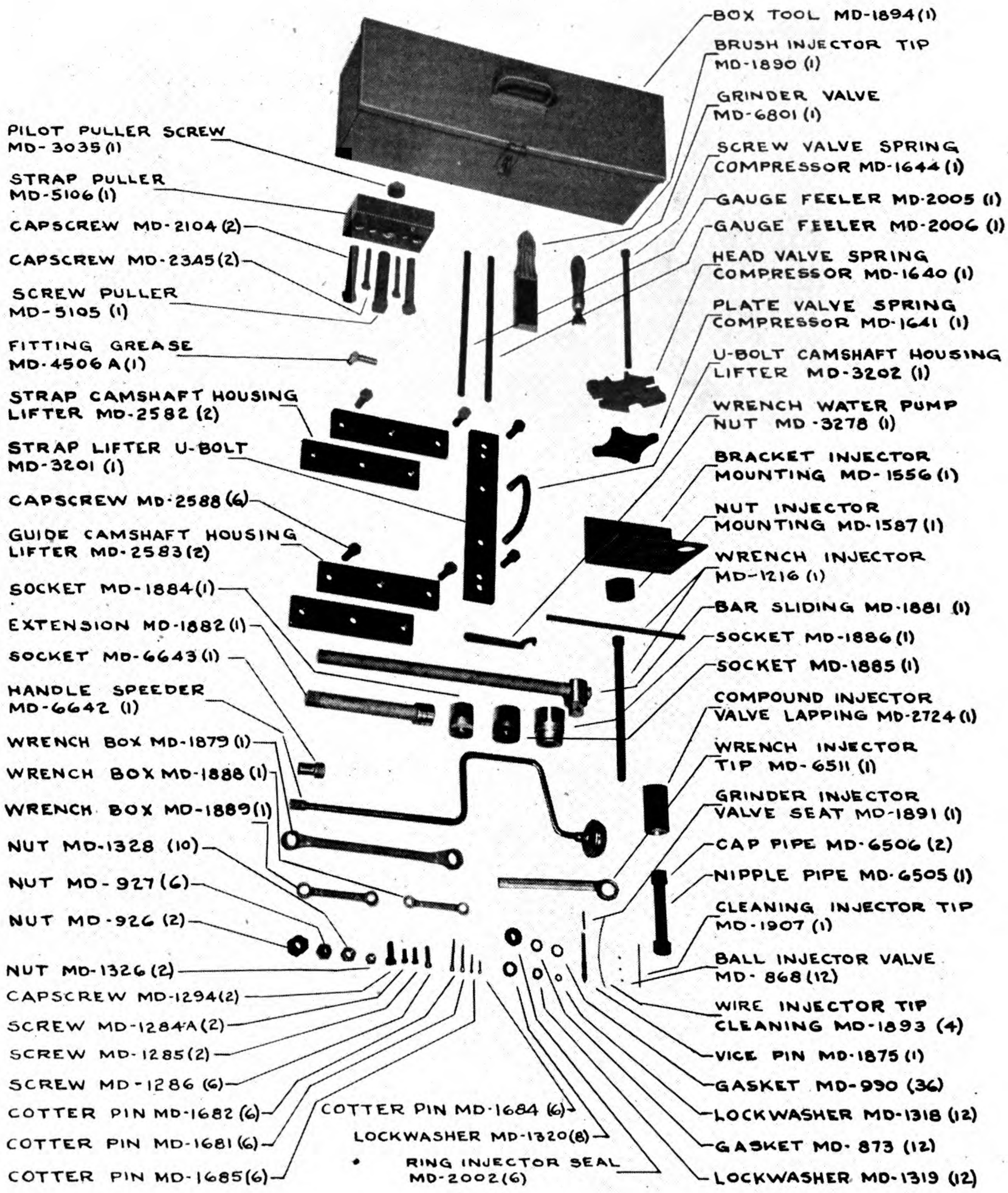


STARTING MOTOR ASSEMBLY
MD-4894A
FIG. 86

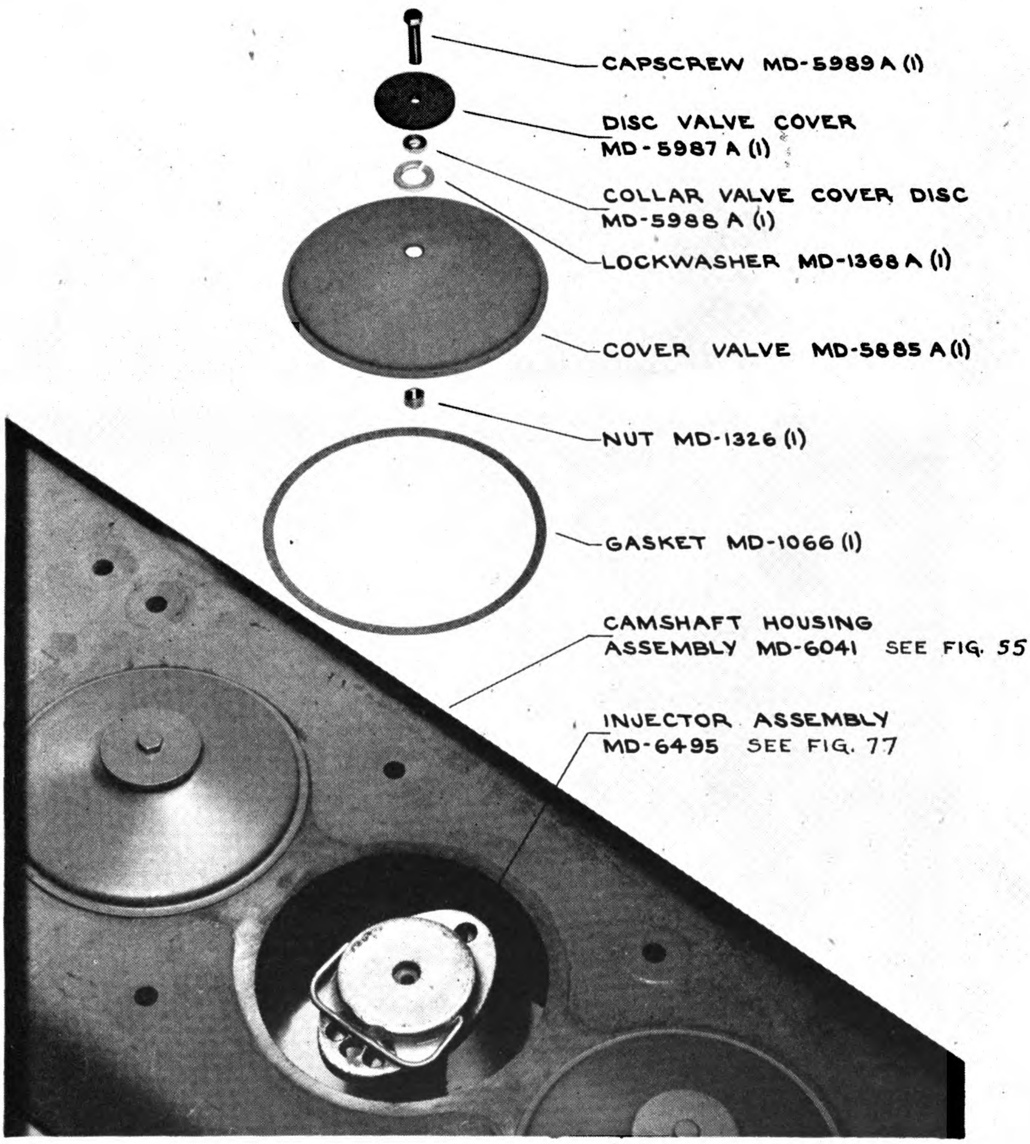
For breakdown of starter and starter switch see Delco Remy Section



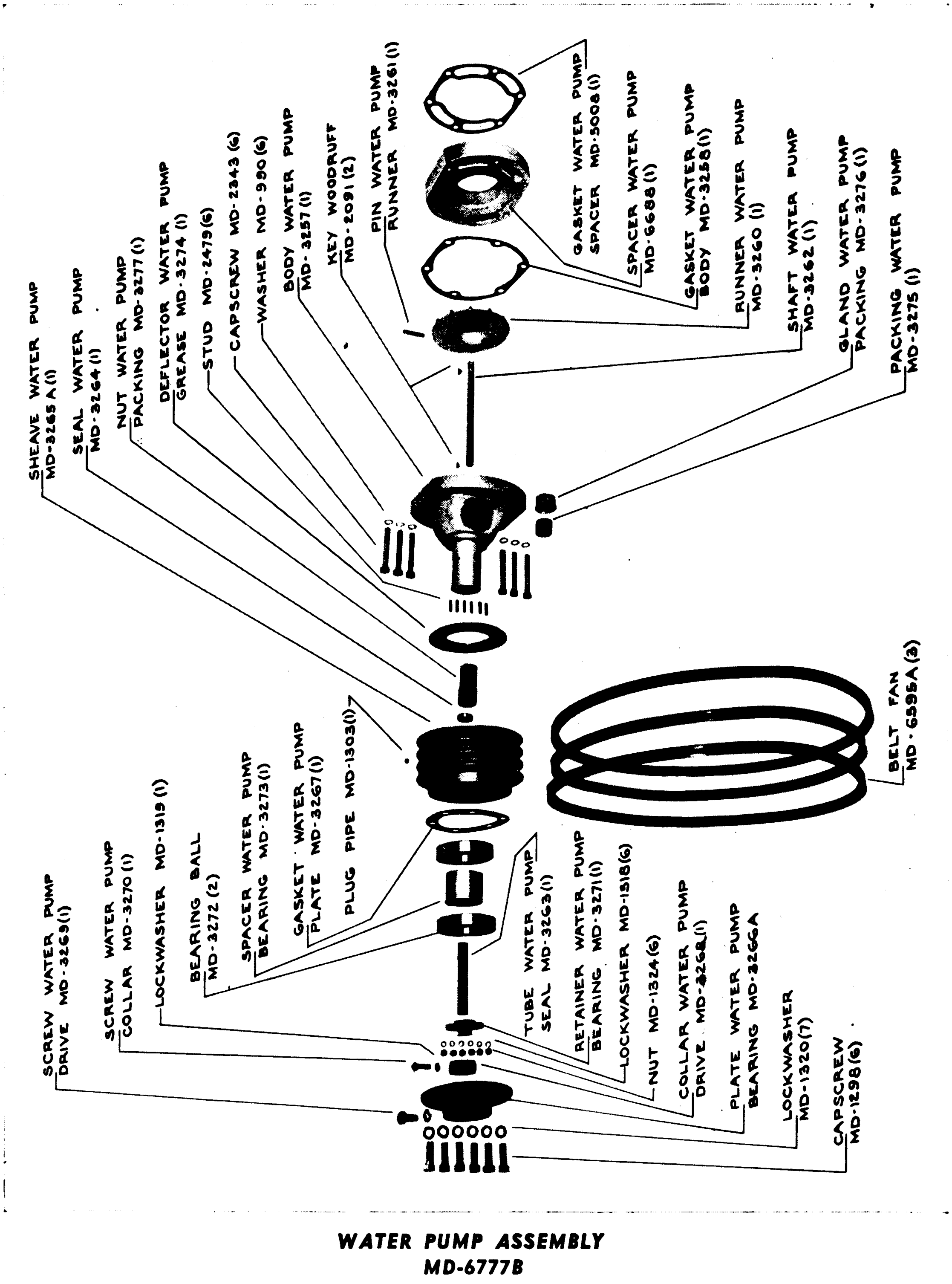
TAPPET GUIDE ASSEMBLY
MD-6127
FIG. 87



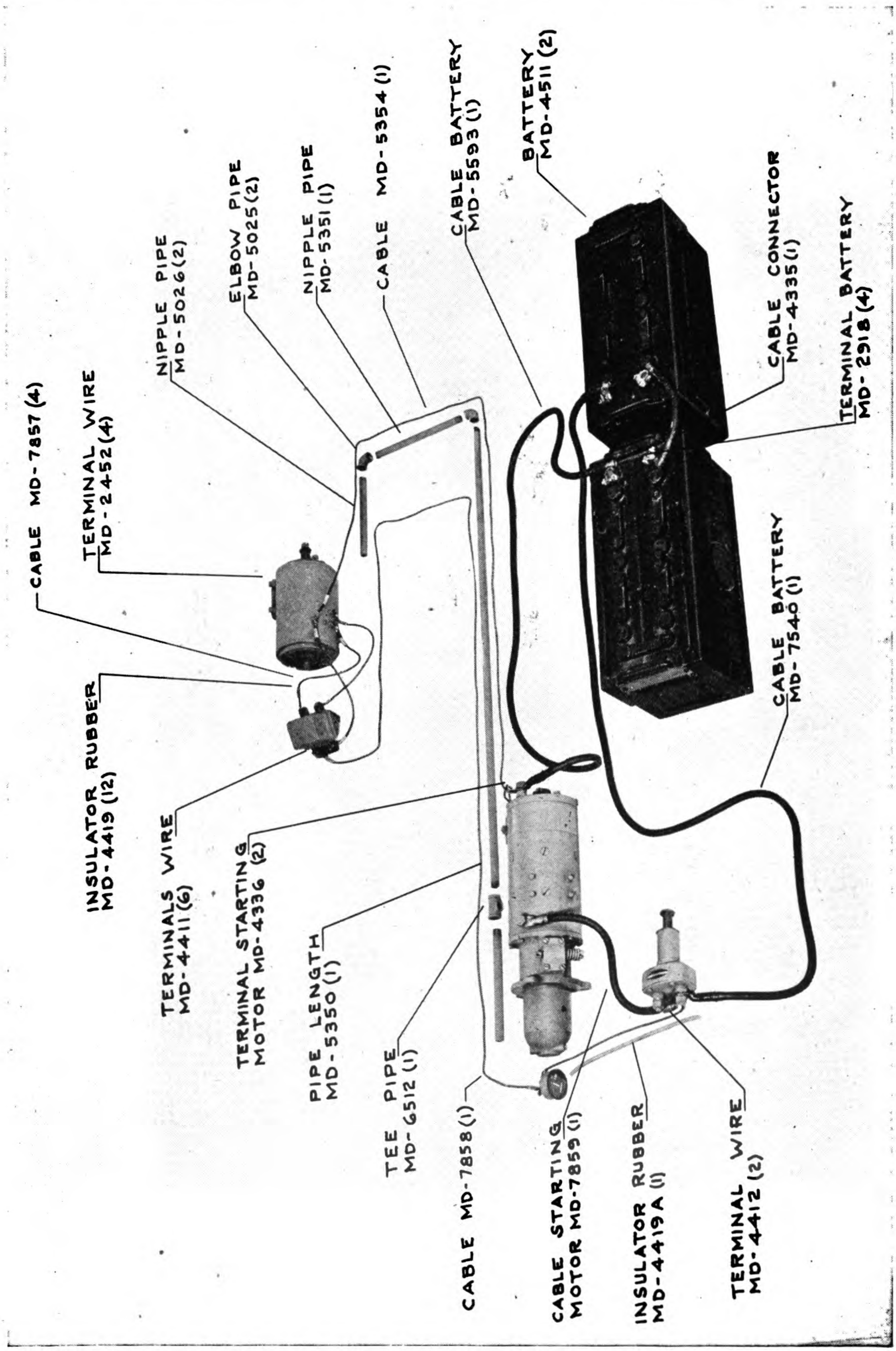
TOOL KIT ASSEMBLY
MD-5069B
FIG. 88



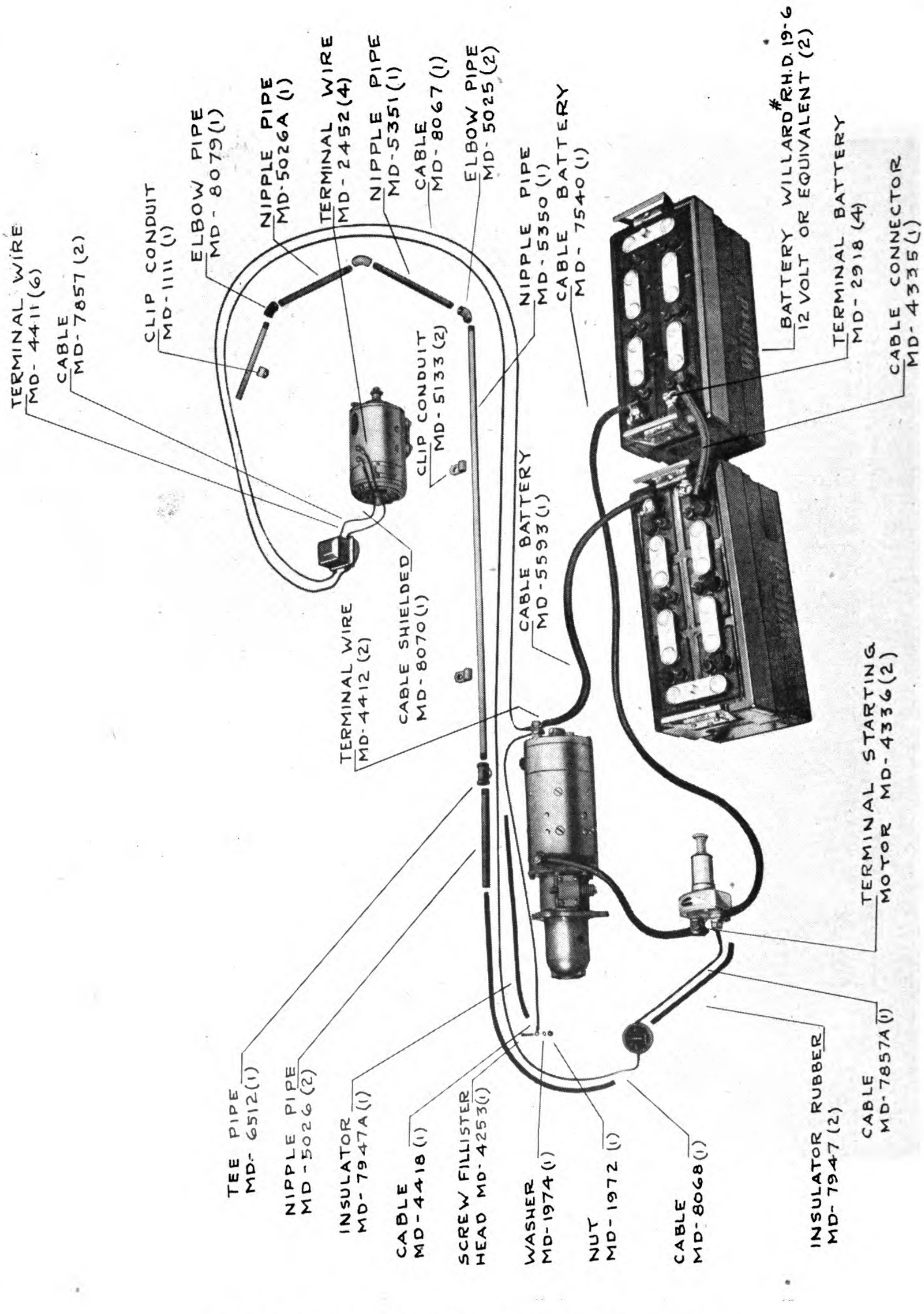
VALVE COVER ASSEMBLY
MD-5952A
FIG. 89



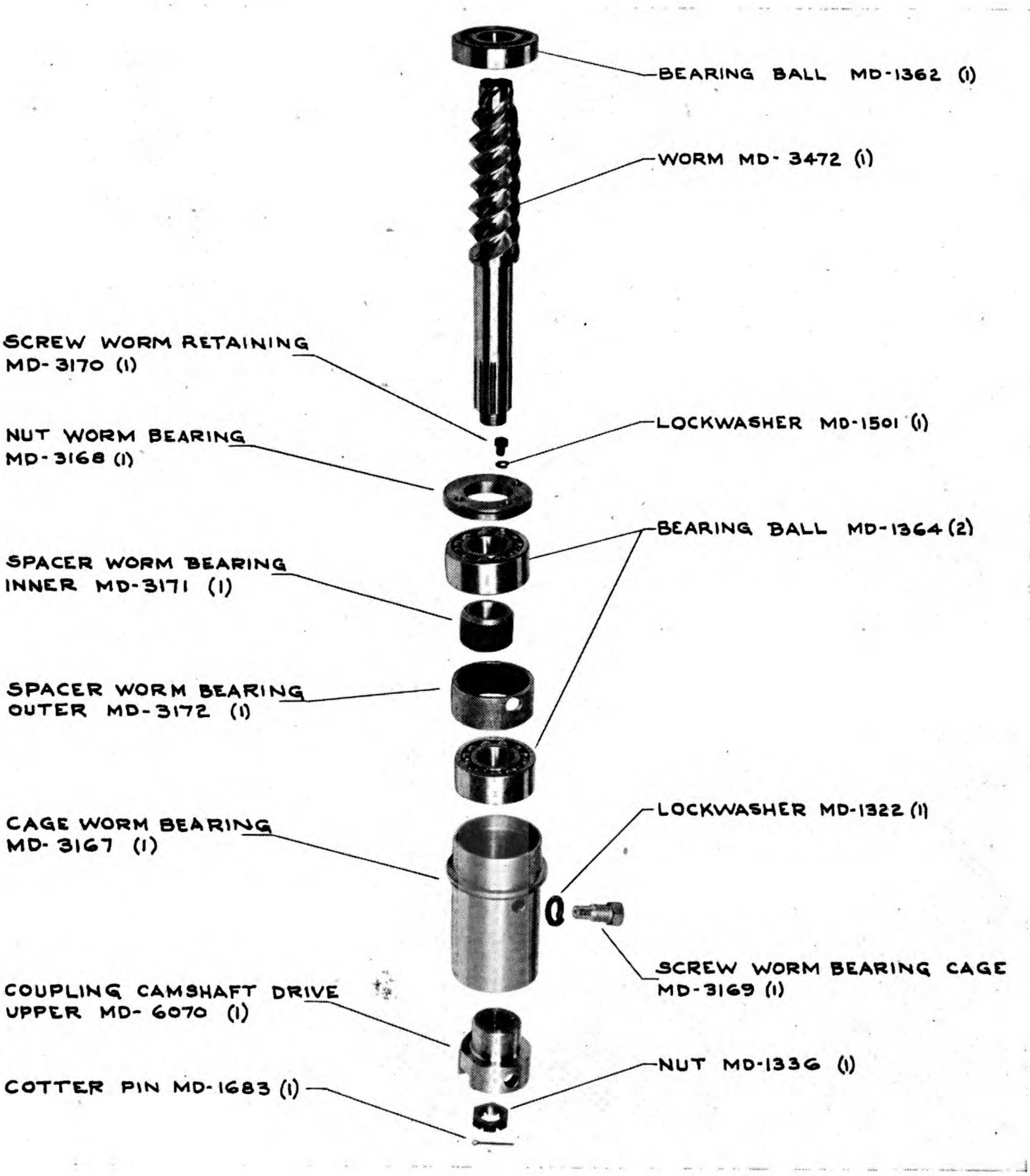
WATER PUMP ASSEMBLY
MD-6777B
FIG. 90



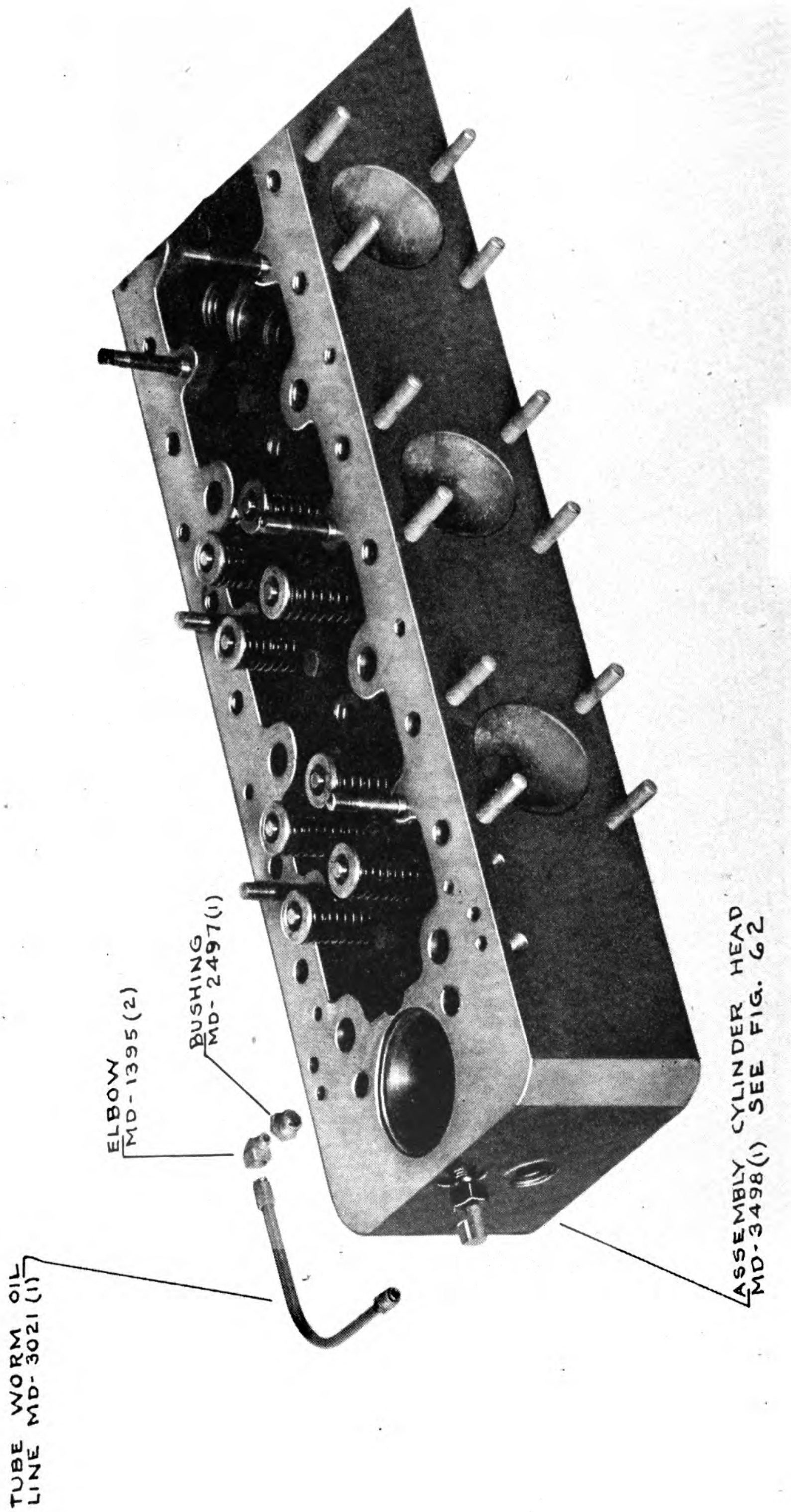
WIRING AND BATTERY CABLE ASSEMBLY
MD-5221 AND MD-6373
FIG. 91



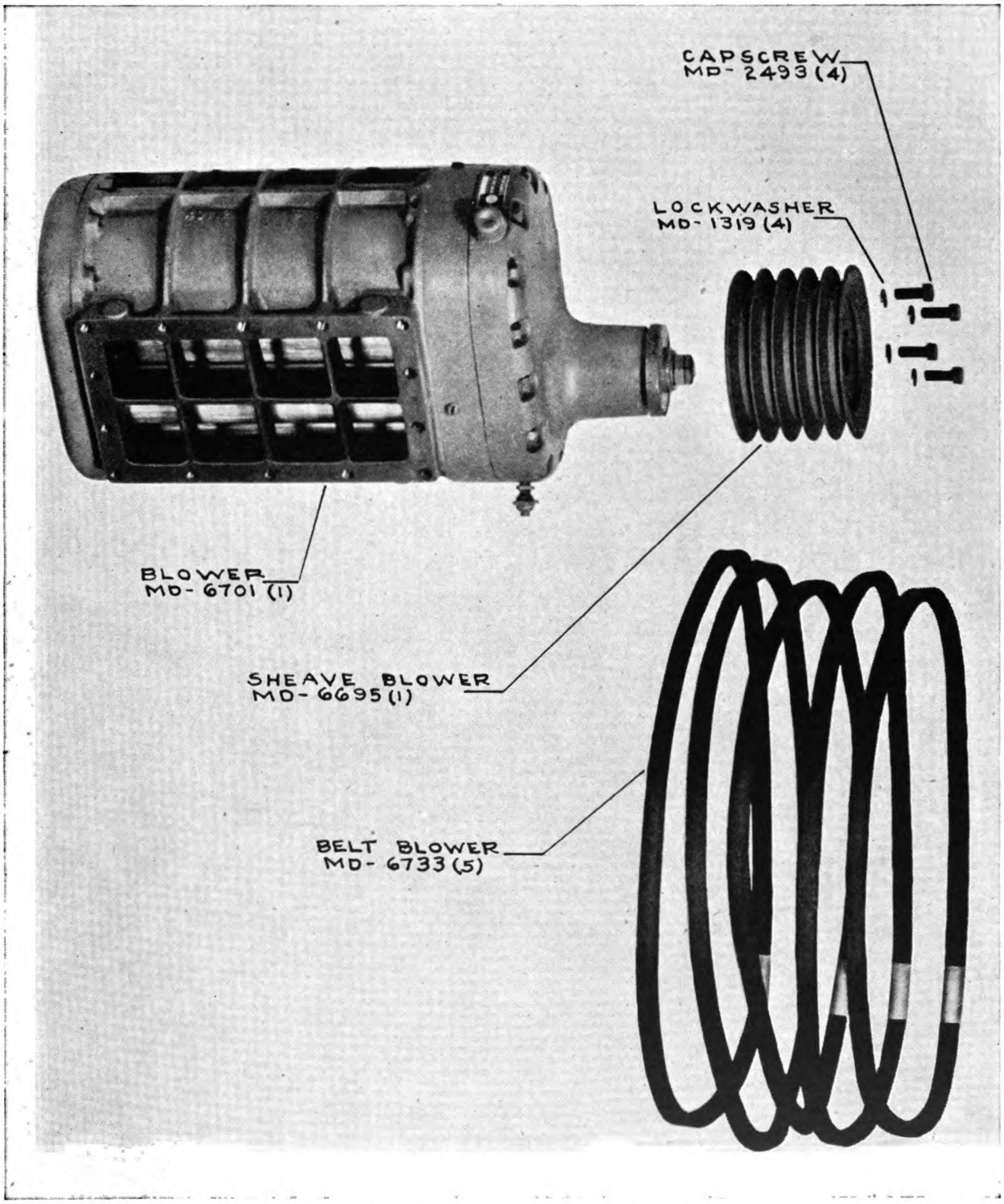
WIRING AND BATTERY CABLE ASSEMBLY
MD-5221A AND MD-6373
FIG. 91A



WORM ASSEMBLY
MD-6316
FIG. 92

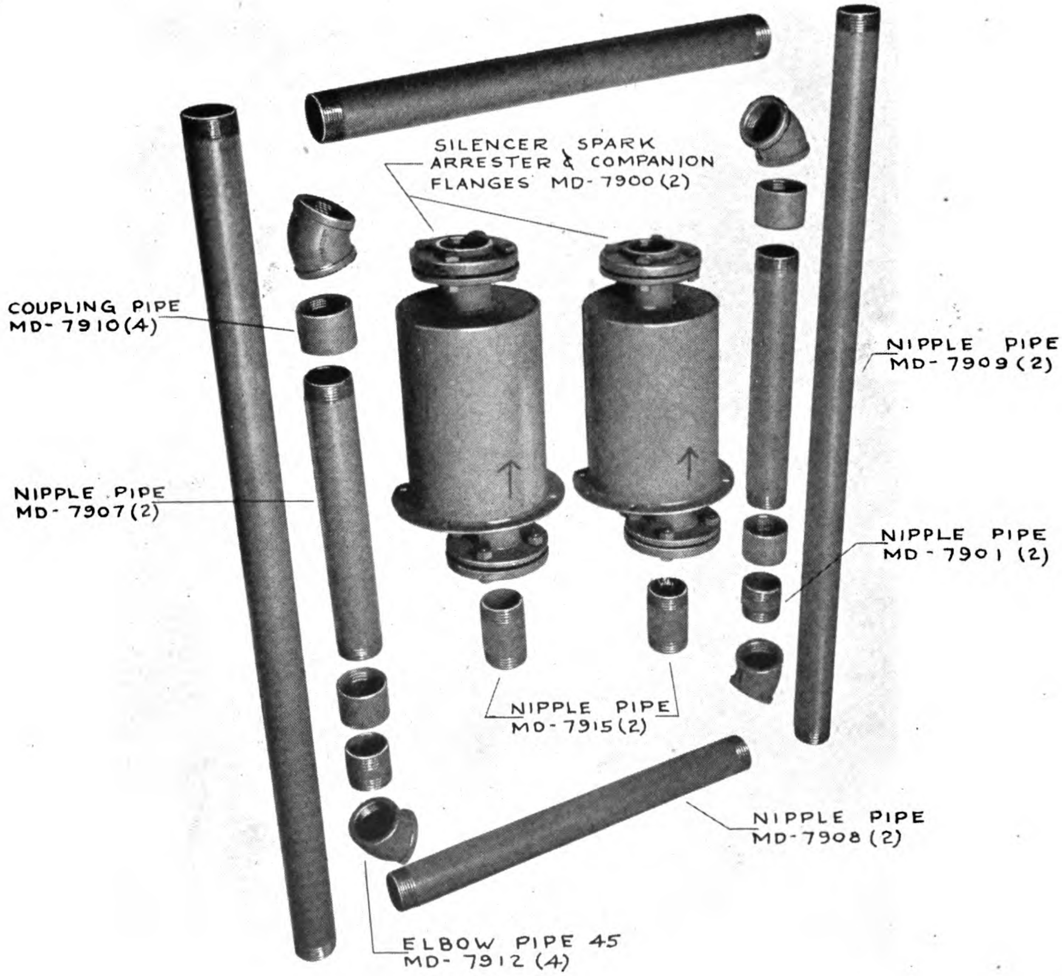


WORM OIL LINE ASSEMBLY
MD-3020
FIG. 93

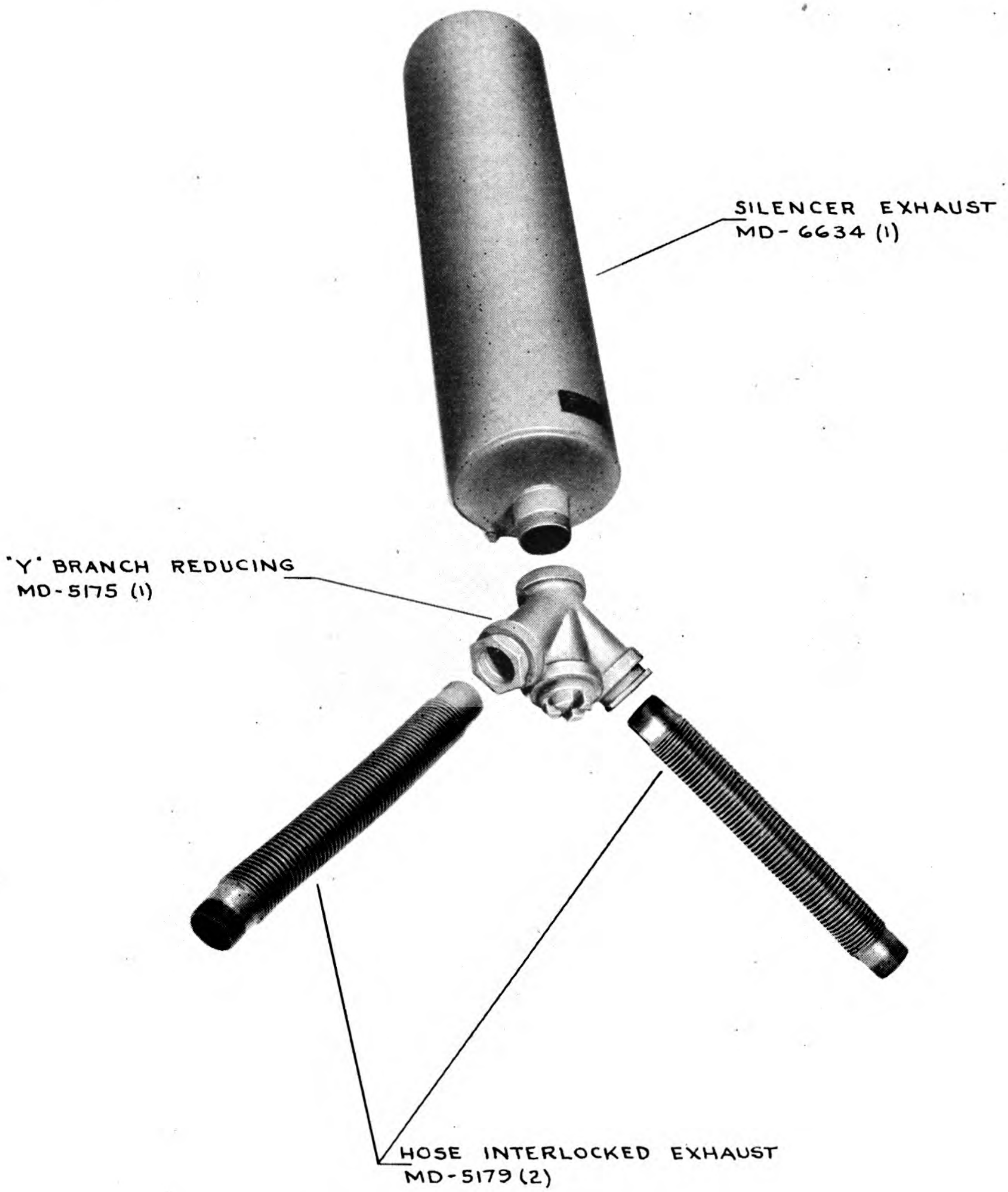


BLOWER AND MOUNTING ASSEMBLY
MD-6778

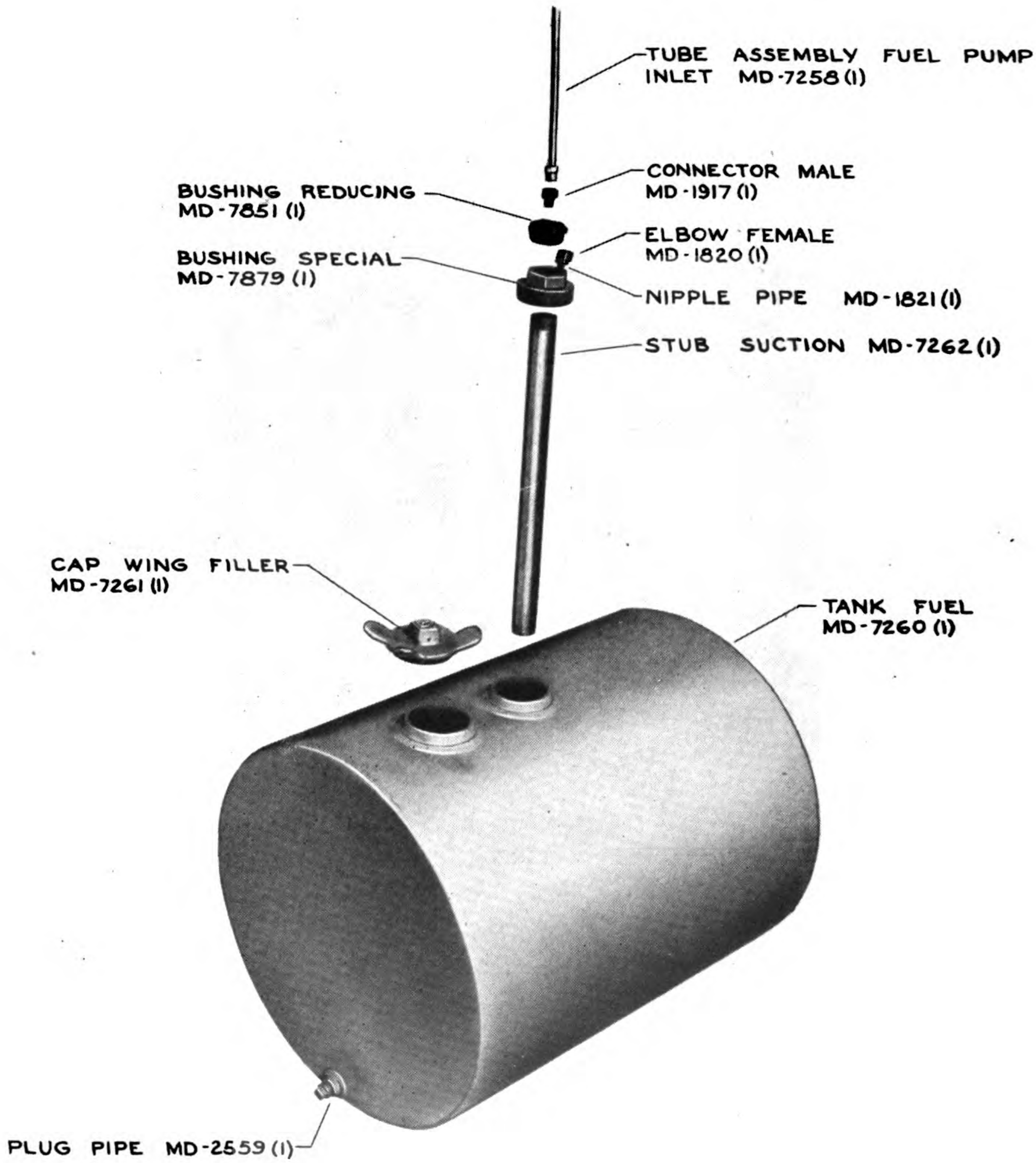
For Breakdown of Blower see Fig. 105 and Fig. 105A
FIG. 94



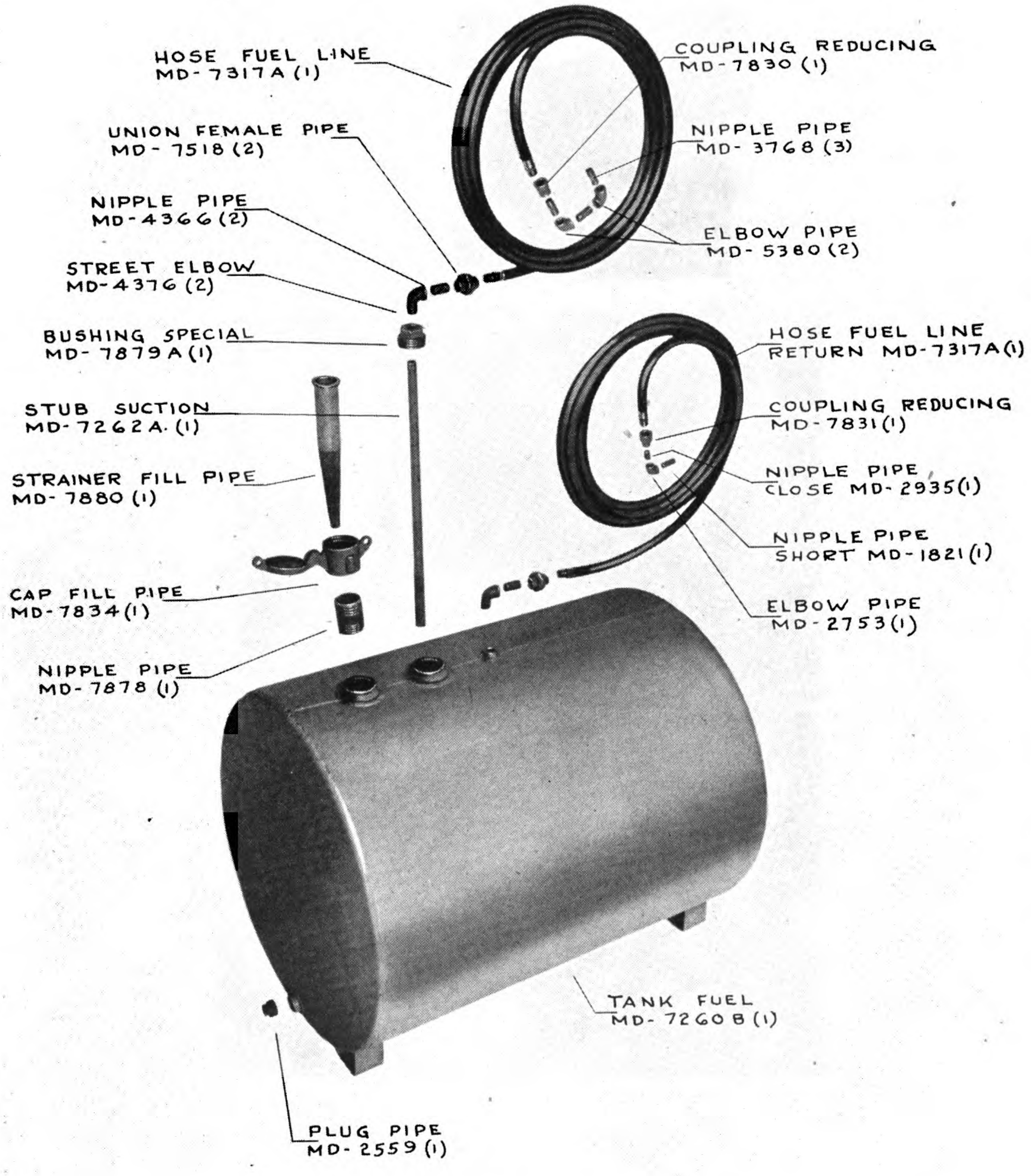
EXHAUST MUFFLER ASSEMBLY
MD-7899
AUXILIARY EXHAUST PIPE ASSEMBLY
MD-7906A
FIG. 95



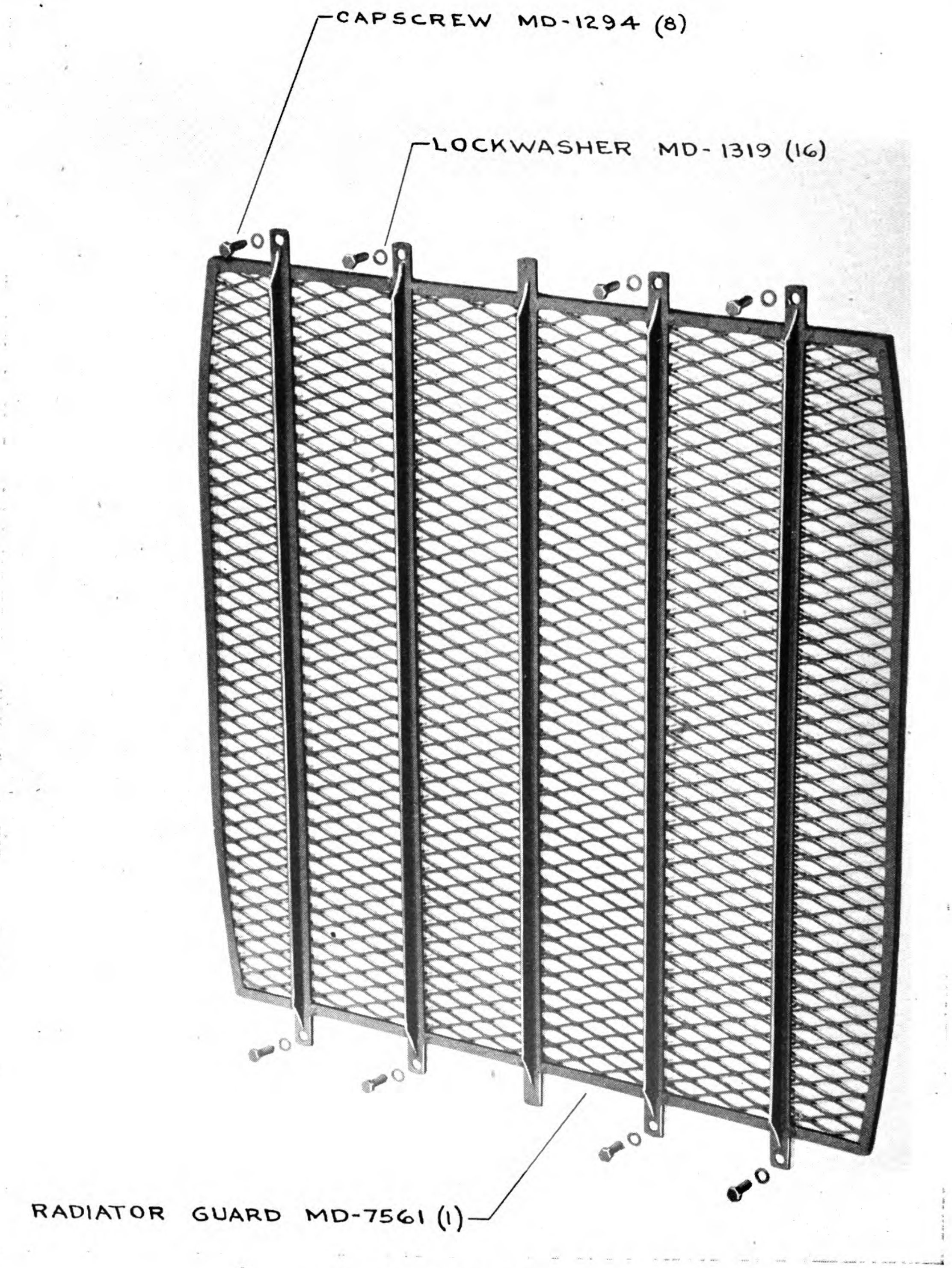
EXHAUST MUFFLER ASSEMBLY
MD-7248
FIG. 96



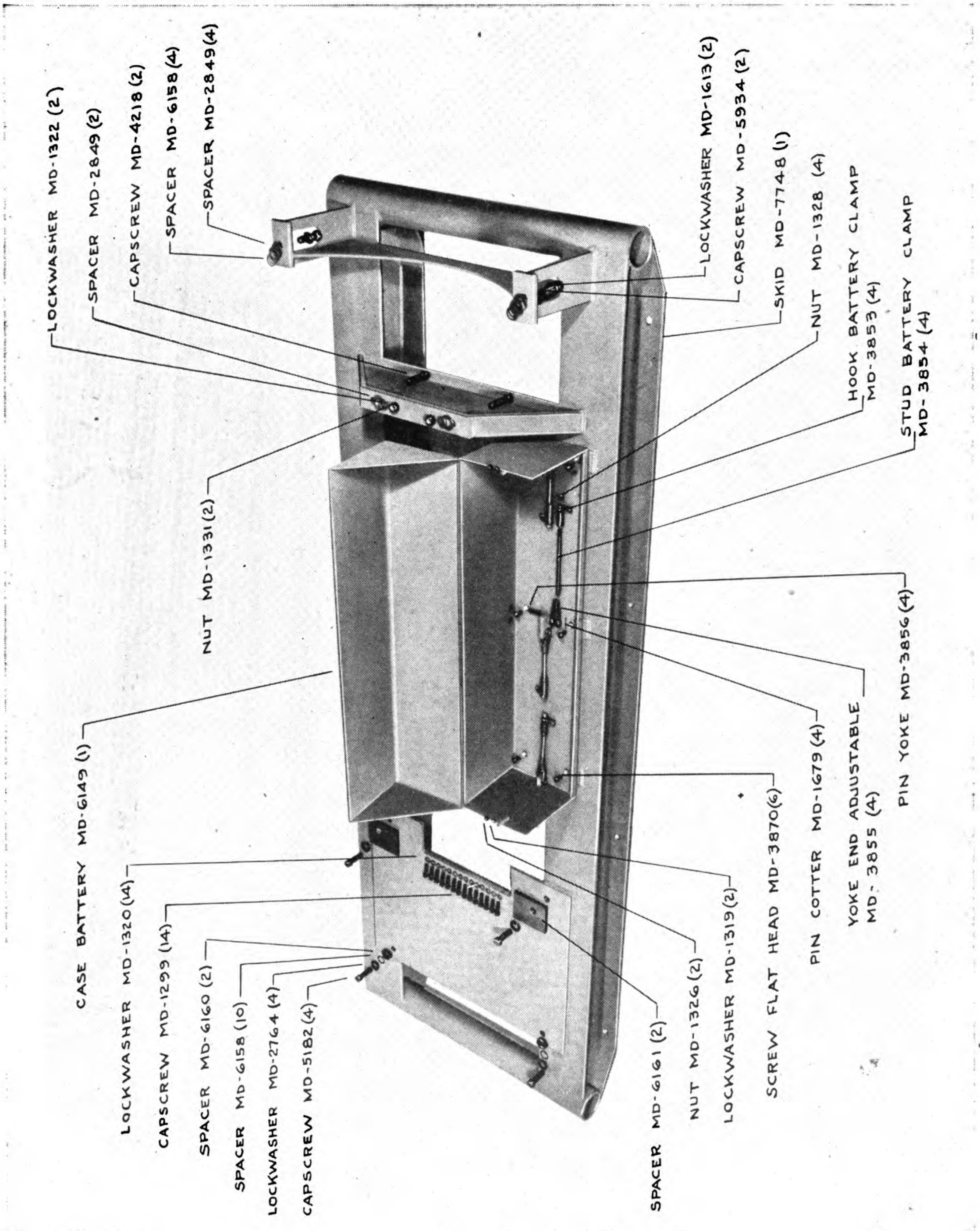
FUEL TANK AND PIPING ASSEMBLY
MD-7254A
FIG. 97



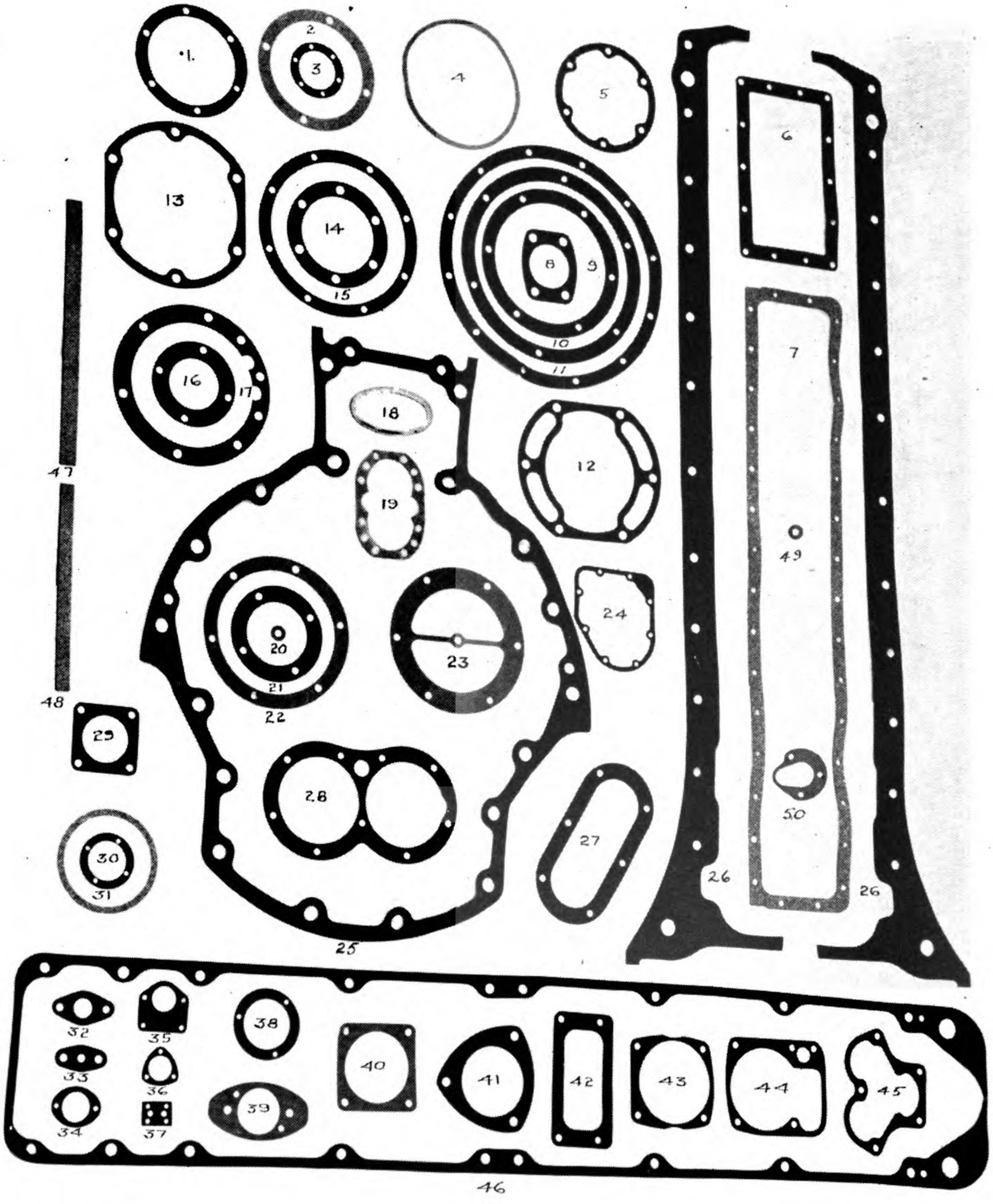
FUEL TANK AND PIPING ASSEMBLY
MD-7254B
FIG. 97A



RADIATOR GUARD ASSEMBLY
MD-7571
FIG. 98



SKID ASSEMBLY
MD-7749
FIG. 99

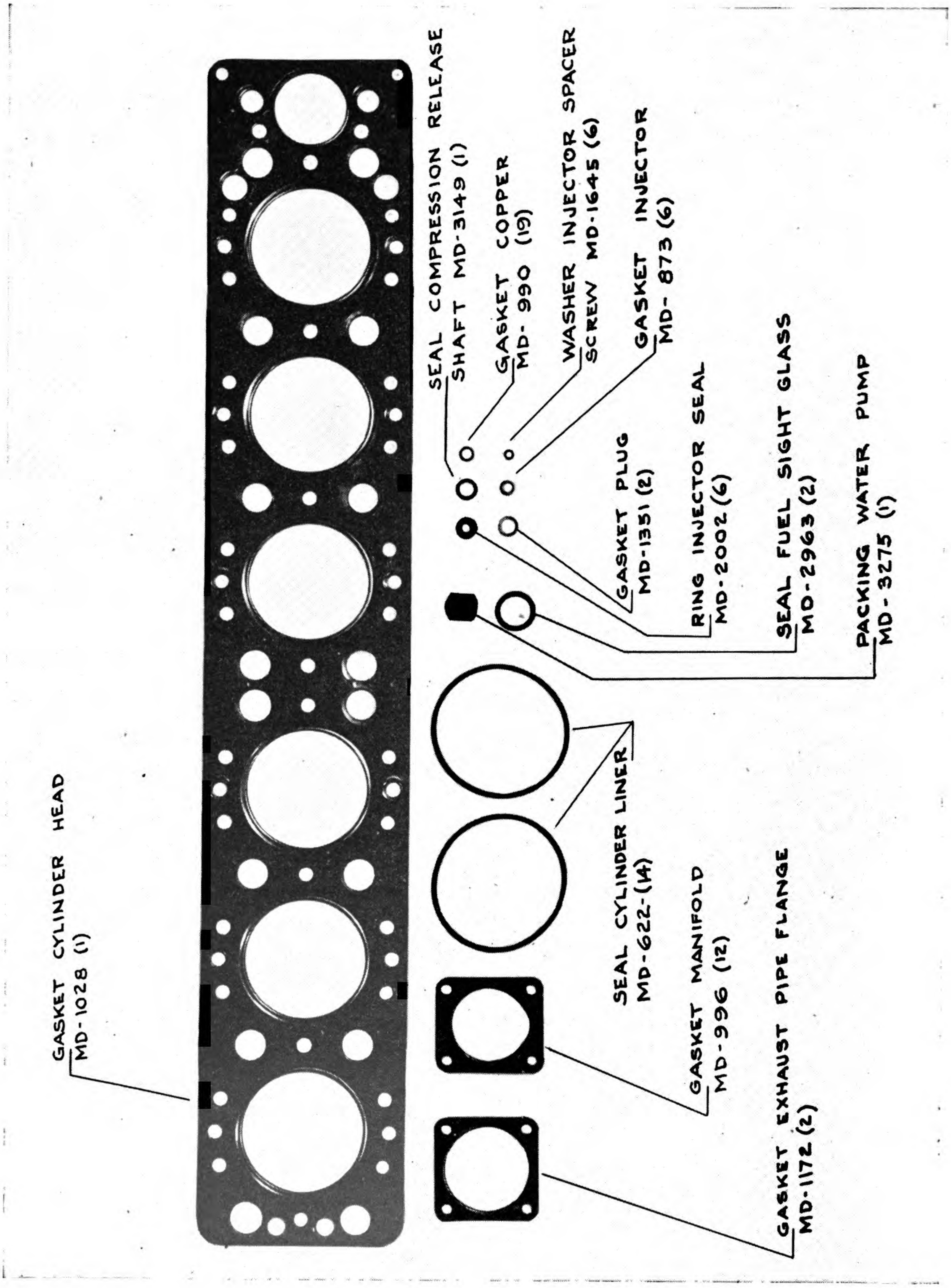


GASKET ASSEMBLY (PAPER)
MD-6770
FIG. 100

List of gaskets as shown on opposite page.

Murphy Diesel No.	Reference No.	Quantity per Engine	Description
MD- 884	11	1	Crankshaft Slinger Cover Gasket
MD- 887	15	1	Crankshaft Slinger Gasket
MD-1065	2	12	Handhole Cover Gasket
MD-1066	4	6	Valve Cover Gasket
MD-1414	46	1	Camshaft Housing Gasket
MD-1415	44	1	Governor Housing Gasket
MD-1418	36	1	Fuel Shaft Cover Gasket
MD-1437	48	1	Rear Bearing Cap Seal (Cork)
MD-1662	32	3	Gasket
			1—Breather Air Cleaner
			2—Breather Cover Plate
MD-1817	24	1	Governor Housing Cover Gasket
MD-1818	3	1	Governor Housing Head Gasket
MD-1844	35	1	Servo Spring Cover Gasket
MD-1845	34	1	Governor Inspection Cover Gasket
MD-2305	27	1	Camshaft Housing End Cover Gasket
MD-2603	38	1	Breather Air Cleaner Gasket
MD-3003	30	3	Fuel Flow Gland Shim
MD-3258	13	1	Water Pump Body Gasket
MD-3267	14	1	Water Pump Plate Gasket
MD-3281	42	1	Thermostat Housing Gasket
MD-3284	45	1	Thermostat Cover Gasket
MD-3288	29	7	Gasket
			4—Radiator
			3—Oil Cooler
MD-3355	43	1	Control Set Bracket Gasket
MD-3453	8	2	Water Inlet Pipe Cover Gasket
MD-3457	21	1	Camshaft Drive Cover Gasket
MD-3465	26	2	Oil Sump Gasket
MD-3467	47	1	Oil Sump Front Seal (Cork)
MD-3478	16	1	Generator Drive Bearing Cover Gasket
MD-3479	1	1	Generator Drive Bearing Cage Gasket
MD-3513	20	2	Generator Drive Cage Seal (Cork)
MD-3726	7	2	Radiator Tank Gasket
MD-3734	9	1	Oil Cooler Gasket
MD-3737	39	1	Radiator Filler Neck Gasket
MD-3745	18	1	Radiator Cap Gasket
MD-4206	40	4	Air Connection Gasket
MD-4220	41	1	Air Cleaner Support Gasket
MD-4685	33	1	Fuel Pressure Valve Gasket
MD-4686	28	1	Lubricating Oil Cover Gasket
MD-4687	22	1	Fuel Filter Cover Gasket
MD-5008	12	1	Water Pump Spacer Gasket
MD-5020	37	6	Fuel Supply Receiver Gasket
MD-5049	19	2	Oil Pump Cover Gasket
MD-5095	25	1	Flywheel Housing Gasket
MD-5119	17	1	Front Engine Support Gasket
MD-5299	49	1	Oil Cooler Return Cover Gasket (Center)
MD-5307	23	1	Oil Cooler Inlet Cover Gasket
MD-5308	5	1	Oil Cooler Return Cover Gasket
MD-6433	31	1	Air Cleaner Gasket—Inner (Cork)
MD-6434	10	1	Air Cleaner Gasket—Outer
MD-6726	6	2	Blower Outlet Connection Gasket
MD-7778	50	1	Governor Valve Lever Support Gasket

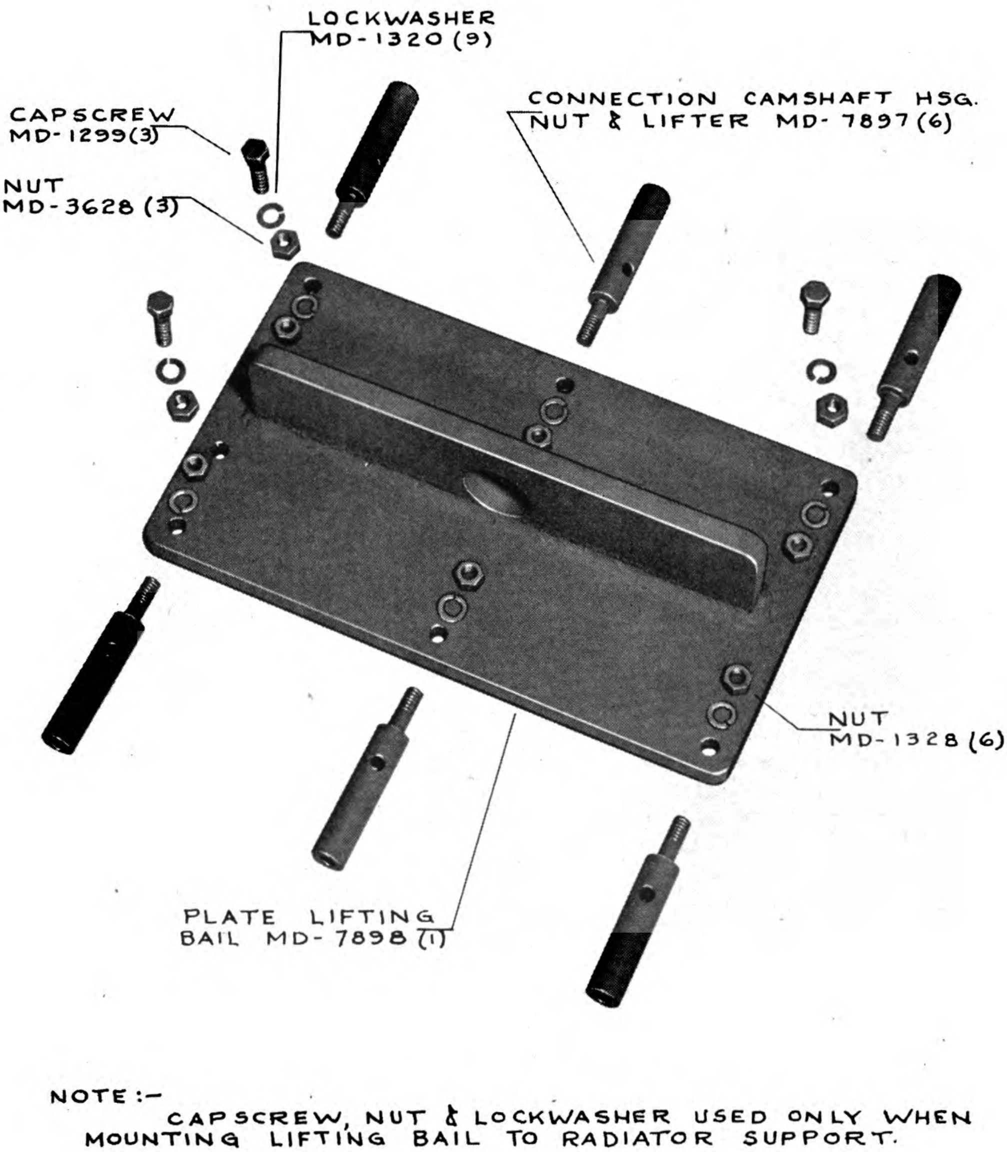
Gasket Assembly — Prepared Paper MD-6770-D



GASKET ASSEMBLY (METALLIC)

MD-3952

FIG. 100A



LIFTING BAIL ASSEMBLY
MD-7839A
FIG. 101

PARTS SECTION

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.	Price Each	Page
MD-510	Connecting Rod Nut	12	3 pcs. 1	$ 0.20	150
MD-622	Cylinder Liner Seal	14	20 pcs. 1	.25	155
MD-855	Piston Pin	6	3	3.30	194
MD-856	Cylinder Liner	6	31½	28.00	155
MD-863	Piston Pin Retainer	12	7 pcs. 1	.10	194
MD-864	Connecting Rod Dowel	12	16 pcs. 1	.15	150
MD-867	Injector Bushing Seal	12	100 pcs. 1	.15	158
MD-868	Injector Valve Ball	6	150 pcs. 1	.05	186
	(Lots 50 or over)			.02	186
MD-869	Injector Tip	6	15 pcs. 1	3.65	186
MD-870	Injector Valve Guide	6	150 pcs. 1	.50	186
MD-871	Injector Valve Seat	6	10 pcs. 1	3.00	186
MD-873	Injector Gasket	6	500 pcs. 1	.05	186
	(Lots 50 or over)			.03	186
MD-873A	Injector Cyl. Gasket	6*	500 pcs. 1	.05	......
MD-874	Injector Ret. Nut	6*	1½	1.35	197
MD-875	Injector Spacer Nut	6*	10 pcs. 1	1.10	......
MD-876	Injector Body Bushing	6*	15 pcs. 1	.45	......
MD-877	Injector Spacer Seal	6*	35 pcs. 1	.10	......
MD-883	Crankshaft Slinger Cov.	1	7	14.10	170
MD-884	Crshft. Slinger Cov. Gask.	1	35 pcs. 1	.25	170
MD-885	Flywheel Bolt	10	¾	.75	172
MD-887	Crankshaft Slinger Gasket	10	150 pcs. 1	.20	170
MD-888	Crankshaft Slinger Bolt Lock	8	150 pcs. 1	.05	170
MD-891	Injector Tappet	6	2¾	15.00	186
MD-892	Injector Spring—Outer	6	1½	2.75	186
MD-893	Injector Spring—Inter.	6	1	1.75	186
MD-894	Injector Spring—Inner	6	½	1.20	186
MD-896	Injector Tap. Thrust But.	6*	25 pcs. 1	1.00	......
MD-898	Injector Control Sleeve-Gear	6*	¾	5.00	......
MD-899	Injector Control Sleeve	6*	½	4.70	......
MD-902	Injector Con Sleeve-Screw	12*	25 pcs. 1	.15	......
MD-903	Injector Filter	6*	¾	5.65	......
MD-904	Injector Spacer Screw	6*	25 pcs. 1	.30	186
MD-905	Injector Cylinder Dowel	6*	100 pcs. 1	.10	......
MD-906	Injector Spring Cover Screw	6	6 pcs. 1	.45	186
MD-907	Injector Spring Cover Support	12*	¼	1.10	......
MD-909	Injector Fuel Connection	6*	¾	4.00	......
MD-910	Injector Body	6*	10	24.85	......
MD-911	Injector Body Plug	12*	50 pcs. 1	.15	......
MD-912	Injector Fuel Conn. Plug	12*	100 pcs. 1	.10	......
MD-913	Injector Valve Spring	7	100 pcs. 1	.35	180
MD-915	Injector Con. Lever Pin	6*	15 pcs. 1	.75	......
MD-916	Injector Con. Lever Collar	6*	35 pcs. 1	.50	......
MD-917	Injector Stop Pin	6*	50 pcs. 1	.10	......
MD-924	Tie Bolt Nut-Plain	16	½	.25	158
MD-925	Tie Bolt Nut-Slotted	16	½	.40	155
MD-926	Cylinder Head Nut	18	¼	.10	158
MD-927	Cap Nut	23	23 pcs. 1	.10	148
MD-928	Fuel Supply Receiver	4	1	3.85	197
MD-928A	Fuel Supply Receiver	2	1	3.85	197
MD-933A	Fuel Control Lever	6	¼	2.70	148
MD-934A	Fuel Con. Float Lever	6	¼	1.65	148
MD-935	Fuel Con. Lever Pin	12	50 pcs. 1	.15	148

*Not shown in illustration cannot be installed in field.

Part Number	Name and Description of Part	Qty.		Approximate Weight, Lbs.	Price Each	Page
MD-973	Handhole Cover	10		2½	2.35	155
MD-974	Tappet Guide	6**-		5½	11.90	197
MD-975	Main Bearing Shell—Frt.	2		¾	5.30	155
MD-976	Main Bearing Shell—Inter.	8		¾	4.70	155
MD-977	Main Bearing Shell—Cen.	2		1	8.10	155
MD-978	Main Bearing Shell—Rear	2		1	12.40	155
MD-983	Main Bearing Cap—Inter.	4***		15¾	8.10	155
MD-984	Main Bearing Cap—Center	1***		22	16.30	155
MD-985	Main Bearing Cap—Rear	1***		20	14.50	155
MD-990	Gasket—Cam. Hsg. Stud	58	100 pcs.	1	.05	148
MD-992	Camshaft Housing Stud	16		½	.25	158
MD-996	Manifold Gasket	12	8 pcs.	1	.20	160
MD-997	Main Bearing Dowel	14	7 pcs.	1	.20	155
MD-1007	Camshaft Bushing—Inter.	12		¼	2.55	149
MD-1008	Camshaft Bushing—Ends	4		¼	2.60	149
MD-1009	Camshaft Thrust Collar	2		½	4.25	148
MD-1010	Bevel Pin. Brg. Cage	1		12	19.90	147
MD-1020	Injector Retention Gear	6		1¼	1.50	197
MD-1021	Injector Wrench Gear	6		1¼	2.60	197
MD-1022	Bevel Pinion Bearing	2	5 pcs.	1	3.20	147
MD-1023	Bevel Pin. Thrust Brg.	2	5 pcs.	1	1.05	147
MD-1028	Cyl. Head Gasket	1		7½	10.50	158
MD-1032	Nut—Rear Main Bearing	2		¼	.30	155
MD-1033	Tie Bolt	16		5¼	3.70	155
MD-1034	Stud—Rear Main Bearing	2		½	.75	155
MD-1035	Cylinder Head Stud—Short	7		¾	.35	155
MD-1036	Cylinder Head Stud—Long	25		¾	.50	155
MD-1039	Rocker Arm Exhaust	12**		1	2.60	148
MD-1040	Rocker Arm Bushing	24	8 pcs.	1	.15	148
MD-1041	Bevel Gear	1		13	30.75	147
MD-1043	Bevel Gear Shim (.003)	4	150 pcs.	1	.25	147
MD-1044	Bevel Pinion Shim	20	300 pcs.	1	.05	147
MD-1044A	Bevel Pinion Shim (.031)	2	30 pcs.	1	.15	147
MD-1046	Dowel-Bevel Pinion Cage	1	20 pcs.	1	.50	147
MD-1056	Oil Tube—Bevel Pinion	1	15 pcs.	1	.55	147
MD-1057	Oil Tube Staple	2	50 pcs.	1	.05	147
MD-1058	Oil Level Gauge Handle	1		¼	1.70	......
MD-1061	Valve Spring—Inner	25	8 pcs.	1	.25	149
MD-1062	Valve Spring—Outer	24	3 pcs.	1	.30	158
MD-1065	Handhole Cover Gasket	12	100 pcs.	1	.15	155
MD-1066	Valve Cover Gasket	6	200 pcs.	1	.15	199
MD-1099	Valve Spring Washer	24	3 pcs.	1	.20	158
MD-1100	Valve Spring Keeper	48	20 pcs.	1	.10	158
MD-1102	Valve Tappet	24		¼	1.10	197
MD-1103	Valve Seat Ring	12	5 pcs.	1	3.30	158
MD-1104	Valve Stem Snap Ring	24	100 pcs.	1	.05	158
MD-1105	Crankcase Oil Tube	6		¼	1.35	155
MD-1110A	Camshaft Supply Oil Tube	1		¼	.75	155
MD-1111	Clip (Camshaft Supply)	1	15 pcs.	1	.05	155
MD-1117	Crankcase Sump Dowel	4		¾	.75	193
MD-1160	Exhaust Manifold	2		31½	18.10	160
MD-1171	Exhaust Pipe Flange	2		4½	7.00	160
MD-1172	Stud—Manifold	2	12 pcs.	1	.45	160

**-Order MD-1408 Tappet Guide Unit Assembly—Price Each $25.00

**Order MD-2994 Exhaust Rocker Arm Assembly—$2.90

***Available only semi-finished. Must be line bored after assembly to crankcase.

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.		Price Each	Page
MD-1177	Stud—Manifold	56	8 pcs.	1	.15	158
MD-1181	Stud—Oil Sump Cover	35	20 pcs.	1	.15	163
MD-1193	Bevel Gear Shim (.010)	2	50 pcs.	1	.35	147
MD-1216	Injector Wrench Assembly	1		2½	2.50	198
MD-1258	Oil—Level Gauge Pin	2	300 pcs.	1	.05	......
MD-1266	Rocker Arm Spring	24	25 pcs.	1	.10	148
MD-1267	Dowel	2	20 pcs.	1	.25	170
MD-1272	Timing Plunger Spring	1	50 pcs.	1	.20	170
MD-1275	Servo Spring	1	10 pcs.	1	.40	181
MD-1283	Fillister Head Screw (¼-20x⅜)	2	40 pcs.	1	.05	173
MD-1284A	Fillister Head Screw (¼-20x⅝)	29	70 pcs.	1	.10	177
MD-1285	Fillister Head Screw (¼-20x¾)	20	70 pcs.	1	.05	152
MD-1286	Fillister Head Screw (¼-20x1)	34	70 pcs.	1	.05	187
MD-1288	Capscrew (¼-28x1¼)	1	35 pcs.	1	.05	196
MD-1289	Capscrew (¼-28x1) Spec. Mat.	6	40 pcs.	1	.25	148
MD-1292	Capscrew (⅜-24x1¾)	1	16 pcs.	1	.05	196
MD-1293	Capscrew (⅜-16x¾)	9	20 pcs.	1	.05	155
MD-1294	Capscrew (⅜-16x1)	148	20 pcs.	1	.05	146
MD-1295	Capscrew (⅜-16x1¼)	28	15 pcs.	1	.05	148
MD-1296	Capscrew (⅜-16x4)	7		¼	.10	184
MD-1298	Capscrew (½-13x1½)	6		¼	.10	200
MD-1299	Capscrew (½-13x1¾)	19		¼	.05	170
MD-1300	Capscrew (½-13x3¼)	4		½	.10	147
MD-1301	Capscrew (½-20x2)	21		¼	.10	193
MD-1302	Capscrew (¾-10x2¼)	18		¾	.20	170
MD-1303	Pipe Plug (⅛ Slotted)	23	25 pcs.	1	.10	149
MD-1304	Pipe Plug (¼ Slotted)	11	15 pcs.	1	.10	148
MD-1305	Pipe Plug (⅜ Sq. Hd.)	3	8 pcs.	1	.10	163
MD-1306	Pipe Plug (⅜ Allen Process)	1	15 pcs.	1	.10	149
MD-1307	Pipe Plug (½ Sq. Hd.)	5	20 pcs.	1	.05	155
MD-1308	Pipe Plug (½ Slotted)	3	8 pcs.	1	.40	148
MD-1309	Pipe Plug (¾ Sq. Hd.)	1	20 pcs.	1	.05	195
MD-1312	Woodruff Key No. 9	8	200 pcs.	1	.05	148
MD-1314	Expansion Plug (½)	2	30 pcs.	1	.05	170
MD-1316	Expansion Plug (1)	1	30 pcs.	1	.05	155
MD-1317	Expansion Plug (1¼)	2	30 pcs.	1	.05	158
MD-1318	Lock Washer (¼)	93	150 pcs.	1	.01	148
MD-1319	Lock Washer (⅜)	247	70 pcs.	1	.01	146
MD-1320	Lock Washer (½)	18	50 pcs.	1	.01	146
MD-1321	Lock Washer (⅝)	7	35 pcs.	1	.05	161
MD-1322	Lock Washer (¾)	30	25 pcs.	1	.02	149
MD-1324	Nut (¼-28)	24	100 pcs.	1	.02	152
MD-1326	Nut (⅜-24)	92	70 pcs.	1	.03	148
MD-1327	Nut (½-20 Castellated)	1	20 pcs.	1	.04	176
MD-1328	Nut (½-20)	118	25 pcs.	1	.03	146
MD-1328A	Nut (½-20)	8	25 pcs.	1	.03	160
MD-1329	Nut (⅝-18)	1	12 pcs.	1	.10	161
MD-1331	Nut (¾-16)	7	8 pcs.	1	.15	158
MD-1333	Injector Tappet Shaft	6*†	8 pcs.	1	.....	......
MD-1334	Injector Tappet Bearing Roller	78*†	150 pcs.	1	.....	......
MD-1336	Nut—Worm Drive	3		¼	.35	147
MD-1342	Gasket	2	500 pcs.	1	.05	190
MD-1346	Injector Lifter Bail	6	15 pcs.	1	.10	186
MD-1351	Water Outlet Stud Gasket	2	300 pcs.	1	.05	170

*†Order MD-3824 Assembly—Price Each $2.55

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.		Price Each	Page
MD-1352	Headless Set Screw	4	50 pcs.	1	.05	153
MD-1354	Comp. Release Seal Washer	2	60 pcs.	1	.10	149
MD-1362	Ball Bearing (ND-3306)	2		¾	5.20	176
MD-1364	Ball Bearing (5307)	2		1½	9.35	203
MD-1366	Oil Seal (1½)	1	5 pcs.	1	2.10	192
MD-1368	Lockwasher (¾x¼x⅛)	1	30 pcs.	1	.05	158
MD-1368A	Lockwasher (¾x¼x⅛)	6	30 pcs.	1	.05	199
MD-1375	Pipe Elbow (½x90)	2		½	.10	......
MD-1376	Ball (⅜)	1	200 pcs.	1	.05	170
MD-1377	Drain Cock	1	20 pcs.	1	.20	163
MD-1390	Male Elbow (¾ Tube)	1		½	1.20	155
MD-1391	Nut (¾ Tube)	1		¼	.40	167
MD-1392	Male Elbow (⅜ Tube)	4	8 pcs.	1	.20	163
MD-1393	Male Connector (⅜ Tube)	1	16 pcs.	1	.15	......
MD-1395	Male Elbow (5/16 Tube)	13	16 pcs.	1	.10	166
MD-1398	Nut (5/16 Tube)	26	15 pcs.	1	.05	......
MD-1399	Male Connector (5/16 Tube)	10	30 pcs.	1	.10	166
MD-1404A	Injector Supply Tube	2•	6 pcs.	1	.50	197
MD-1405A	Injector Supply Tube	1••	6 pcs.	1	.50	197
MD-1414	Camshaft Housing Gasket	1	8 pcs.	1	.50	148
MD-1415	Governor Housing Gasket	1	500 pcs.	1	.10	178
MD-1418	Fuel Shaft Cover Gasket	1	500 pcs.	1	.05	179
MD-1437	Rear Bearing Cap Seal	1	45 pcs.	1	.10	193
MD-1471	Servo Piston Ring	2	45 pcs.	1	.15	179
MD-1492	Pin	1	8 pcs.	1	.25	153
MD-1499	Lockwasher (No. 8)	2	1000 pcs.	1	.01	154
MD-1501	Lockwasher (5/16)	2	300 pcs.	1	.01	166
MD-1502	Washer	2	50 pcs.	1	.05	152
MD-1512	Male Elbow (½ Tube)	2	8 pcs.	1	.50	156
MD-1513	Nut (½ Tube)	3	15 pcs.	1	.10	156
MD-1556	Injector Mounting Bracket	1		5½	3.95	198
MD-1560	Cup Plug (1¼)	1	15 pcs.	1	.05	146
MD-1587	Injector Mounting Nut	1		1	.50	198
MD-1598	Thrust Bearing Anchor Screw	8	30 pcs.	1	.05	147
MD-1613	Lockwasher (⅞)	2	10 pcs.	1	.05	211
MD-1615	Pipe Plug (⅛ Sq. Hd.)	12	25 pcs.	1	.05	148
MD-1640	Valve Spring Comp. Head	1	3 pcs.	1	1.00	198
MD-1641	Valve Spring Comp. Plate	1		1	1.00	198
MD-1644	Valve Spring Comp. Screw	1		½	1.25	198
MD-1645	Injector Spacer Screw Washer	6*	800 pcs.	1	.05	186
MD-1646	Injector Control Segment	6*	3 pcs.	1	3.90	......
MD-1647	Injector Control Crank	6*		½	4.00	......
MD-1652	Injector Control Spring Pin	6*	200 pcs.	1	.10	......
MD-1653	Injector Control Spring	6*	40 pcs.	1	.25	......
MD-1656	Injector Key Pin	6*	500 pcs.	1	.10	......
MD-1662	Breather Air Cleaner Gasket	3	50 pcs.	1	.05	156
MD-1663	Camshaft Housing Dowel	1	8 pcs.	1	.25	148
MD-1664	Tappet Guide Ferrule	12	20 pcs.	1	.15	197
MD-1665	Stud	12	5 pcs.	1	.15	158
MD-1666	Camshaft Housing Plug	1	8 pcs.	1	.25	148
MD-1676	Breather Cover Plate	1	3 pcs.	1	.50	156
MD-1676A	Breather Cover Plate	1	3 pcs.	1	.75	156
MD-1679	Cotter Pin (⅛x1)	6	150 pcs.	1	.01	170
MD-1681	Cotter Pin (⅛x1¼)	36	150 pcs.	1	.01	148

•Order MD-1404 Assembly—Price Each $0.50

••Order MD-1405 Assembly—Price Each $0.50

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.		Price Each	Page
MD-1682	Cotter Pin (⅛x1½)	22	100 pcs.	1	.01	155
MD-1683	Cotter Pin (⅛x1¾)	3	100 pcs.	1	.01	147
MD-1684	Cotter Pin (3/32x½)	30	500 pcs.	1	.01	148
MD-1685	Cotter Pin (3/32x¾)	12	400 pcs.	1	.01	149
MD-1686	Cotter Pin (1/16x½)	8	500 pcs.	1	.01	152
MD-1727	Capscrew (½-20x4)	3	15 pcs.	1	.15	165
MD-1741	Expansion Plug (¾)	1	20 pcs.	1	.05	179
MD-1744	Radiator Overflow Pipe	1		½	.75	195
MD-1745	Rad. Overflow Pipe Clip	1	150 pcs.	1	.10	167
MD-1750	Capscrew (¾-10x3½)	1		1	.20	196
MD-1772	Governor Housing Head	1		2½	1.50	179
MD-1773	Governor Case	1		15½	8.50	178
MD-1775	Governor Weight	2		½	3.45	178
MD-1778	Governor Drive Spring	1		¼	.75	178
MD-1780	Governor Piston	1		2	10.50	179
MD-1788	Governor Weight Shaft	2	20 pcs.	1	.85	178
MD-1789	Governor Servo Spring Pl.	1		¼	.80	178
MD-1792	Governor Bell Crank	1		1¼	8.75	180
MD-1796	Governor Valve Stop Screw	1	70 pcs.	1	.30	179
MD-1800	Ball Bearing (ND38)	1	30 pcs.	1	1.80	180
MD-1803	Ball Bearing (206-K)	2		½	4.00	177
MD-1804	Governor Bell Crank Shaft	1		1	1.15	180
MD-1805	Governor Bell Crank Bearing	1		¼	1.15	181
MD-1807	Capscrew (⅜-16x2¾)	2	16 pcs.	1	.15	152
MD-1813	Pin (¼x1⅜)	2	15 pcs.	1	.10	149
MD-1815	Capscrew (⅜-24x1½)	1	16 pcs.	1	.20	196
MD-1817	Governor Housing Cover Gasket	1	300 pcs.	1	.10	180
MD-1818	Governor Housing Head Gasket	1	150 pcs.	1	.05	179
MD-1820	Female Elbow (⅜ Tube)	2	16 pcs.	1	.35	181
MD-1821	Pipe Nipple (¼ Pipe x 1½ Lg.)	4	16 pcs.	1	.05	163
MD-1828	Throttle Ball Joint	2	8 pcs.	1	.25	152
MD-1836	Capscrew (⅜-24x¾)	2	16 pcs.	1	.05	149
MD-1841	Governor Inspection Cover	1		¼	.75	181
MD-1844	Servo Spring Cover Gasket	1	150 pcs.	1	.05	181
MD-1845	Governor Inspection Cover Gasket	1	300 pcs.	1	.05	181
MD-1875	Pin Vise	1	30 pcs.	1	1.75	198
MD-1879	Box Wrench (¾ and 25/32)	1		½	.80	198
MD-1881	Sliding Bar	1		2½	4.35	198
MD-1882	Extension	1		1¼	2.65	198
MD-1884	Socket 1"	1		¼	1.20	198
MD-1885	Socket 1⅛"	1	3 pcs.	1	1.50	198
MD-1886	Socket 1 5/16"	1		½	1.80	198
MD-1888	Box Wrench (7/16 and ⅜)	1	8 pcs.	1	.65	198
MD-1889	Box Wrench (9/16 and ½)	1	5 pcs.	1	.70	198
MD-1890	Injector Tip Brush	1	5 pcs.	1	.20	198
MD-1891	Injector Valve Seat Grinder	1	150 pcs.	1	.25	198
MD-1893	Injector Tip Cleaning Wire .009	4	1000 pcs.	1	.01	198
MD-1894	Tool Box	1		6	4.75	198
MD-1907	Injector Tip Cleaner	1	200 pcs.	1	.25	198
MD-1912	Camshaft Drive Coupling—Lower	1		2½	10.05	147
MD-1917	Male Connector (½ Tube)	2		¼	.35	156
MD-1972	Brass Nut (8-32)	2	60 pcs.	1	.01	154
MD-1974	Washer (Brass No. 8)	2	125 pcs.	1	.03	154
MD-1998	Cotter Pin (⅛x¾)	1	150 pcs.	1	.01	......
MD-1999	Bevel Pinion	1		8	44.25	147

Part Number	Name and Description of Part	Qty.		Approximate Weight, Lbs.	Price Each	Page
MD-2002	Injector Seal Ring	6	150 pcs.	1	.10	186
MD-2005	Feeler Gauge (.012)	1	16 pcs.	1	.55	198
MD-2006	Feeler Gauge (.015)	1	16 pcs.	1	.55	198
MD-2026	Cap Screw (¾-16x1½ Spec.)	2	5 pcs.	1	.20	149
MD-2029	Comp. Release Shaft	1		12	13.05	149
MD-2091	Woodruff Key No. 5	2	300 pcs.	1	.10	200
MD-2058	Wire Terminal	4	300 pcs.	1	.05	......
MD-2104	Cap Screw (⅝-11x4)	2		¾	.15	198
MD-2109	Washer	1	80 pcs.	1	.05	......
MD-2112	Elbow	1	11 pcs.	1	.20	167
MD-2115A	Injector Seal Spring Seat	6	5 pcs.	1	.70	186
MD-2119	Female Connector (5/16 Tube)		30 pcs.	1	.25	188
MD-2161	Timing Plunger	1	3 pcs.	1	.90	170
MD-2163	Pipe Plug (¼ Sq. Hd.)	12	40 pcs.	1	.05	161
MD-2230	Governor Servo Spring Cover	1		1	3.60	181
MD-2231	Governor Servo Plunger Stop	1	8 pcs.	1	.50	181
MD-2232	Cup Plug 1"	1	45 pcs.	1	.10	155
MD-2280	Woodruff Key No. 3	1	150 pcs.	1	.03	196
MD-2305	Gasket	1	45 pcs.	1	.15	148
MD-2316	Rocker Arm—Inlet	12×		1¼	2.55	148
MD-2321	Nut (⅞-14 Half Nut)	8	5 pcs.	1	.10	185
MD-2343	Cap Screw (½-13x3¾)	6		½	.20	200
MD-2344	Cap Screw (½-13x1¼)	8	5 pcs.	1	.10	146
MD-2345	Cap Screw (⅜-16x3)	4		¼	.20	159
MD-2346	Fillister Head Screw (¼-20x½)	2	88 pcs.	1	.05	154
MD-2367	Governor Plunger	1		½	3.50	178
MD-2368	Governor Valve	1		¾	6.00	179
MD-2369	Governor Ball Pin	3	25 pcs.	1	.35	178
MD-2452	Wire Terminal (9/32)	4	50 pcs.	1	.05	201
MD-2466	Throttle Spring Bracket	2	35 pcs.	1	.15	152
MD-2473	¾ Pipe Plug—Countersunk	4	8 pcs.	1	.10	148
MD-2479	Stud	8	150 pcs.	1	.15	181
MD-2487	Throttle Ratchet Spring	1	8 pcs.	1	.15	152
MD-2493	Cap Screw (⅜-24x1)	4	15 pcs.	1	.05	205
MD-2497	Pipe Bushing (⅜ to ⅛)	3	100 pcs.	1	.10	158
MD-2503	Spacer	1	16 pcs.	1	.45	......
MD-2509	Fuel Filter to Cyl. Head Tube	1	3 pcs.	1	1.60	167
MD-2531	Injector Wrench Handle	1	5 pcs.	1	.50	......
MD-2559	Pipe Plug 1" Sq. Hd.	2	16 pcs.	1	.05	149
MD-2569	Fuel Control Shaft Lever	1		½	5.60	149
MD-2582	Camshaft Housing Lifter Strap	2		2¼	1.00	198
MD-2583	Camshaft Housing Lifter Guide	2		2¼	1.25	198
MD-2588	Cap Screw (½-20x1½)	6		¼	.10	198
MD-2592	Breather Air Cleaner	1		2¾	4.05	156
MD-2599	Fuel Control Shaft Sleeve	1		¼	1.00	149
MD-2603	Breather Air Cleaner Gasket	1	60 pcs.	1	.10	156
MD-2607	Governor Piston Plug	6	150 pcs.	1	.10	179
MD-2614	Flared Tube Union (5/16)	2	150 pcs.	1	.15	166
MD-2627	Plug	1	6 pcs.	1	.50	170
MD-2682	Governor Roller	4	16 pcs.	1	.50	149
MD-2683	Governor Roller Shaft—Long	1	16 pcs.	1	.85	149
MD-2684	Governor Roller Shaft—Short	1	12 pcs.	1	.70	180

×Order MD-2993 Assembly—Price Each $3.25

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.	Price Each	Page
MD-2689	Stud	3	6 pcs. 1	.30	184
MD-2707	Cap Screw (3/8-16x2 1/4)	2	16 pcs. 1	.15	192
MD-2714	Stud (3/8x2 3/16)	5	30 pcs. 1	.60	......
MD-2724	Injector Valve Lapping Comp.	1	8 pcs. 1	.60	190, 198
MD-2764	Lock Washer (1x5/16x1/4)	4	5 pcs. 1	.10	211
MD-2826	Cap Screw (1/2-20x1)	1	8 pcs. 1	.10	152
MD-2849	Washer (29/32 I.D. x 1 3/4 O.D.)	6	30 pcs. 1	.10	211
MD-2871	Nut (1/4x20)	4	40 pcs. 1	.02	153
MD-2877	Reducing Bushing (1/2 to 3/8)	1	30 pcs. 1	.10	......
MD-2910	Reducing Bushing (1/4 to 1/8)	6	45 pcs. 1	.10	163
MD-2918	Battery Terminal	4	8 pcs. 1	.20	201
MD-2925A	Order 2925	1		.35	168
MD-2933	Pipe Tee (1/4 Malleable)	1	8 pcs. 1	.15	163
MD-2935	Pipe Nipple	1		.05	169
MD-2946	Starting Hand Throttle Seal	1	30 pcs. 1	1.00	179
MD-2949	Fuel Con. Shaft Bushing	1	1/2	5.25	179
MD-2950	Fuel Con. Shaft Extension	1	1 1/4	3.50	179
MD-2958	Injector Bushing	6	1 1/4	6.00	158
MD-2963	Fuel Sight Glass Seal	2	150 pcs. 1	.25	187
MD-2977	Bushing (3/8 to 1/4)	1	30 pcs. 1	.05	173
MD-2998	Ammeter (30-0-30, 24 Volt)	1	1/2	4.50	187
MD-2999	Oil Pressure Gauge (100 lbs.)	1	1/2	1.80	187
MD-3001	Fuel Flow Gauge Gland	1	5 pcs. 1	4.50	187
MD-3003	Fuel Flow Gland Shim	3	150 pcs. 1	.05	187
MD-3004	Fuel Sight Glass	1	25 pcs. 1	.55	187
MD-3021A	Worm Oil Line Tube	1xx	1/4	.80	204
MD-3035	Puller Screw Pilot	1	3 pcs. 1	.60	198
MD-3055	Stud (1/2x1 1/16)	4	10 pcs. 1	.25	165
MD-3149	Comp. Release Shaft Seal	1	10 pcs. 1	.10	149
MD-3157	File Handle	1	10 pcs. 1	.35	......
MD-3167	Worm Bearing Cage	1	7	30.00	203
MD-3168	Worm Bearing Retaining Nut	1	1/2	7.00	203
MD-3169	Worm Bearing Cage Screw	1	4 pcs. 1	1.35	203
MD-3170	Worm Retaining Nut Lockscrew	1	25 pcs. 1	.25	203
MD-3171	Worm Bearing Spacer—Inner	1xxx	3/4	3.00	203
MD-3172	Worm Bearing Spacer—Outer	1xxx	3/4	3.00	203
MD-3178	Fuel Con. Shaft Collar	1	1/2	5.15	179, 183
MD-3180	Fillister Hd. Screw (1/4-20x1 1/4)	3	50 pcs. 1	.05	179
MD-3191	Fuel Control Cross Bar	5	3/4	2.35	148
MD-3192	Cross Bar Adj. Block	5	7 pcs. 1	.80	148
MD-3193	Cap Screw (1/4-28x1/2)	12	75 pcs. 1	.05	148
MD-3201	Lifter U Bolt Strap	1	3 1/2	1.85	198
MD-3202	Camshaft Hsg. Lifter Bolt	1	1/2	.85	198
MD-3205	Tubing Clip Spacer—Single	3	100 pcs. 1	.15	167
MD-3206	Tubing Clip	3	65 pcs. 1	.40	167
MD-3224	Fuel Control Shaft	1	12	8.90	149
MD-3253	Cap Screw (3/8-16x4 1/2)	1	3/4	.15	185
MD-3257	Water Pump Body	1	19	20.00	200
MD-3258	Water Pump Body Gasket	1	45 pcs. 1	.20	200
MD-3260	Water Pump Runner	1	3 1/4	5.25	200
MD-3261	Water Pump Runner Pin	1	32 pcs. 1	.40	200
MD-3262	Water Pump Shaft	1	1	4.95	200
MD-3263	Water Pump Seal Tube	1	10 pcs. 1	.30	200
MD-3264	Water Pump Seal	1	32 pcs. 1	.90	200
MD-3265A	Water Pump Pulley	1	18	20.00	200
MD-3266A	Water Pump Bearing Plate	1	4	10.10	200

xxOrder MD-3021 Assembly—Price Each $0.80

xxxReplace these 2 parts MD-3071 and MD-3072 as a unit

Part Number	Name and Description of Part	Qty.		Approximate Weight, Lbs.	Price Each	Page
MD-3267	Water Pump Plate Gasket	1	100 pcs.	1	.10	200
MD-3268	Water Pump Drive Collar	1		¾	3.10	200
MD-3269	Water Pump Drive Screw	1	5 pcs.	1	.45	200
MD-3270	Water Pump Collar Screw	1	10 pcs.	1	.35	148
MD-3271	Water Pump Bearing Retainer	1		½	4.00	200
MD-3272	Water Pump Bearing	2		1¾	7.80	200
MD-3273	Water Pump Bearing Spacer	1		2½	1.25	200
MD-3274	Water Pump Grease Def.	1		1¼	6.00	200
MD-3275	Water Pump Packing	1		¼	1.25	200
MD-3276	Water Pump Packing Gland	1	3 pcs.	1	1.60	200
MD-3277	Water Pump Packing Nut	1		1¾	7.20	200
MD-3278	Water Pump Nut Wrench	1	8 pcs.	1	1.00	198
MD-3279	Camshaft Hsg. End Cover	1		9	6.50	148
MD-3280	Thermostat Housing	1		9¾	12.00	159
MD-3281	Thermostat Housing Gasket	1	60 pcs.	1	.10	159
MD-3282	Cap Screw (⅜-16x3½)	4	4 pcs.	1	.10	159
MD-3283	Thermostat Cover	1		4	5.35	159
MD-3284	Thermostat Cover Gasket	1	100 pcs.	1	.15	159
MD-3285	Cap Screw (⅜-16x1¾)	5	14 pcs.	1	.08	159
MD-3286	Radiator Inlet Flange	1		1½	2.60	195
MD-3288	Radiator Inlet Elbow Gasket	7	120 pcs.	1	.10	190
MD-3327	Cylinder Head (6 Cyl.)	1		361	240.00	158
MD-3343	Compression Release Lever	1		1¼	6.50	153
MD-3344A	Ratchet Plate	1		6¼	13.50	152
MD-3346A	Control Latch	1		1¼	6.00	152
MD-3347	Instrument Panel Spacer	1		½	.85	189
MD-3348	Control Lever Shaft	1		1½	3.50	153
MD-3349	Compression Release Cam	1	6 pcs.	1	1.10	153
MD-3350A	Control Lever Hub	1		1¼	9.75	153
MD-3352A	Control Lever	1		2	12.50	152
MD-3353	Ratchet Plate Support	1		2	3.80	153
MD-3354	Control Set Bracket	1		4¼	10.50	153
MD-3355	Control Set Bracket Gasket	1	60 pcs.	1	.15	153
MD-3357	Ratchet Lever Spring Clip	2	32 pcs.	1	.10	152
MD-3361	Stud	2	12 pcs.	1	.15	153
MD-3363	Cap Screw (⅜-24x2½)	1	11 pcs.	1	.10	152
MD-3364	Cap Screw (⅝-18x3)	1		½	.20	161
MD-3365A	Control Lever Handle	2		¾	2.50	152
MD-3366	Cap Nut (⅜x24)	2	16 pcs.	1	.75	152
MD-3367	Control Latch Pin	1	16 pcs.	1	.45	152
MD-3369	Throttle Bell Crank Button	1	16 pcs.	1	.75	152
MD-3370	Throttle Bell Crank Shaft	1	8 pcs.	1	.60	152
MD-3373	Compression Rel. Roller Pin	1	16 pcs.	1	.45	153
MD-3374	Control Lever Roller Pin	1	32 pcs.	1	.45	152
MD-3380	Stud	1		¼	.20	189
MD-3382	Control Lever Spring	1		½	.70	152
MD-3383	Compression Release Spring	1	3 pcs.	1	.40	153
MD-3385	Cap Screw (⅜-16x1¼)	2	15 pcs.	1	.08	......
MD-3392	Male Connector	2	34 pcs.	1	.15	169
MD-3398	Generator Drive Counter Shaft	1		2½	12.05	177
MD-3399	Generator Drive Shaft	1		3½	16.50	176
MD-3400	Generator Drive Bearing Cover	1		1¼	3.50	176
MD-3401	Generator Drive Cover Plate	1		½	3.00	177
MD-3402	Generator Gear Shift Shaft	1		¾	1.00	177
MD-3405	Generator Drive Gear—Driven	1		1½	8.75	177

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.		Price Each	Page
MD-3406	Generator Drive Gear—Driven	1		1	6.50	176
MD-3407	Generator Drive Bearing Cage	1		5½	14.00	177
MD-3408	Generator Drive Housing	1		14	30.00	176
MD-3425	Cap Screw (⅝-11x2$\frac{7}{32}$)	6	3 pcs.	1	.15	170
MD-3431	Starter Hole Cover	1		3	2.00	170
MD-3432	Gear Ring	1		13¼	17.25	172
MD-3437	Water Inlet Pipe Cover	1		1½	1.75	175
MD-3438	Generator Drive Gear Washer	1	10 pcs.	1	.30	176
MD-3439	Generator Drive Gear Spacer	1		¾	.60	176
MD-3440	Countershaft Bearing Retainer	2	6 pcs.	1	.75	177
MD-3442	Woodruff Key (XX SX Spec.)	1	16 pcs.	1	1.10	157
MD-3444	Bearing Retainer Washer	1	12 pcs.	1	.50	177
MD-3451	Roller Bearing Washer	1	80 pcs.	1	.05	176
MD-3453	Water Inlet Pipe Cov. Gasket	2	40 pcs.	1	.10	175
MD-3455	Oil Pump Idler Washer	3	68 pcs.	1	.40	192
MD-3456	Stud (½x5)	1		¼	.25	155
MD-3457	Cam. Drive Cover Gasket	1	80 pcs.	1	.10	148
MD-3458	Camshaft Drive Cover	1		3	6.00	148
MD-3460	Generator Drive Shifter Fork	1	4 pcs.	1	2.75	177
MD-3465	Oil Sump Gasket 6 Cyl.	2	6 pcs.	1	.85	193
MD-3467	Oil Sump Front Seal	1	36 pcs.	1	.15	193
MD-3469	Camshaft Housing, 6 Cyl.	1		235	205.00	148
MD-3470	Thermostat	3	3 pcs.	1	2.40	159
MD-3471	Woodruff Key (No. SX)	2	16 pcs.	1	.20	149
MD-3472	Worm	1		5	40.00	203
MD-3473	Ratchet Plate Spacer	2	8 pcs.	1	.25	153
MD-3474	Con. Lever Hub Washer	1	7 pcs.	1	.30	152
MD-3475	Stud	4	4 pcs.	1	.25	155
MD-3476	Water Inlet Pipe Support	1	3 pcs.	1	.95	175
MD-3477	Stud	1	8 pcs.	1	.20	175
MD-3478	Gen. Drive Bearing Cover Gasket..	1	160 pcs.	1	.10	176
MD-3479	Gen. Drive Bearing Cage Gasket....	1	160 pcs.	1	.10	177
MD-3481	Cap Screw (⅜-24x¾)	6	16 pcs.	1	.05	176
MD-3482	Rivet ($\frac{3}{16}$x⅞ Countersunk)	1	20 pcs.	1	.03	153
MD-3484	Gen. Coupling Flange Washer	1	36 pcs.	1	.10	177
MD-3485	Slotted Nut (¾-16)	1	7 pcs.	1	.20	177
MD-3487	Gen. Gear Shifter Spring	1	16 pcs.	1	.20	177
MD-3488	Generator Drive Seal	2		¼	1.35	176, 177
MD-3489	Roller Bearing	2	5 pcs.	1	3.75	176
MD-3501	Front Support Clamp Washer	2	32 pcs.	1	.10	161
MD-3501A	Cyl. Head Nut Washer	31	20 pcs.	1	.02	158
MD-3502	Front Support Clamp Shim	1	64 pcs.	1	.25	161
MD-3506	Woodruff Key (No. 1)	1	350 pcs.	1	.02	173
MD-3507	Cap Screw ($\frac{5}{16}$—24)	1	20 pcs.	1	.05	195
MD-3508	Nut ($\frac{5}{16}$-24)	1	125 pcs.	1	.02	166
MD-3513	Priming Plunger Packing	2	2000 pcs.	1	.05	177
MD-3519	Rocker Arm Shaft	2		5¼	12.50	149
MD-3520	Rocker Shaft Locating Screw	2	20 pcs.	1	.25	148
MD-3541	Cap Screw (¾-16x2)	2		½	.20	149
MD-3542	Worm Gear Flange	2		2	4.95	149
MD-3547	Governor Case Cover	1		1¾	7.40	178
MD-3560	Instrument Panel	1		3½	2.75	187
MD-3605	Cup Plug 1"	1	30 pcs.	1	.10	181
MD-3615	Breather Air Cleaner Bracket	1		2½	6.70	156
MD-3628	Nut (½-13)	11	16 pcs.	1	.05	215
MD-3636	Cylinder Head Stud Spacer	1	8 pcs.	1	.45	158

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.	Price Each	Page
MD-3649	Worm Gear	2	5½	30.00	149
MD-3687	Inlet Valve	12	½	.75	158
MD-3689	Piston Pin Bushing	12	¼	.40	150
MD-3696	Valve Grinder Stem	1	15 pcs. 1	.55	......
MD-3697	Valve Guide	24	½	1.70	158
MD-3698	Valve Seat Ring (Inlet)	12	6 pcs. 1	.50	158
MD-3703	Radiator Top Tank	1	28	35.00	195
MD-3707	Strip Reinforcing Header	4	2	2.50	195
MD-3709	Radiator Filler Neck	1	1½	1.50	195
MD-3714	Oil Cooler Body	1	39	30.00	190
MD-3719A	Oil Cooler Core Assembly	1	38½	125.00	190
MD-3726	Radiator Tank Gasket	2	16 pcs. 1	.50	195
MD-3728	Stud	8	16 pcs. 1	.15	190
MD-3729	Valve—Exhaust	12	½	2.65	158
MD-3731	Stud	1	10 pcs. 1	.25	190
MD-3733A	Radiator Inlet Elbow	1	6¾	4.50	195
MD-3734	Oil Cooler Gasket	1	32 pcs. 1	.10	190
MD-3736	Radiator Cap	1	¾	1.50	195
MD-3737	Radiator Filler Neck Gasket	1	100 pcs. 1	.10	195
MD-3745	Radiator Cap Gasket	1	20 pcs. 1	.25	195
MD-3746	Radiator Cap Bail	1	30 pcs. 1	.15	195
MD-3749	Hose Clamp	4	5 pcs. 1	.10	190
MD-3750	Cap Screw 5/16-24x1½	67	16 pcs. 1	.05	195
MD-3753A	Engine Number Plate	1	16 pcs. 1	.55	152
MD-3754	Escutcheon Pin No. 12	10	120 pcs. 1	.01	152
MD-3756	Radiator Cap Hinge Pin	1	30 pcs. 1	.15	195
MD-3766	Street Ell (⅜")	1	5 pcs. 1	.15	173
MD-3767	Tee (⅜) Mall.	1	12 pcs. 1	.25	169
MD-3768	Pipe Nipple (⅜ x 1½)	3	6 pcs. 1	.10	209
MD-3769	Inverted Flared Tube Tee	1	12 pcs. 1	.50	168
MD-3785	Throttle Bell Crank	1	½	2.50	152
MD-3789	Connecting Rod Bolt	12	¾	1.55	150
MD-3797	Throttle Pull Rod	1	8 pcs. 1	.20	152
MD-3802	Engine Name Plate	1	6 pcs. 1	.90	184
MD-3803	Oil Cup	1	30 pcs. 1	.15	152
MD-3804	Comp. Release Spring Stud	1	18 pcs. 1	.15	170
MD-3805	Plug	1	5 pcs. 1	.50	170
MD-3810	Injector Bushing Collar	6	20 pcs. 1	.25	158
MD-3821	Piston Pin Bushing Dowel	12	1	.15	150
MD-3822	Radiator Filler Assembly	1	2¾	3.05	......
MD-3824	Injector Roller Assembly	2	½	2.55	186
MD-3842	Stud	2	14 pcs. 1	.15	163
MD-3853	Battery Clamp Hook	4	3 pcs. 1	.50	211
MD-3854	Battery Clamp Stud	4	3 pcs. 1	1.50	211
MD-3855	Adjustable Yoke End (½)	4	10 pcs. 1	.30	211
MD-3856	Adjustable Yoke Pin (½)	4	16 pcs. 1	.05	211
MD-3870	Flat Head Screw (½-13x1)	6	16 pcs. 1	.10	211
MD-3934	Con. Lever Spring Stud	1	½	.50	158
MD-3945	Injector Plunger (.400 dia.)	6¶	3 pcs. 1	.....	......
MD-3957	Pipe Elbow (¾)	2	¼	.15	166
MD-3958	Pipe Nipple ¾ x 2	4	5 pcs. 1	.10	166
MD-3960	Pipe Tee (¾ x ¼ x ¾)	1	4 pcs. 1	.35	166
MD-3961	Groove Pin	1	150 pcs. 1	.05	177
MD-3984	Pipe Plug (1½ Countersunk Head)	1	½	.15	163
MD-3987	Flexible Hose	2	8 pcs. 1	2.00	166
MD-3993	Check Valve (¼)	1	¼	4.00	163
MD-3996	Tubing Clip Support Spacer	1	25 pcs. 1	.10	167
MD-4001	Injector Bearing Roller Washer	12¶¶	39 pcs. 1	.....	......
MD-4002	Injector Tappet Roller	6¶¶	½	.....	......

¶Cannot be serviced in field, return complete unit for overhaul

¶¶Order MD-3824 Assembly—Price Each $2.55

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.		Price Each	Page
MD-4061	Pipe Nipple (¾x3)	2			.10	166
MD-4063	Connecting Rod	6¶¶¶		12	.....	150
MD-4064	Connecting Rod Cap	6¶¶¶		4	.....	150
MD-4065	Connecting Rod Bearing Shell	12		½	4.70	150
MD-4087	Stud (¼x1⅛)	3	200 pcs.	1	.10	167
MD-4113	Fuel Pressure Gauge (30 lb.)	1	3 pcs.	1	1.45	163
MD-4115	Connecting Rod & Cap Assembly	6		18	47.00	150
MD-4131	Crankshaft Slinger	1		2¾	3.25	170
MD-4162	Injector Key	6†	100 pcs.	1	.20	......
MD-4185	Cap Screw (½-13x2¼)	6	3 pcs.	1	.10	161
MD-4194	Valve Adjusting Screw	24	13 pcs.	1	.30	148
MD-4196	Jam Nut (⅜-24)	1	100 pcs.	1	.03	179
MD-4198	Injector Spring Cover	6		1¾	3.00	186
MD-4199	Inlet Manifold	1		81	55.00	184
MD-4201	Air Cleaner Support Bracket	1		14	21.00	184
MD-4204	Blower Air Connection	1		2¼	2.20	184
MD-4205	Inlet Manifold Cover	1		1¾	3.30	184
MD-4206	Air Connection Gasket	4	60 pcs.	1	.15	184
MD-4210	Blower Discharge Hose	1		½	.70	184
MD-4218	Cap Screw (¾-16x3)	2		¾	.20	211
MD-4220	Air Cleaner Support Gasket	1	50 pcs.	1	.15	146
MD-4230	Hose Clamp	6		¾	1.40	184
MD-4237	Generator Gear Shifter Handle	1		¼	1.15	177
MD-4243	Governor Housing	1		14½	37.50	178
MD-4251	Generator Motoring Switch	2	30 pcs.	1	.35	154
MD-4253	Fillister Head Screw	2	100 pcs.	1	.01	154
MD-4279	Fuel Pressure Valve	1	8 pcs.	1	.55	163
MD-4280	Fuel Pressure Valve Spring	1	20 pcs.	1	.20	163
MD-4310	Piston	6		17¾	20.00	194
MD-4314	Piston Cooling Nozzle	6	16 pcs.	1	.95	150
MD-4321	Voltage Regulator	1		1¼	4.95	154
MD-4334	Cap Screw (⅜-24x2)	2	11 pcs.	1	.06	195
MD-4335	Battery Conn. Cable	1	3 pcs.	1	1.50	201
MD-4336	Starting Motor Terminal	2	16 pcs.	1	.15	201
MD-4363	Cap Screw (5/16-24x1)	1	32 pcs.	1	.10	166
MD-4366	Short Nipple (½)	4	14 pcs.	1	.10	209
MD-4376	Street Elbow	2		¼	.15	209
MD-4407	Fan Guard Brace	1	5 pcs.	1	.45	195
MD-4410	Wire Terminal	1	200 pcs.	1	.05	......
MD-4411	Wire Terminal (3/16 Hole)	6	100 pcs.	1	.05	201
MD-4412	Wire Terminal (Delco Remy)	2	100 pcs.	1	.25	201
MD-4419	Rubber Insulator	4	250 pcs.	1	.01	201
MD-4419A	Rubber Insulator	12	16 pcs.	1	.15	201
MD-4451	Thermometer	2		½	2.50	166
MD-4456	Camshaft (Inlet) Use 4456A	1		40	93.00	149
MD-4457	Camshaft (Exhaust) Use 4457A	1		40	93.00	149
MD-4489	Piston Ring—Compression	24	8 pcs.	1	.30	194
MD-4490	Piston Ring—Oil Regulat.	12	5 pcs.	1	.40	194
MD-4506A	45° Alemite Grease Fit.	1	16 pcs.	1	.35	198
MD-4510A	Crankcase Breather Tube	1		½	.08	156
MD-4511	Battery *(See Note Below)*	2		117		201
MD-4518	Cross Bar Adjustment Block	1			.80	148
MD-4613	Generator Coupling Flange	1		1	4.50	174
MD-4614	Generator Drive Coupling Disc	1	8 pcs.	1	1.10	177
MD-4615	Washer	6	150 pcs.	1	.02	177
MD-4616	Cap Screw (5/16-24x1⅛)	6	30 pcs.	1	.05	177
MD-4635	Castellated Nut (5/16-24)	6	80 pcs.	1	.02	177
MD-4636A	Control Pawl	1	8 pcs.	1	1.00	152
MD-4662	Filter Housing	1		56½	35.00	163
MD-4666	Fuel Filter Cartridge	1		4	8.85	163
MD-4667	Lube Oil Filter Element	2		2½	8.40	163
MD-4676	Lube Oil Filter Cov.	1		6½	5.00	163
MD-4678	Oil Filter Element Guide	2	7 pcs.	1	.85	163
MD-4679	Filter Support Guide	6	10 pcs.	1	.20	165

Note—Use 12 Volt Heavy Duty Battery—Willard RHD6-19 or equivalent

¶¶¶Order MD-4115 Assembly—Price Each $47.00

†No service in field

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.	Price Each	Page
MD-4680	Filter Support Angle	2	1½	.80	165
MD-4681	Fuel Pressure Valve Body	1	2	7.50	163
MD-4683	Fuel Pressure Valve Stop	1	2	.95	163
MD-4684	Fuel Pressure Valve Plug	1	8 pcs. 1	.55	163
MD-4685	Fuel Pressure Valve Gasket	1	250 pcs. 1	.05	163
MD-4686	Lub. Oil Cover Gasket	1	30 pcs. 1	.30	163
MD-4687	Fuel Filter Cover Gasket	1	50 pcs. 1	.20	163
MD-4717A	Fuel Supply Tube	2‡	¼	.60	197
MD-4840	Pipe Elbow ¾ x 45°	2	¼	.25	166
MD-4844	Tube Clip (5/16 Tube)	1	30 pcs. 1	.25	166
MD-4853	Crankshaft	1	369	481.00	157
MD-4886	Starting Motor Switch Support	1	2	10.00	196
MD-4889B	Starting Lever	1	2	10.00	196
MD-4897	Close Nipple (1" x 1½")	2	8 pcs. 1	.10	166
MD-4920	Injector Holder Box	1	10¼	1.75	......
MD-4940	Crankshaft Nut	1	½	1.25	157
MD-4943	Crankshaft Nut Lock Washer	1	16 pcs. 1	.35	157
MD-5008	Water Pump Spacer Gasket	1	50 pcs. 1	.20	200
MD-5020	Fuel Supply Receptacle Gasket	6	500 pcs. 1	.05	197
MD-5025	Pipe, Tee	1	6 pcs. 1	.10	201
MD-5026	Pipe Nipple	2	5 pcs. 1	.10	201
MD-5047	Oil Pump Body	1	12½	25.00	192
MD-5048	Oil Pump Cover	1	6	10.00	192
MD-5049	Oil Pump Cover Gasket	2	200 pcs. 1	.30	192
MD-5050	Oil Pump Cover Dowel	2	8 pcs. 1	.35	192
MD-5051	Oil Pump Shaft	1	4	10.00	192
MD-5053	Oil Pump Key	2	50 pcs. 1	.05	192
MD-5054	Oil Pump Sheave Spacer	1	8 pcs. 1	.70	192
MD-5055	Oil Pump Ball Bearing	1	¾	6.00	192
MD-5056	Oil Pump Bushing	1	3 pcs. 1	.85	192
MD-5057	Oil Pump Drive Gear	1	1½	12.00	192
MD-5058	Oil Pump Idler Gear	1	1½	11.35	192
MD-5059	Oil Pump Idler Shaft	1	¾	1.50	192
MD-5060	Oil Pump Roller	38	125 pcs. 1	.06	192
MD-5074	Flywheel Housing	1	130	150.00	170
MD-5075	Water Inlet Pipe	1	26	25.00	175
MD-5076	Generator Drive Cap	1	2¼	4.55	175
MD-5077	Oil Pump Support Cap	1	1¾	4.05	175
MD-5080	Fuel Supply Pump	1	5	15.00	173
MD-5082	Oil Inlet	1	2¾	2.15	193
MD-5083	Short Nipple (1" Extra Short)	1	3 pcs. 1	.15	193
MD-5084	Cap Screw (⅜-16x2¾)	2	10 pcs. 1	.05	178
MD-5085	Generator Motor. Switch Handle	1	22 pcs. 1	.65	154
MD-5087	Generator Bracket	1	20½	14.30	174
MD-5090	Generator Shim	8–15	16 pcs. 1	.15	174
MD-5095	Flywheel Housing Gasket	1	8 pcs. 1	1.40	170
MD-5105	⅞-9x4 Hd. Oval Pt. Set Screw	1	¾	.45	198
MD-5106	Puller Strap	1	3 pcs. 1	4.50	198
MD-5110	Crankcase	1	905	525.00	155
MD-5111	Main Bearing Cap—Front	1‡‡	17	17.40	155
MD-5115	Cap Screw (½-13x2¾)	14	6 pcs. 1	.10	157
MD-5117	Front Trunnion	1	24½	15.00	161
MD-5118	Front Engine Support	1	23	15.00	161
MD-5119	Front Engine Support Gasket	1	125 pcs. 1	.30	161
MD-5120	Front Engine Seal (Leather)	1	3 pcs. 1	3.40	161
MD-5133	Conduit Clip—Side	2	40 pcs. 1	.15	202
MD-5138A	Cylinder Head to Gen. Dr. Tube	1	3 pcs. 1	.60	166
MD-5139	Flexible Hose	1	8 pcs. 1	2.70	166
MD-5161	Pipe Nipple (¾ x 3½ Long)	1	4 pcs. 1	.10	166
MD-5175	4x3-45° Reduced Double Y	1	44½	14.50	207
MD-5179	Interlocked Ex. Hose	2	10¼	20.25	207
MD-5182	Cap Screw (⅛x3 long)	4	¾	.35	211

‡Order MD-4717 Assembly—Price Each $0.60

‡‡Semi-finished only. Must be line bored after assembly to crankcase.

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.		Price Each	Page
MD-5184	Water Inlet Pipe & Cap Assembly	1		49	35.00	......
MD-5208	Oil Relief Valve Spring	2	8 pcs.	1	.60	191
MD-5277	Reducing Tee	1		½	.30	166
MD-5292	Governor Spring	1	8 pcs.	1	.60	180
MD-5297	Oil Pump Slinger	1	8 pcs.	1	.95	192
MD-5299	Oil Cooler Ret. Cover Gasket	1	500 pcs.	1	.05	190
MD-5304	1" Short Nipple	1		¼	.10	166
MD-5307	Oil Cooler In. Cover Gasket	1	80 pcs.	1	.15	190
MD-5308	Oil Cooler Ret. Cover Gasket	1	100 pcs.	1	.10	190
MD-5309	Oil Cooler Inlet Cover	1		10¼	7.50	190
MD-5310	Oil Cooler Ret. Cover	1		4	4.50	190
MD-5327	Reducing Tee (1" x 1" x ¾")	1	3 pcs.	1	.35	166
MD-5329	Pipe Tee (¾")	1	3 pcs.	1	.20	166
MD-5331	Oil Relief Valve Body	1		3¾	13.25	191
MD-5332	Relief Valve Body Cap	1		½	2.35	191
MD-5333	Relief Valve Body Gasket	1	32 pcs.	1	.20	191
MD-5334	Oil Relief Valve	1	8 pcs.	1	4.00	191
MD-5335	Valve Adjusting Screw	1	5 pcs.	1	1.25	191
MD-5336	Relief Valve Spring Guide	1	8 pcs.	1	.50	191
MD-5350	Pipe Nipple	1		2	.55	201
MD-5351	Pipe Nipple	1		½	.15	201
MD-5354	Cable	1	8 pcs.	1	4.00	201
MD-5433	Oil Pump Drain Tube Assembly....	1		¼	.40	166
MD-5501	Fuel Pump to Fuel Press. Valve Tube	1	3 pcs.	1	.60	167
MD-5582	Washer—Gen. Drive Cage Seal	1	500 pcs.	1	.10	174
MD-5593	Battery Cable	1		2½	4.15	201
MD-5713	Pipe Nipple	1		1¼	.35	166
MD-5723	Throttle Ret. Spring	1	6 pcs.	1	.30	152
MD-5748	Injector Cyl. Sleeve	6†	30 pcs.	1		......
MD-5787	90° Reducing Elbow (1¼" x 1")	1			.75	166
MD-5788	Hose Nipple (1¼" x 3¼" Long)	2		½	.75	166
MD-5790	Hose Connection (1½" I.D. x 2⅛" O.D. x 7" Long)	1		2	1.90	166
MD-5791	Hose Connection (1½" I.D. x 2⅛" O.D. x 4¼" Long)	1		1	1.15	166
MD-5792	Hose Clamp (For 1½" I.D. x 2⅛" O.D. Hose)	4	20 pcs.	1	.30	166
MD-5793	Pipe Elbow (1¼" x 45°)	1		½	.45	166
MD-5794	Pipe Bushing (1¼" x 1")	1		¼	.10	166
MD-5795	Hose Connection Filler (1½" O.D. x 1¼" Long)—Steel Tubing	1	12 pcs.	1	.15	166
MD-5796A	Flexible Hose	3		1	4.00	166
MD-5797A	Flexible Hose	1		¾	3.40	166
MD-5814	Lube Oil Pipe Clamp	1	10 pcs.	1	.10	166
MD-5818	Oil Slinger Washer	1	50 pcs.	1	.10	177
MD-5820	Fuel Shaft Starting Rod	1	8 pcs.	1	.85	179
MD-5822	Cap Screw (⅜-24x1" long)	1	22 pcs.	1	.10	179
MD-5824	Lube Oil Pipe Bracket	1		¾	.50	166
MD-5828	Flexible Hose Seal	1	250 pcs.	1	.10	166
MD-5885A	Valve Cover	6		1	1.50	199
MD-5934	Cap Screw (⅞-9x2½ long)	2		½	.25	211
MD-5956	Fuel Pump Bracket	1		¼	5.70	173
MD-5957	Fuel Pump Coupling Disc	1	16 pcs.	1	.50	173
MD-5958	Fuel Pump Coupling Flange	1		½	1.60	173
MD-5959	Fuel Pump Dr. Coupling Flange....	1		½	1.80	173
MD-5960	Groove Pin	6	60 pcs.	1	.05	173
MD-5961	Generator Drive Coupling Flange....	1		2½	7.75	177
MD-5963	Woodruff Key No. 6	1	150 pcs.	1	.05	173
MD-5987A	Valve Cover Disc	6	3 pcs.	1	1.00	199
MD-5988A	Valve Cover Disc Collar	6	50 pcs.	1	.15	199
MD-5989A	Cap Screw (⅜-24x1¾ long)	6	16 pcs.	1	.20	199
MD-5998	⅜ Cast Iron Countersunk Pipe Plug	1	20 pcs.	1	.10	149
MD-6020	Cyl. Head to Oil Pressure Gauge	1		½		166

†Cannot be installed in field

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.	Price Each	Page
MD-6019	Gov. Oil Line Tube Assembly	1	5 pcs. 1	.35	167
MD-6021	Cyl. Head to Fuel Sight Glass Tube	1	½	....	167
MD-6022	Tube Sight Glass to Valve	1	½	....	167
MD-6022A	Order 6022	1		.75	168
MD-6055	Front Trunnion Support	1	34	26.40	161
MD-6062	Oil Cooler Inlet Elbow	1	5	5.80	190
MD-6063	Oil Cooler Outlet Elbow	1	6½	5.85	190
MD-6064	Pipe Nipple	1	2¾	....	166
MD-6070	Camshaft Drive Cpl. Upper	1	1¾	19.50	203
MD-6111A	Thomas Flex. Coupling	1	100	....	......
MD-6112A	Flywheel	1	306	....	172
MD-6149	Battery Case	1	45	....	211
MD-6158	Generator Mounting Spacer	14	300 pcs. 1	....	211
MD-6160	Generator Mounting Spacer	2	6 pcs. 1	....	211
MD-6161	Generator Mounting Spacer	2	3	....	211
MD-6383A	Injector Supply Tube	2§	8 pcs. 1	.60	197
MD-6384	Fuel Pump Coupling Cover	1	5 pcs. 1	....	173
MD-6391	Cap Screw (⅜-16x5¾ long)	2	6 pcs. 1	....	173
MD-6394	Fuel Filter Cover	1	7¾	3.55	163
MD-6429	Air Cleaner Support	1	15	....	146
MD-6432	Air Inlet Tube Flange Assembly	1	2	7.00	146
MD-6433	Air Cleaner Gasket—Inner	1	200 pcs. 1	.15	146
MD-6434	Air Cleaner Gasket—Outer	1	60 pcs. 1	.30	146
MD-6466	Flywheel Housing Drain Plug	1	¼	.55	170
MD-6483	Injector Cylinder (.400 Dia.)	6††	¼	....	......
MD-6495	Injector Assembly	1	15	150.00	186
MD-6505	Pipe Nipple (⅜x4 long)	1	7 pcs. 1	....	198
MD-6506	Pipe Cap (⅜)	2	10 pcs. 1	....	198
MD-6511	Injector Tip Wrench	1	½	2.50	198
MD-6512	Pipe Tee	1	6 pcs. 1	....	201
MD-6538	Oil Sump	1	385	150.00	193
MD-6595A	Fan Belt	6	1½	3.30	200
MD-6597	Injector Seal Spring	6	20 pcs. 1	.15	186
MD-6614A	Generator and Coupling Cover	1	3½	2.00	174
MD-6634	Exhaust, Silencer	1	60	120.00	207
MD-6642	Speeder Handle	1	1¾	3.00	198
MD-6643	$\frac{9}{16}$ Socket	1	8 pcs. 1	.90	198
MD-6683	Compression Release Lever Ex.	1	7 pcs. 1	1.00	153
MD-6687A	Crankshaft Sheave	1	23	60.00	157
MD-6688	Water Pump Spacer	1	12¾	9.00	200
MD-6690	Blower Outlet Connection	1	41	15.75	185
MD-6691A	Blower Inlet Bracket	1	33¼	20.00	185
MD-6692A	Blower Adapter Plate	1	18¼	12.00	185
MD-6693	Blower Inlet Elbow—Plain	1	12	3.80	184
MD-6694	Blower Inlet Elbow	1	5½	7.50	184
MD-6695	Blower Sheave	1	9	14.50	205
MD-6697	Crankshaft Sheave Hub	1	12	19.50	157
MD-6700	Bushing for Crankshaft Sh. Bolt	6	16 pcs. 1	1.50	157
MD-6701	Blower	1	122	450.00	205
MD-6704	Crankshaft Sh. Bolt Spc.	1	2¾	8.55	157
MD-6721	Blower Inlet Hose	1	2	2.25	184
MD-6722	Blower Inlet Hose Filler	1	2¼	3.60	184
MD-6723	Blower Outlet Hose	1	1¼	1.65	184
MD-6724	Blower Outlet Hose Filler	1	1½	3.35	184
MD-6726	Blower Outlet Conn. Gasket	2	80 pcs. 1	.25	185
MD-6733	Blower Belt	5	¾	3.30	205
MD-6747	Valve Grinder Tip	1	60 pcs. 1	.10	......
MD-6753	Oil Level Gauge Guide	1	¾	.55	155
MD-6762	Pipe Nipple	1	1	....	166
MD-6782A	Generator Drive Sheave	1	½	15.00	176
MD-6785A	Oil Pump Sheave	1	9½	15.00	192
MD-6790	Blower Belt Guard Bracket	1	16 pcs. 1	.75	195
MD-6791	Cap Screw (¼-28x⅝ long)	3	60 pcs. 1	.05	195
MD-6796	Blower Belt Guard	1	4¼	4.50	195

§Order 6383 Assembly—Price Each $0.60

††**Not serviced in field. Return injector assembly for rebuilding.**

Part Number	Name and Description of Part	Qty.	Approximate Weight, Lbs.	Price Each	Page
MD-6801	Valve Grinder	1	½	1.15	198
MD-6912	Oil Level Gauge Blade	1	8 pcs. 1	....	......
MD-7240	Air Cleaner	1	37	50.65	146
MD-7258	Fuel Pump Inlet Tube Assembly....	1	2	....	208
MD-7259	Fuel Press. Valve Outlet Tube Assy.	1	3	....	......
MD-7260A	Fuel Tank	1	176	....	208
MD-7261	4" Wing Filler Cap	1	4¼	....	208
MD-7262A	1½" Suction Stub & Bushing	1	1¾	....	208
MD-7317A	Fuel Line Hose	1	7	14.50	209
MD-7496	Ratchet Plate Bushing	1	½	1.95	152
MD-7510	Stud (⅞x4 long)	3	½	1.00	185
MD-7513	Stud	1	½	1.00	185
MD-7518	Pipe Union (½)	2	3 pcs. 1	.50	209
MD-7540	Battery Cable (No. 00-84 lg.)	1	3	4.90	201
MD-7554	Side Radiator	2	16	11.25	195
MD-7555	Tank Radiator Bottom	1	32	14.50	195
MD-7560	Water Inlet Pipe Elbow	1	4½	....	190
MD-7561	Radiator Guard	1	26	25.00	210
MD-7562	Radiator Core	1	90	145.00	195
MD-7563	Shroud Fan	1	5	18.75	195
MD-7564	Guard Fan	1	5	12.50	195
MD-7566	Water Inlet Pipe Hose	1	½	.45	190
MD-7567	Radiator Brace	1	1¾	....	195
MD-7568	Radiator Inlet Hose	1	¾	.55	195
MD-7570	Fan	1	23	70.65	162
MD-7575	Radiator Assembly	1	395	265.00	195
MD-7748	Skid	1	1600	....	211
MD-7755	Governor Housing Cover	1	2	5.45	180
MD-7759	Gov. Valve Lever Shaft Assembly	1	½	9.65	180
MD-7761	Gov. Valve Lever Spacer	1	8 pcs. 1	.80	180
MD-7762	Ball Bearing Single Felt Seal	1	32 pcs. 1	2.40	180
MD-7763	Governor Spring Pin Stop	1	32 pcs. 1	3.25	180
MD-7764	Fillister Head Machine Screw	2	300 pcs. 1	.02	180
MD-7765	Lockwasher (No. 6)	2	1000 pcs. 1	.01	180
MD-7766	Gov. Spring Pin Adjust. Screw......	1	20 pcs. 1	1.60	180
MD-7767	Gov. Spring Pin Adjust. Screw......	1	20 pcs. 1	5.55	180
MD-7768	Gov. Con. Lever & Spring Support	1	3 pcs. 1	6.50	180
MD-7769	Gov. Spring Adjust. Stud	1	75 pcs. 1	.75	180
MD-7770	Gov. Spring Adjust. Nut	1	16 pcs. 1	1.05	180
MD-7777	Gov. Valve Lever Support	1	¾	3.55	180
MD-7778	Gov. Valve Lever Support Gasket..	1	400 pcs. 1	.10	180
MD-7779	Cap Screw (¼-20x⅝ long)	3	60 pcs. 1	.03	180
MD-7807	Tie Bolt Nut Washer	16	30 pcs. 1	.02	158
MD-7813	Pre-Cleaner Glass Jar	1	¼	.35	146
MD-7814	Pre-Cleaner Rubber Seal Ring	1	16 pcs. 1	.15	146
MD-7815	Fan Blade—2 laminations	8	1¼	2.00	162
MD-7816	Fan Blade Rivet (½x¾ lg. hd.)....	56	50 pcs. 1	.02	162
MD-7825	Gauge Gland	1	½	8.50	188
MD-7826	Gauge Body	1	7	14.25	188
MD-7827	Gauge Gland Shim	3	50 pcs. 1	.10	188
MD-7832	Reducing Bushing	2	3 pcs. 1	....	......
MD-7834	2" Fill. Pipe	1	4	....	209
MD-7851	Reducing Bushing	1	32 pcs. 1	....	208
MD-7852	Gov. Spring Adj. Screw Pin	1	32 pcs. 1	....	180
MD-7857	Cable	4	½	....	201
MD-7858	Cable	1	2	....	201
MD-7859	Starting Motor Cable	1	2½	....	201
MD-7876	Reducing Bushing (½x¼)	1	10 pcs. 1	....	......
MD-7878	Pipe Nipple	1	¾	....	209
MD-7879	Special Bushing	1	3	....	208
MD-7880	2 Fill. Pipe Strainer	1	3 pcs. 1	....	209
MD-7916	Carriage Bolt (½x2 lg.)	2	6 pcs. 1	....	......
MD-7917	Grommet	1	100 pcs. 1	.10	188
MD-7930	Governor Weight	2	¼	1.35	182
MD-7931	Governor Weight Shaft	2	25 pcs. 1	1.95	182
MD-7932	Governor Weight Needle Bearing....	4	70 pcs. 1	.60	182
MD-7933	Governor Needle Bearing Spacer....	2	40 pcs. 1	.65	182

All prices in this book are subject to change.

Parts Section

for

DELCO REMY

GENERATOR
(1106538)

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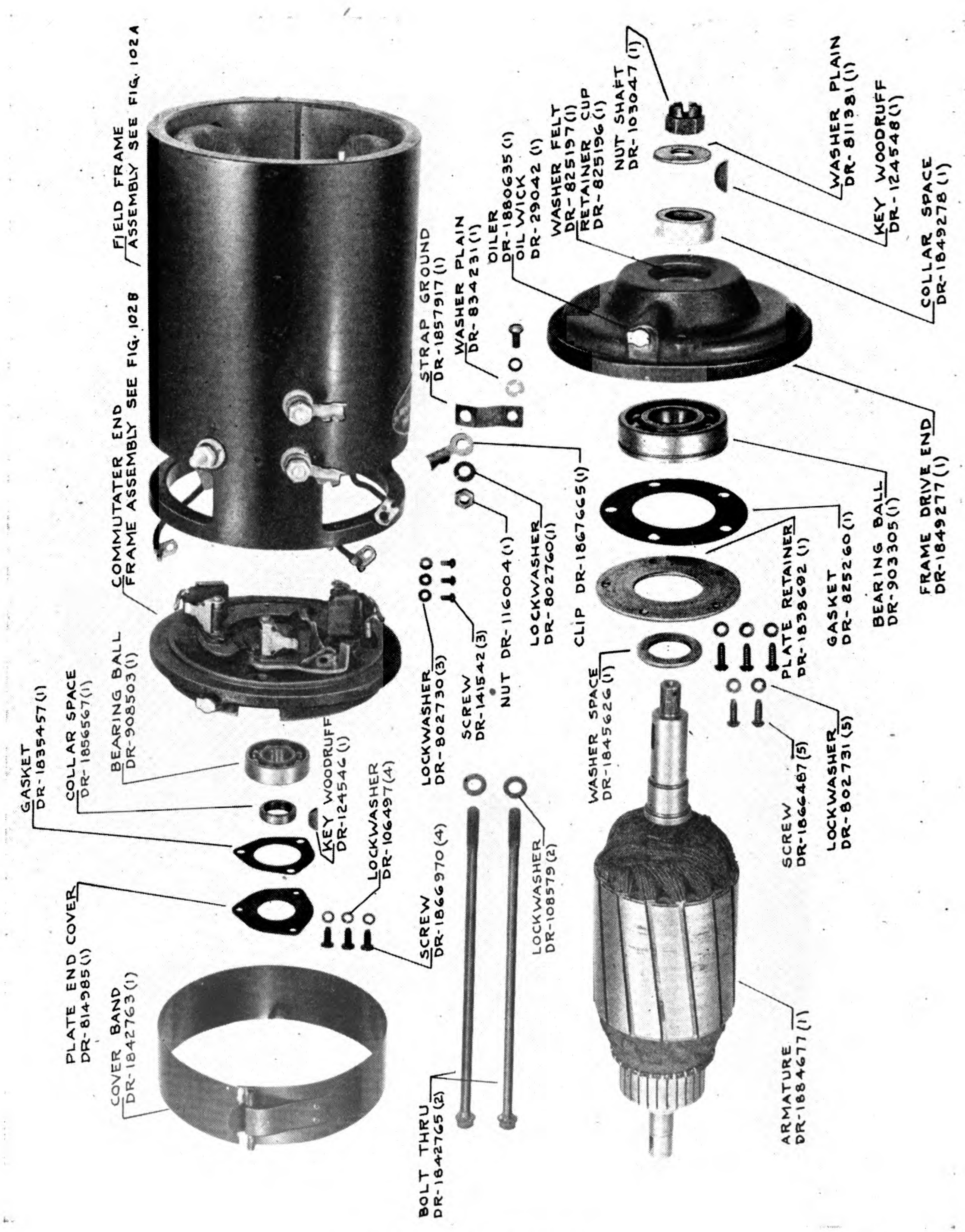
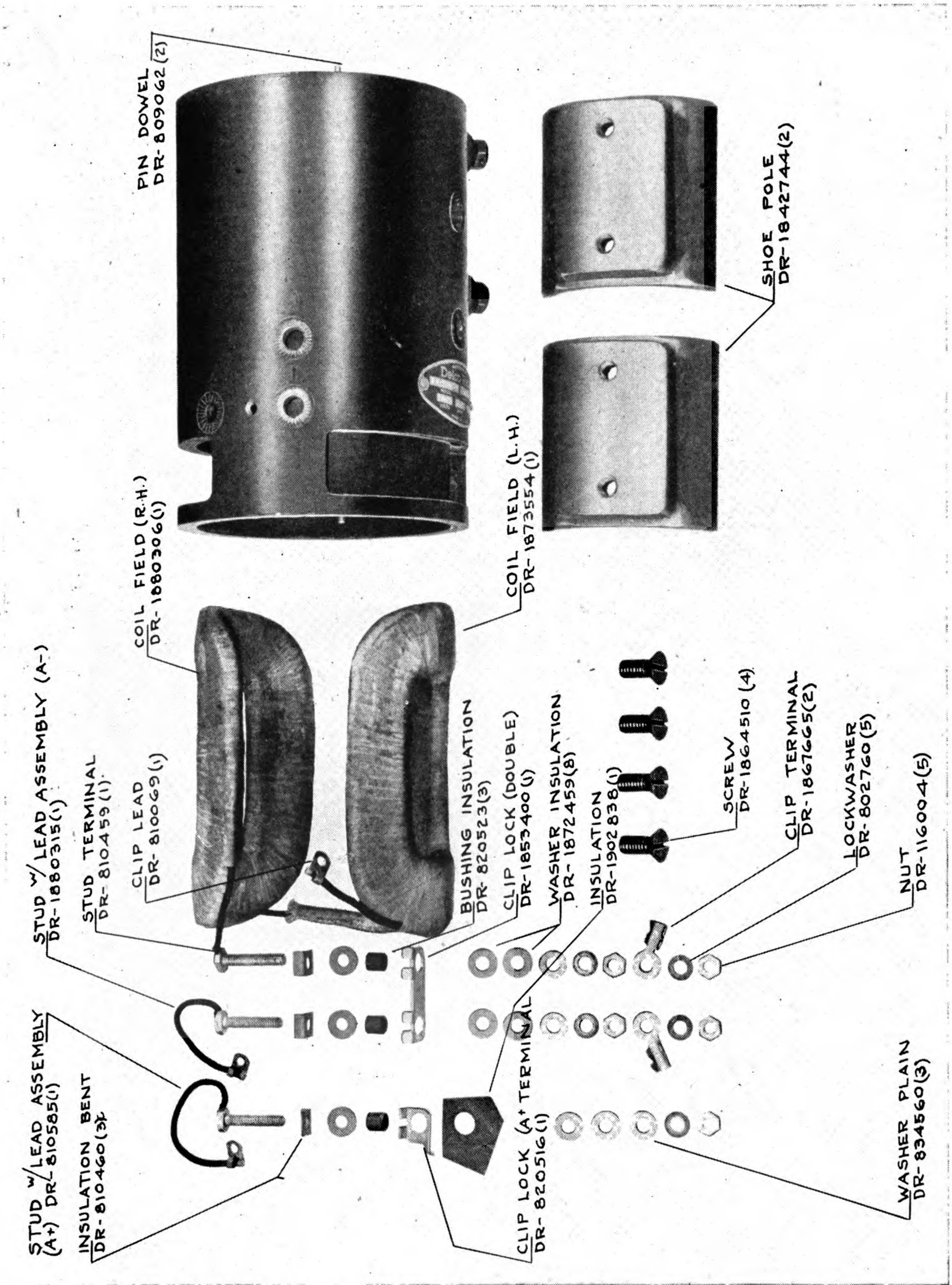
CRANKING MOTOR
(825)

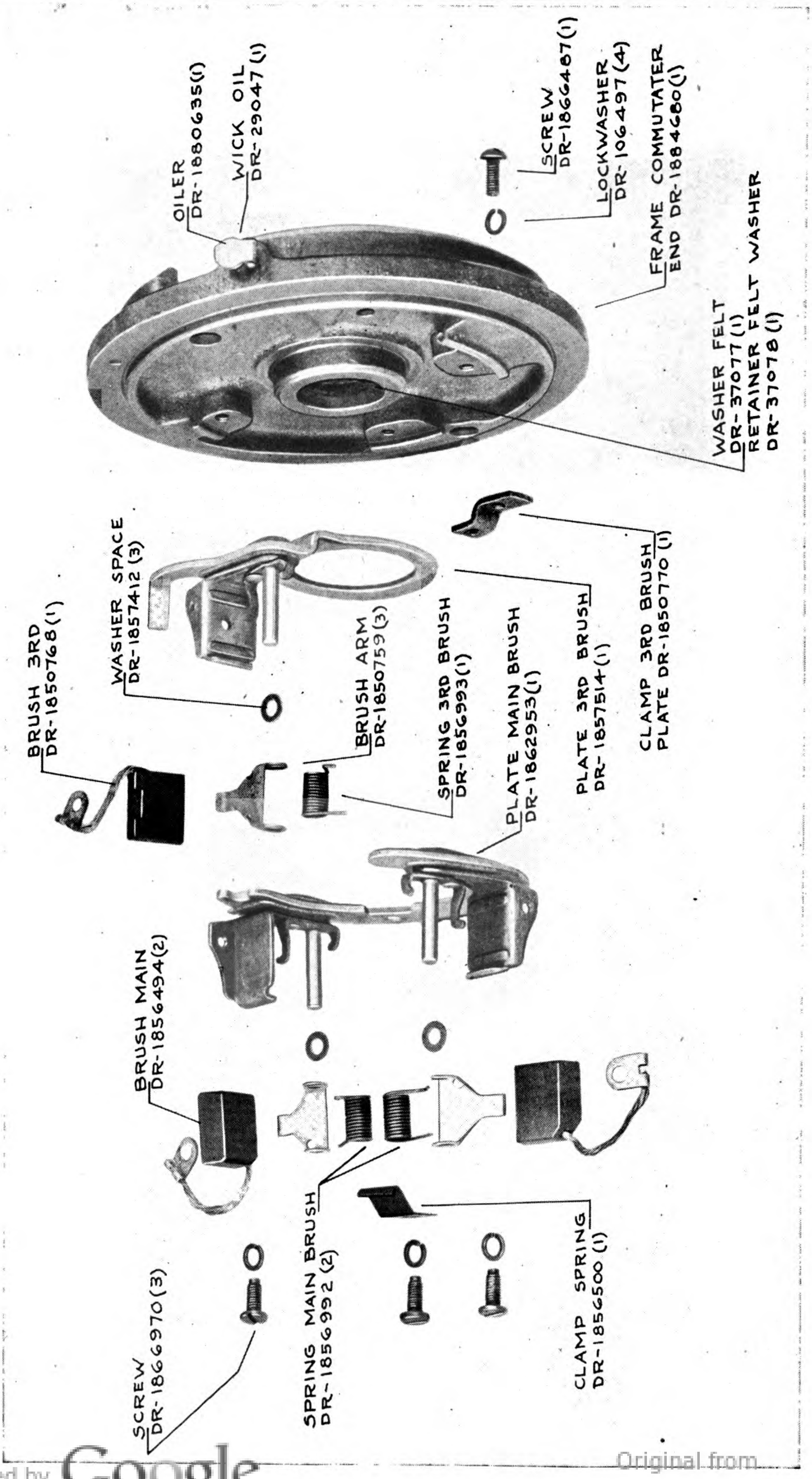
CRANKING SWITCH
(1996453)



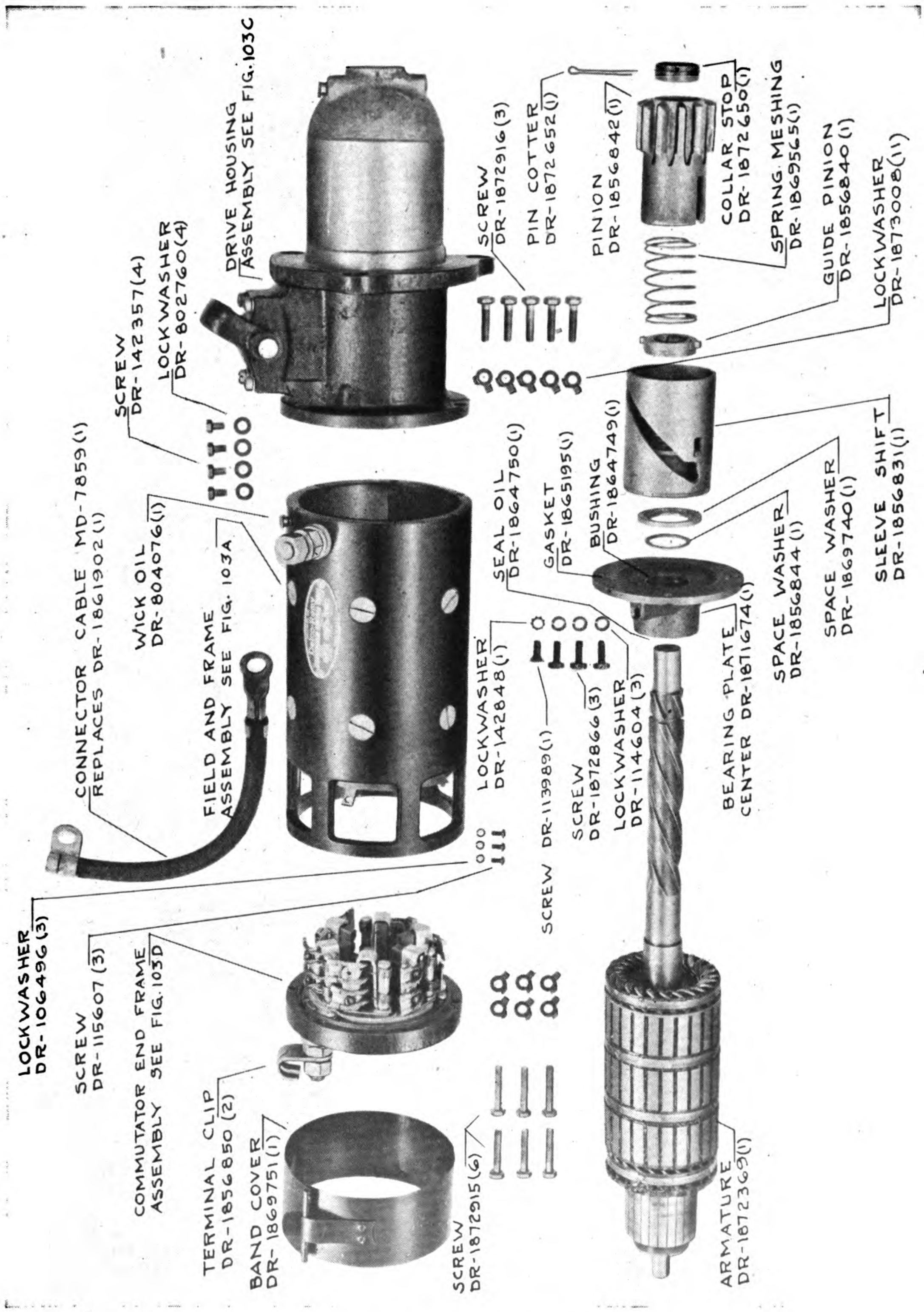
GENERATOR ASSEMBLY
DR-1106538
FIG. 102



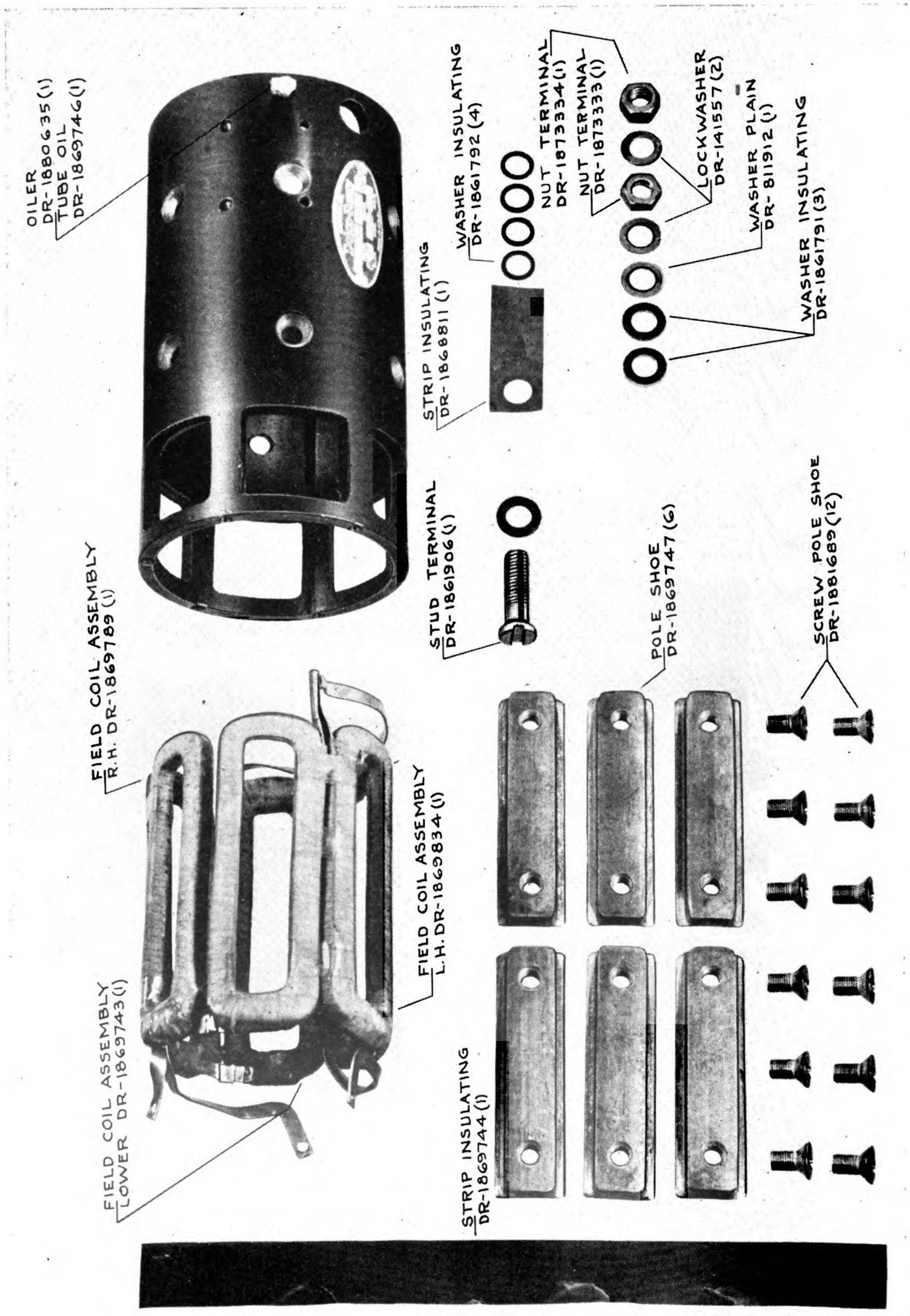
FIELD FRAME ASSEMBLY
FOR DELCO-REMY GENERATOR DR-1106538
FIG. 102A



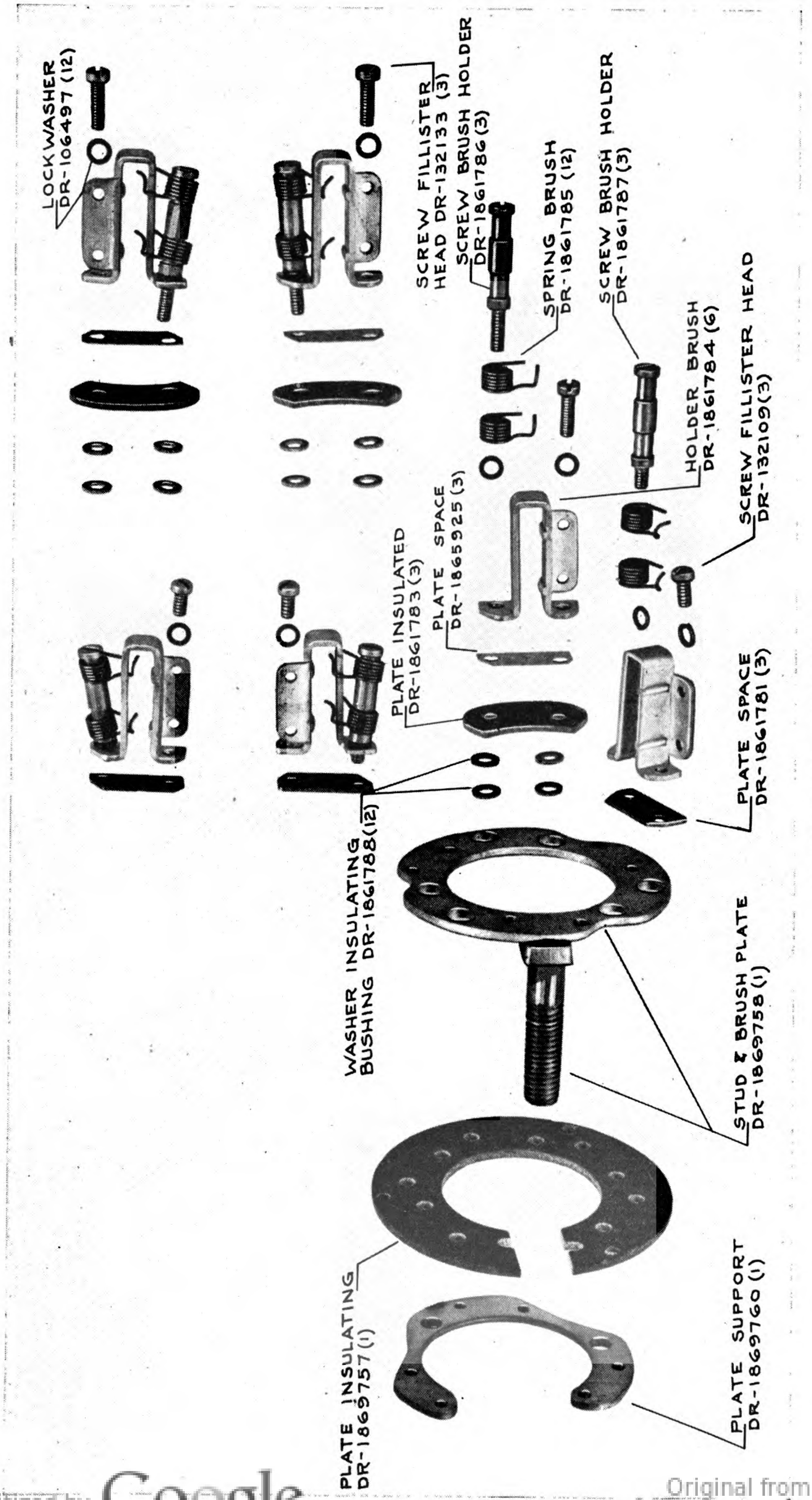
COMMUTATOR END FRAME ASSEMBLY FOR DELCO-REMY GENERATOR DR-1106538
FIG. 102B



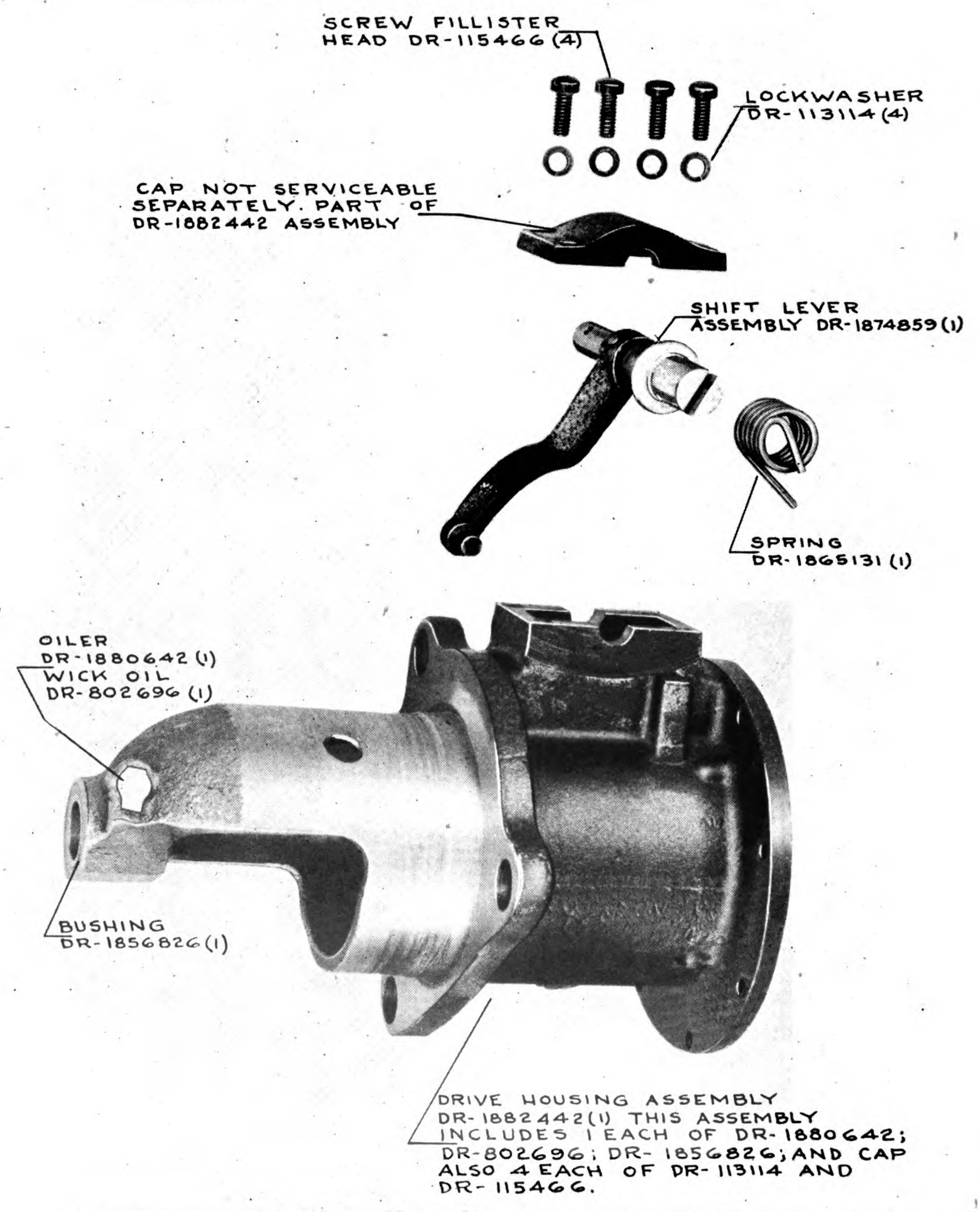
CRANKING MOTOR ASSEMBLY
DR-825
FIG. 103



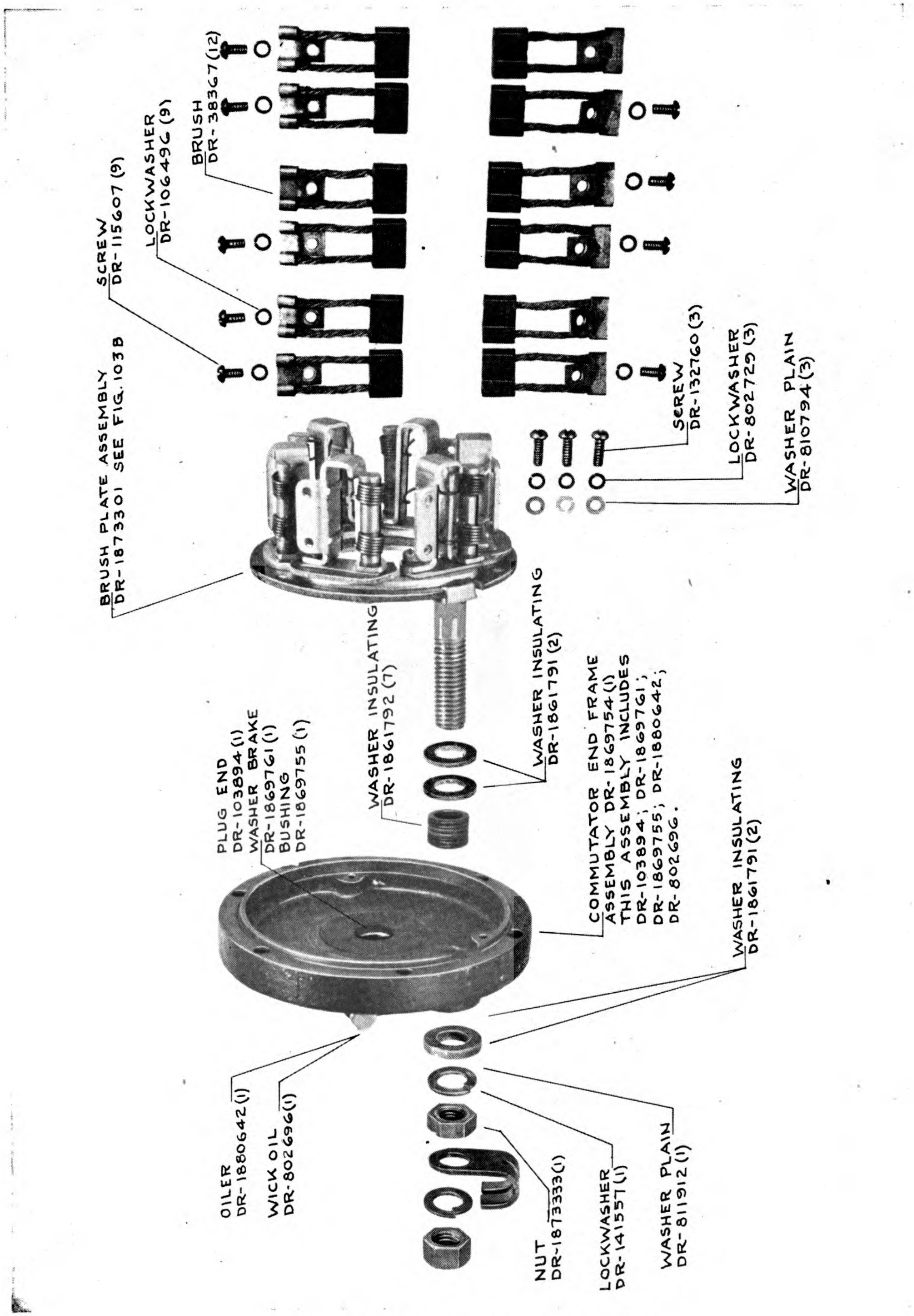
FIELD AND FRAME ASSEMBLY
FOR DELCO-REMY STARTER DR-825
FIG. 103A



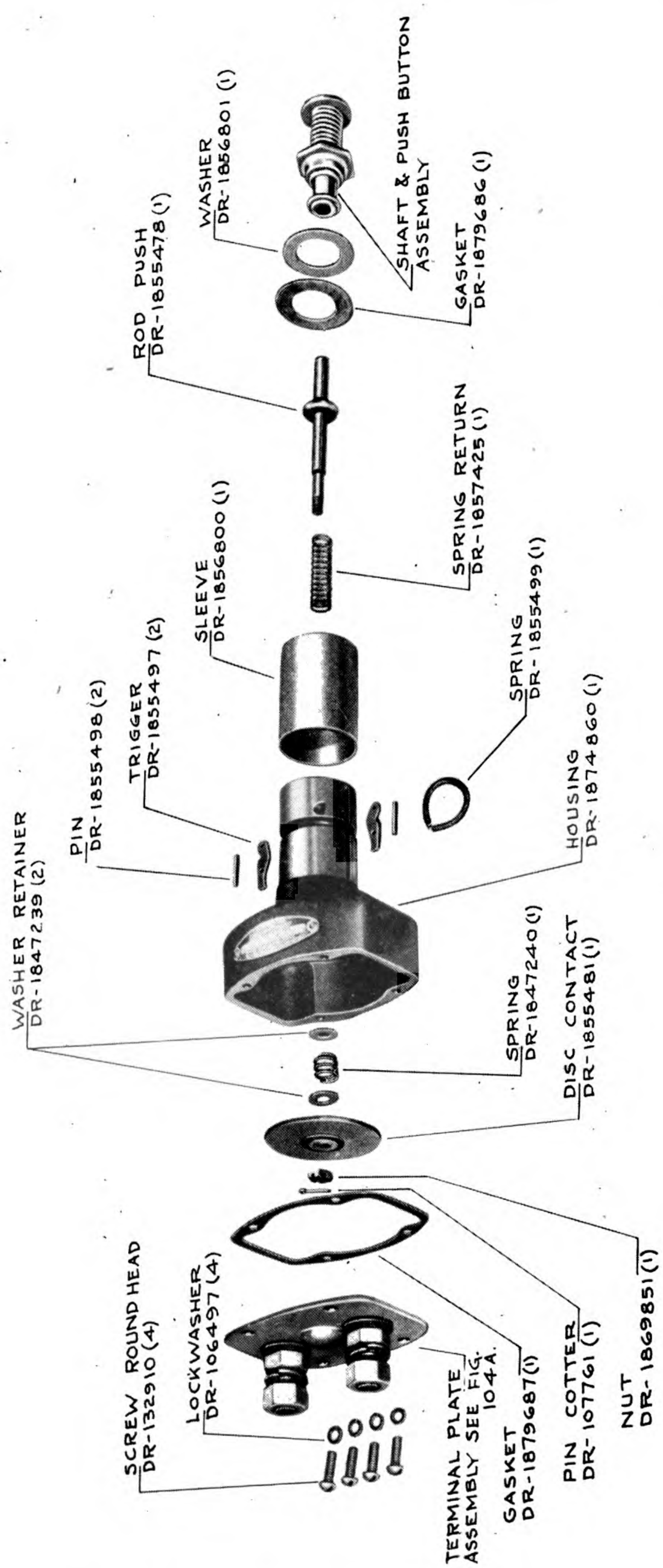
BRUSH PLATE ASSEMBLY
DR-1873301
FOR DELCO-REMY STARTER DR-825
FIG. 103B



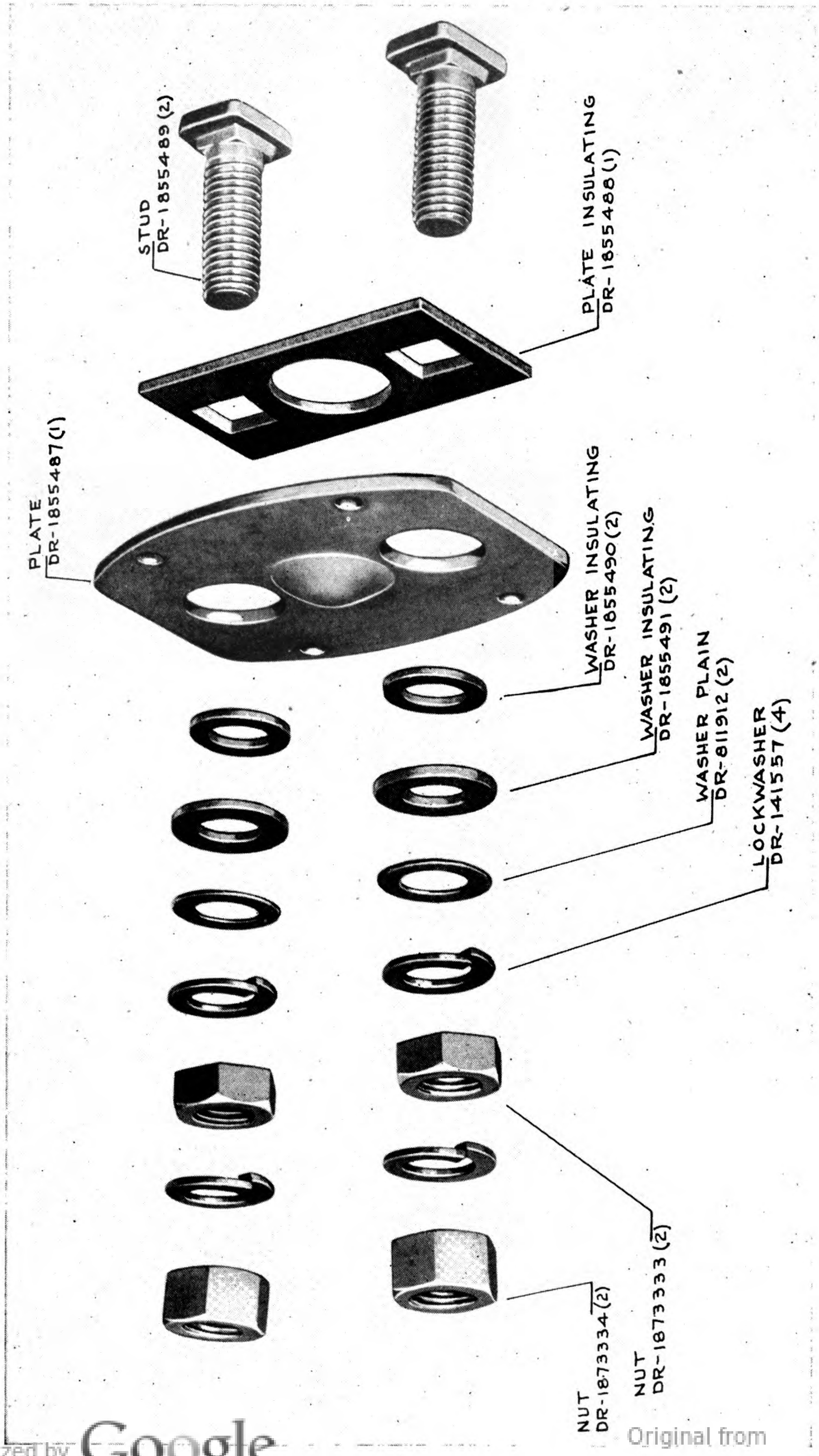
DRIVE HOUSING ASSEMBLY
DR-1882442
FOR DELCO-REMY STARTER DR-825
FIG. 103C



COMMUTATOR END FRAME ASSEMBLY
FOR DELCO-REMY STARTER DR-825
FIG. 103D



STARTING MOTOR SWITCH ASSEMBLY
DR-1996453
FIG. 104



TERMINAL PLATE ASSEMBLY FOR STARTING SWITCH DR-1996453
FIG. 104A

DELCO REMY (1106538) GENERATOR (24 Volt—Insultd.)

Part Number	Name and Description of Part	Qty.	Price	Page
DR-1884677	Armature	1	$30.00	232
DR-1842744	Pole Shoe	2	1.50	233
DR-1883864	Pole Shoe Screw	4	.05	
DR- 809062	Dowel Pin (C. E. & D. E.)	2	.05	233
DR- 810585	Terminal Stud & Lead Assembly ("A" Pos. Term.)	1	.20	233
DR-1880315	Terminal Stud & Lead Assembly ("A" Neg. Term.)	1	.20	233
DR- 810459	Terminal Stud Only	1	.15	
DR- 820516	Terminal Stud Lock Clip (Single)	1	.05	233
DR-1853400	Terminal Stud Lock Clip (Double)	1	.10	233
DR- 810460	Terminal Stud Insulation (Bent Strip)	3	.05	233
DR- 820523	Terminal Stud Ins. Bushing	3	.10	233
DR-1872459	Terminal Stud Ins. Washer	9	.01	233
DR- 834560	Terminal Stud Plain Washer	3	.05	233
DR- 802760	Terminal Stud Lock Washer	6	.01	232
DR- 134551	Terminal Stud Nut	6	.05	......
DR-1867665	Terminal Clip (On Stud)	3	.01	232
DR- 810069	Terminal Clip (To Brush)	2	.05	233
DR-1880306	Field Coil (R. H.)	1	2.75	233
DR-1873554	Field Coil (L. H.)	1	2.75	233
DR-1884680	Commutator End Frame	1	4.00	234
DR-1880635	Oiler C. E.	1	.05	234
DR- 29047	Oil Wick C. E.	1	.05	234
DR- 37077	Felt Washer C. E.	1	.05	234
DR- 37078	Felt Washer Retainer Cup C. E.	1	.10	234
DR-1862953	Main Brush Plate	1	.70	234
DR-1866970	Main Brush Plate Attaching Screw	3	.01	232
DR- 106497	Main Brush Plate Attaching Lockwasher	3	.01	232
DR-1857514	Third Brush Plate	1	.50	234
DR-1850770	Third Brush Plate Clamp (Upper)	1	.05	234
DR-1866487	Third Brush Plate Clamp Screw (Upper)	1	.05	234
DR- 106497	Third Brush Plate Clamp Lockwasher (Upper)	1	.01	234
DR-1856500	Third Brush Plate Clamp Spring (Lower)	1	.05	234
DR-1856494	Main Brush	2	.40	234
DR-1850768	Third Brush	1	.15	234
DR-1856992	Main Brush Spring	2	.05	234
DR-1856993	Third Brush Spring	1	.05	234
DR-1850759	Brush Arm	3	.05	234
DR-1857412	Brush Arm Space Washer	3	.01	234
DR- 141542	Brush Lead Attaching Screw	3	.02	232
DR- 802730	Brush Lead Attaching Screw Lockwasher	3	.01	232
DR- 908503	Ball Bearing (C. E.)	1	1.95	232
DR- 814985	End Cover Plate C. E.	1	.10	232
DR-1835457	End Cover Plate Gasket C. E.	1	.05	232
DR-1866970	End Cover Plate Screw C. E.	3	.01	232
DR- 106497	End Cover Plate Screw Lockwasher (C. E.)	3	.01	234
DR-1856567	Space Collar (Outside C. E.)	1	.20	232
DR- 124546	Woodruff Key (C. E.)	1	.05	232
DR-1842763	Cover Band	1	.30	232
DR-1849277	Drive End Frame	1	4.00	232
DR-1880635	Oiler (D. E.)	1	.05	232
DR- 29047	Oil Wick D. E.	1	.05	234

DELCO REMY GENERATOR — (Cont'd)

Part Number	Name and Description of Part	Qty.	Price	Page
DR-1849278	Space Collar (Outside—D. E.)	1	1.25	232
DR-1845626	Space Washer (Inside—D. E.)	1	.20	232
DR- 825197	Felt Washer (D. E.)	1	.05	232
DR- 825196	Felt Washer Retainer Cup (D. E.)	1	.15	232
DR- 903305	Ball Bearing D. E.	1	4.10	232
DR-1838692	Ball Bearing Retainer Plate (D. E.)	1	.15	232
DR- 825260	Ball Bearing Retainer Plate Gasket (D. E.)	1	.10	232
DR-1866487	Ball Bearing Retainer Plate Screw (D. E.)	5	.05	232
DR- 802731	Ball Bearing Retainer Plate Lockwasher (D. E.)	5	.01	232
DR- 124548	Woodruff Key D. E.	1	.05	232
DR- 103047	Shaft Nut D. E.	1	.05	232
DR- 811381	Shaft Nut Plain Washer (D. E.)	1	.05	232
DR-1842765	Thru Bolt	2	.15	232
DR- 108579	Thru Bolt Lockwasher	2	.01	232
DR-1857917	Terminal Ground Strip	1	.10	232
DR-1866970	Terminal Ground Strip Screw	1	.01	232
DR- 106497	Terminal Ground Strip Screw Lockwasher	1	.01	232
DR- 834231	Terminal Ground Strip Screw Plain Washer	1	.05	232
DR- 116004	Nut	1	.05	232, 233
DR- 29042	Oil Wick	1	.05	232
DR-1864510	Screw	4	.05	233
DR-1902838	Insulator	1	....	233
DR-1872459	Washer Insulation	8	.01	233
DR- 810459	Stud Terminal	1	.15	233

DELCO REMY (825) CRANKING MOTOR

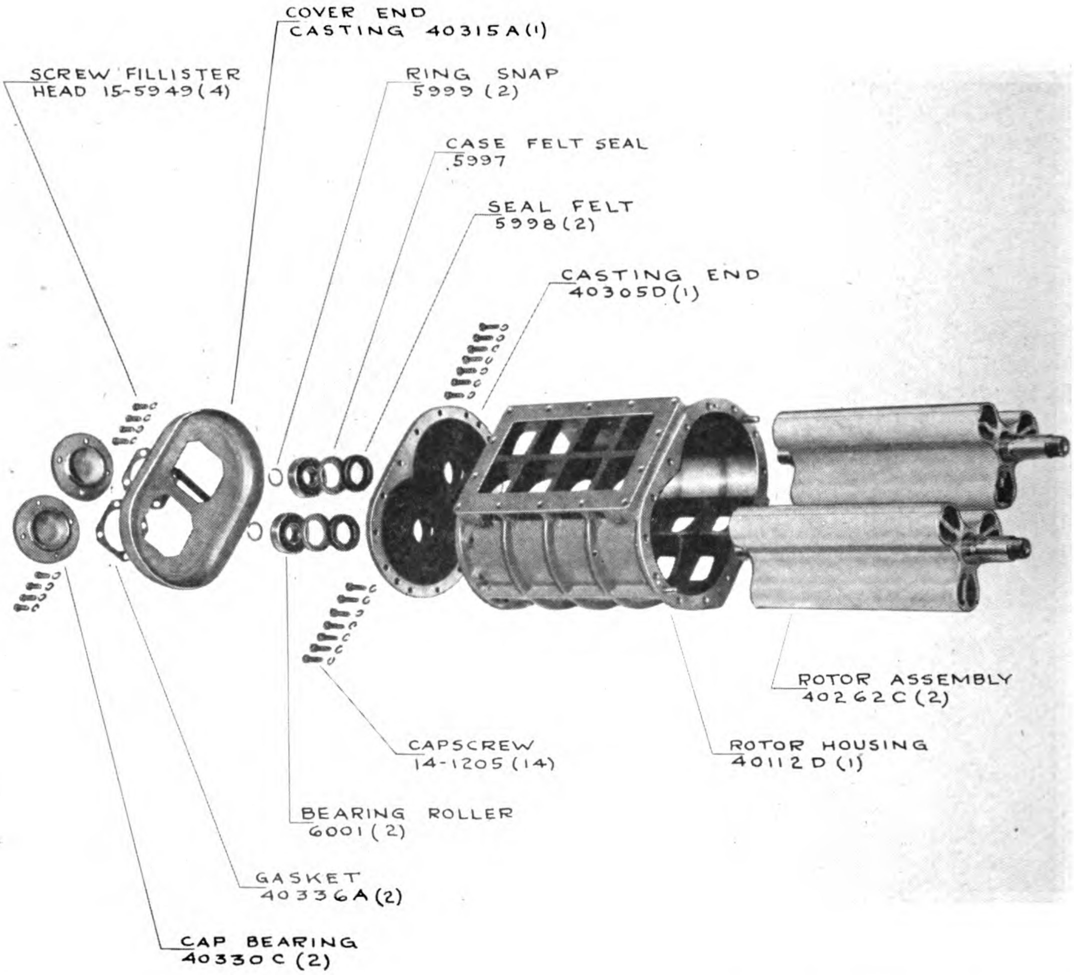
Part Number	Name and Description of Part	Qty.	Price	Page
DR-1872369	Armature	1	$77.00	235
DR-1869761	Brake Shoe Washer	1	.65	239
DR-1869747	Pole Shoe	6	2.00	236
DR-1843646	Pole Shoe Screw	12	.02	
DR-1880635	Oiler (In field frame)	1	.05	236
DR-1869746	Oil Tube (In field frame)	1	.50	236
DR-1861906	Field Terminal Stud	1	.30	236
DR-1861791	Field Terminal Stud Ins. Washer (7/8-O.D.)	2	.05	236
DR-1861792	Field Terminal Stud Ins. Washer (11/16-O.D.)	4	.05	236
DR- 811912	Field Terminal Stud Plain Washer	1	.05	236
DR- 141557	Field Terminal Stud Lockwasher	2	.01	236
DR-1873333	Field Terminal Stud Nut (5/16—thk.)	1	.05	239
DR-1873334	Field Terminal Stud Nut (7/16—thk.)	1	.05	
DR-1869834	Field Coil Assembly (L. H.)	1	1.80	236
DR-1869743	Field Coil Assembly (Lower)	1	1.80	236
DR-1869789	Field Coil Assembly (R. H.)	1	1.80	236
DR-1868811	Field Coil Ins. Strip (D. E.)	1	.05	236
DR-1869744	Field Coil Ins. Strip (C. E.) (Order 32330)	1	.05	236
DR-1869754	Commutator End Frame	1	5.50	239
DR-1869755	Bushing (C. E.)	1	.75	239
DR-1880642	Oiler (C. E.)	1	.05	237
DR- 802696	Oil Wick (C. E.)	1	.10	238
DR-1869761	Brake Washer (C. E.)	1	.05	239
DR- 103894	End Plug (C. E.)	1	.10	239
DR-1872915	C. E. Frame Attaching Screw	6	.10	235
DR-1873008	C. E. Frame Attaching Screw Lockwasher	6	.03	235
DR-1873301	Brush Plate Assembly (Less Brushes)	1	10.00	239
DR-1869758	Brush Plate & Stud	1	2.00	237
DR-1869757	Brush Plate Ins. Plate	1	.75	237
DR- 132760	Brush Plate Ins. Plate Attaching Screw	3	.02	239
DR- 802729	Brush Plate Ins. Plate Attaching Lockwasher	3	.01	239
DR- 810794	Brush Plate Ins. Plate Attaching Screw Pl. Washer	3	.01	239
DR- 38367	Brush	12	.40	239
DR-1861785	Brush Spring	12	.05	237
DR-1861784	Brush Holder	6	.25	237
DR-1861783	Brush Holder Ins. Plate (2 Hole)	3	.10	237
DR-1861781	Brush Holder Space Plate (Ground Brush)	3	.10	237

DELCO REMY (825) CRANKING MOTOR — *(Cont'd)*

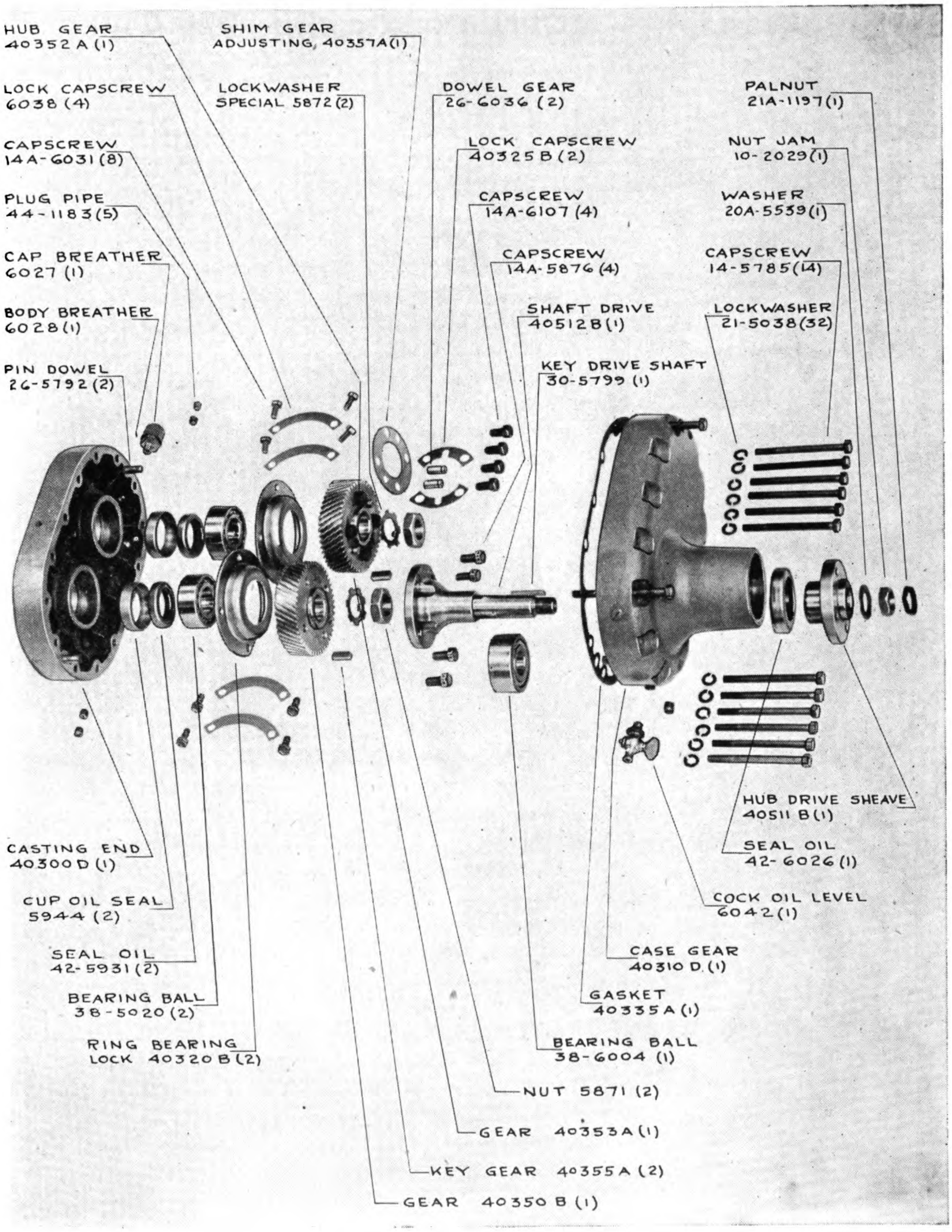
Part Number	Name and Description of Part	Qty.	Price	Page
DR-1865925	Brush Holder Space Plate (Insulated Brush)	3	.20	237
DR-1861786	Brush Holder Screw (Long—Insulated Brush)	3	.15	237
DR- 132123	Brush Holder Screw (Short—Insulated Brush)	3	.02	
DR-1861787	Brush Holder Screw (Long—Grounded Brush)	3	.15	237
DR- 132109	Brush Holder Screw (Short—Grounded Brush)	3	.02	237
DR- 106497	Brush Holder Screw Lockwasher	12	.10	237
DR-1861788	Brush Holder Screw Ins. Bushing Washer	12	.05	237
DR-1869760	Brush Holder Screw Support Plate (Brass)	1	.75	237
DR- 115607	Brush Lead Screw	12	.01	235
DR- 106496	Brush Lead Screw Lockwasher	12	.01	235
DR-1861791	Terminal Stud Ins. Washer (C. E. $\frac{7}{8}$ O. D.)	4	.05	239
DR-1861792	Terminal Stud Ins. Washer (C. E. $\frac{11}{16}$ O. D.)	8	.05	236
DR-1874492	Terminal Stud Plain Washer (C. E.)	1	.05	......
DR- 141557	Terminal Stud Lockwasher (C. E.)	2	.01	239
DR-1873333	Terminal Stud Nut (C. E. $\frac{5}{16}$ thk.)	1	.05	
DR-1873334	Terminal Stud Nut (C. E. $\frac{7}{16}$ thk.)	1	.05	236
DR-1869751	Cover Band	1	.35	235
DR-1882442	Motor Drive Housing	1	24.00	238
DR-1856826	Motor Drive Housing Bushing	1	.50	238
DR- 115466	Motor Drive Housing Cover Screw	4	.03	238
DR- 113114	Motor Drive Housing Cover Screw Lockwasher	4	.05	238
DR- 114998	Oiler (D. E.)	1	.05	
DR- 802696	Oil Wick (D. E.)	1	.10	238
DR-1872916	Motor Drive Housing Attaching Screw	7	.10	235
DR-1873008	Motor Drive Housing Attaching Screw Lockwasher	7	.03	235
DR-1871674	Center Bearing Plate	1	4.00	235
DR-1864749	Center Bearing Bushing	1	.75	235
DR- 804076	Oil Wick (Center Bearing)	1	.05	235
DR-1864750	Oil Seal (In Center Bearing)	1	.85	235
DR-1872866	Center Bearing Screw (Hex. Hd.)	3	.10	235
DR- 113989	Center Bearing Screw (Flat Hd.)	1	.01	235
DR- 114604	Center Bearing Screw Lockwasher	3	.01	235
DR- 142848	Center Bearing Screw Lockwasher (Countersunk)	1	.03	235
DR-1865195	Center Bearing Gasket	1	.25	235
DR-1874859	Shift Lever (Shaft—Lower)	1	6.00	238
DR-1865131	Shift Lever Spring	1	.30	238
DR-1856844	Space Washer (Between Shift Sleeve & Center Brg.)	1	.10	235
DR-1869740	Space Washer (Cupped—Between Shift Sleeve & Center Bearing	1	.20	235
DR-1856831	Shift Sleeve	1	3.00	235
DR-1856842	Motor Drive Pinion	1	6.50	235
DR-1856840	Motor Drive Pinion Guide	1	2.35	235
DR-1869565	Motor Drive Pinion Meshing Spring	1	.10	235
DR-1872650	Motor Drive Pinion Stop Collar	1	.75	235
DR-1872652	Motor Drive Pinion Stop Collar Cotter Pin	1	.05	235
DR-1881689	Screw Pole Shoe (Use DR-828675)	12	.05	236
DR- 132133	Screw Fillister Screw	3	.10	237

DELCO REMY (1996453) CRANKING SWITCH

Part Number	Name and Description of Part	Qty.	Price	Page
DR-1996453	Starting Switch	1	20.00	
DR- 142357	Switch Mounting Screw	4	.02	235
DR- 802760	Switch Mounting Screw Lockwasher	4	.01	235
MD- 7859	Switch Connector Cable	1	....	235
DR-1856850	Terminal Clip (For Battery Cable)	1	.20	235
DR-1874860	Switch Housing	1	8.00	240
DR-1856800	Switch Housing Sleeve	1	.20	240
DR-1856801	Switch Housing Sleeve Retainer Washer	1	.05	240
DR-1855481	Switch Contact Disc.	1	1.25	240
DR-1847240	Switch Contact Disc Cushion Spring	1	.05	240
DR-1847239	Switch Contact Disc Cushion Spring Retainer Washer	2	.05	240
DR-1869851	Switch Contact Disc Attaching Nut	1	.10	240
DR -107761	Switch Contact Disc Attaching Nut Cotter Pin	1	.01	240
DR-1855478	Switch Contact Push Rod	1	1.00	240
DR-1857425	Switch Contact Push Rod Return Spring	1	.10	240
DR-1879682	Push Button & Shaft Assembly	1	2.50	240
DR-1836822	Push Button	1	.65	240
DR-1855496	Push Button Spring	1	.10	240
DR-1884521	Push Button Shaft	1	1.25	240
DR-1855495	Push Button Shaft Nut	1	.25	240
DR-1855497	Push Rod Release Arm	2	.10	240
DR-1855498	Push Rod Release Arm Pin	2	.10	240
DR-1855499	Push Rod Release Arm Spring	2	.15	240
DR-1855486	Terminal Plate Assembly	1	7.00	240
DR-1855487	Terminal Plate Only	1	.25	240
DR-1855489	Terminal Stud	2	2.50	240
DR-1855488	Terminal Stud Ins. Plate (Inside)	1	.20	240
DR-1855490	Terminal Stud Ins. Bushing Washer	2	.05	240
DR-1855491	Terminal Stud Ins. Washer	2	.05	240
DR- 811912	Terminal Stud Plain Washer	2	.05	240
DR- 141557	Terminal Stud Lockwasher	4	.01	240
DR-1873333	Terminal Stud Nut (½-13x$\frac{5}{16}$ thk.)	2	.05	240
DR-1873334	Terminal Stud Nut (½-13x½ thk.)	2	.05	240
DR- 132910	Terminal Plate Attaching Screw	4	.05	240
DR- 106497	Terminal Plate Attaching Screw Lockwasher	4	.01	240
DR-1879686	Gasket	1	.10	240
DR-1879687	Gasket	1	.15	240



BLOWER ASSEMBLY
MC-4012
FIG. 105



BLOWER ASSEMBLY
MC-4012
FIG. 105A

McCULLOCH ENGINEERING CORPORATION
Milwaukee, Wisconsin

PARTS LIST — MODEL B4012 and MODEL C4012

No. Req'd		Part No.	Part Name	Price
1		40112D	Rotor Housing	$185.00
2		40262C	Rotor Assembly	162.50
1		40300D	End Casting (Gear End)	55.00
1		40305D	End Casting (Closed End)	42.50
1		40310D	Gear Case	42.50
1		40315A	End Casting Cover	5.00
2		40320B	Bearing Lock Ring	1.00
2		40330C	Bearing Cap (Closed End)	5.00
1		40335A	Gasket (Gear Case)	.75
2		40336A	Gasket (Bearing Cap)	.13
1		40350B	Gear (Drive) always furnished with:	115.00
1		40351B	Gear Assembly (Driven) always includes:	
	1	40352A	Gear Hub	
	1	40353A	Gear	
	1	40357A	Gear Adjusting Shim	1.00
	2	26-6036	Gear Dowel	
	4	14B-6039	Hex. Hd. Cap Screw 3/8-24x5/8	.13
	2	40325B	Cap Screw Lock	.25
2		40355A	Gear Key	1.15
2		5871	Hex. Nut 1-14 (Special)	.75
2		5872	Lock Washer (Special)	.25
4		6038	Cap Screw Lock	.13
8		14A-6031	Hex. Hd. Cap Screw 5/16-18x5/8	.13
14		14-5785	Hex. Hd. Cap Screw 5/16-18x3 1/2	.13
14		14-1205	Hex. Hd. Cap Screw 5/16-18x1	.13
4		15-5949	Fill. Hd. Cap Screw 5/16-18x3/4	.13
32		21-5038	Lock Washer 5/16"—1/16" thick	.13
6		26-5792	Dowel Pin, 3/8"	.25
5		44-1183	Pipe Plug 1/8 Std. Slotted	.13
2		38-5020	Ball Bearing, Double Row	15.00
2		6001	Roller Bearing	8.75
1		38-6004	Ball Bearing, Double Row	15.25
2		42-5931	Oil Seal 1 3/8 I.D. x 2 7/64 O.D. x 15/32	1.50
1		42-6026	Oil Seal 1 1/2 I.D. x 2 1/4 O.D. x 1/2	1.50
2		5944	Oil Seal Cup	3.15
2		5997	Felt Seal Case	.50
2		5998	Felt Seal	.75
1		40512B	Drive Shaft	22.50
1		30-5799	Drive Shaft Key 3/16x1/4x1 7/16	.50
1		20A-5539	Flat Washer 13/16 I.D. x 1 3/8 O.D. x 1/8	.13
1		10-2029	Jam Nut 3/4-16	.50
1		21A-1197	Palnut 3/4-16	.13
4		14A-5876	Hex. Hd. Cap Screw 3/8-24 x 3/4	.13
2		5999	Snap Ring	.40
1		6027	Breather Cap	2.75
1		6028	Breather Body	2.15
1		6042	Oil Level Cock	1.00
1		40511B	Drive Sheave Hub	15.00

RADIO INTERFERENCE NOISE SUPPRESSION

General Description

The Radio Interference Noise Suppression system used on this generating equipment is made up of a filter and condensers located as shown on illustrations Fig. 106 through 112. The suppression system limits radio noise so that there is no undesirable interference, either radiated or conducted, over a frequency range of 0.5 through 40.0 megacycles.

The suppression system is supplemental to the main generating unit and in no way effects the efficiency of the generator.

Items used in the Suppression system are as follows:

1. Filter—Radio Interference Suppression Unit (25655-S) for the voltage regulator.
2. Condensers (25657, Fig. 110) from the main generator leads to ground.
3. Condensers (25658, Fig. 110) from the exciter leads (in the line unit) to ground.
4. Condensers (25657, Fig. 111) from the collector ring brushes to ground.
5. Condensers (25658, Fig. 112) from the exciter brushes to ground.

Maintenance

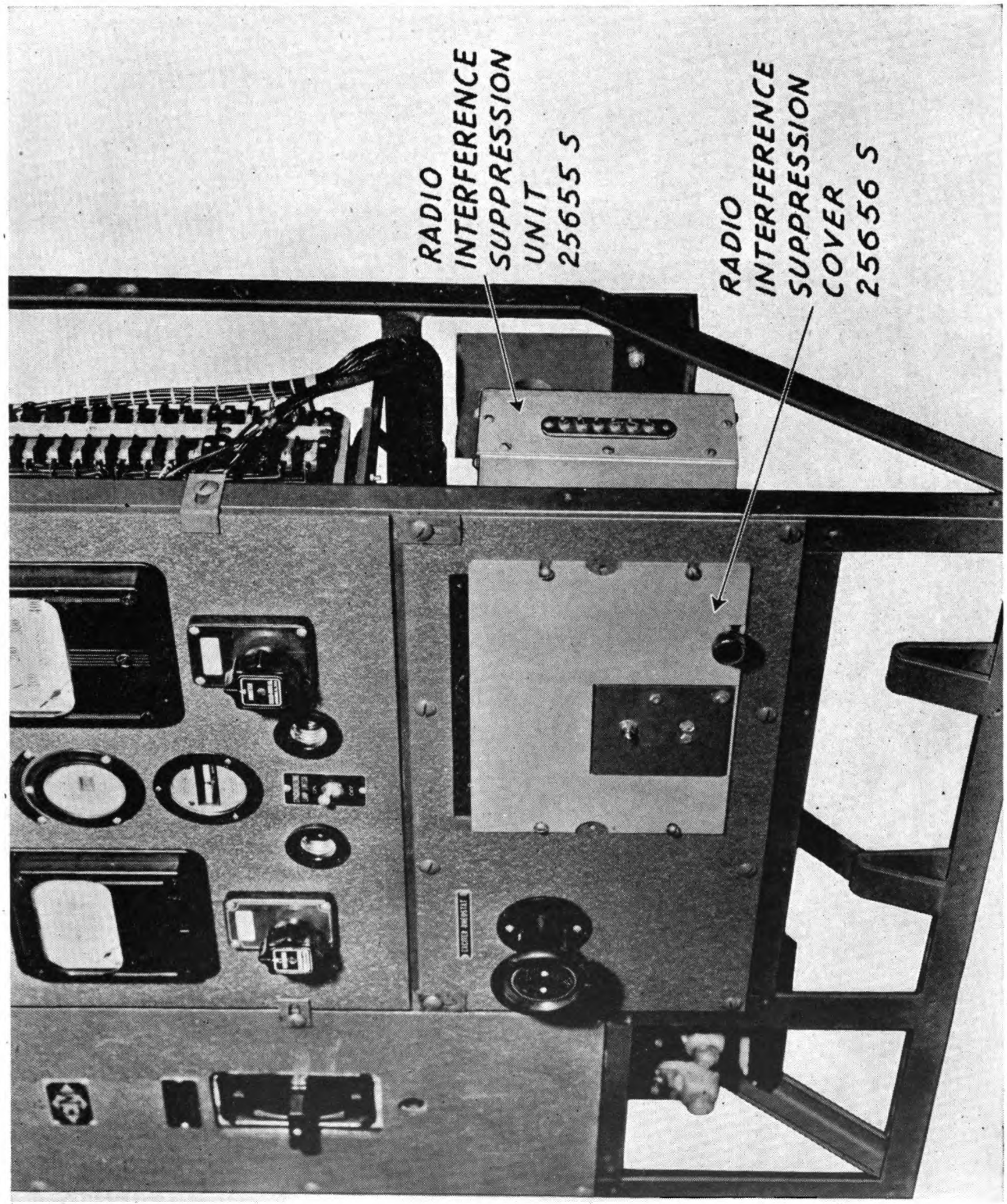
The filter unit attached on back of the voltage regulator is a composite unit made up of condensers and choke coils. The presence of radio interference which can be eliminated by changing the generator over to hand regulation (Regulator off) would indicate trouble in this unit. First check the regulator contacts and replace the spark condensers. If that doesn't help, disconnect the filter unit, remove it and replace it with a new filter unit. Do not attempt to repair the filter unit proper.

The presence of radio interference which cannot be eliminated by putting the generator on hand regulation indicates defective condensers. Make sure all electrical connections are tight and that the collector ring brushes, collector rings, exciter brushes and exciter commutator are in proper condition. If the radio interference continues, start replacing condensers until the interference stops. If the proper testing equipment is available each condenser can be tested directly and the faulty condenser replaced.

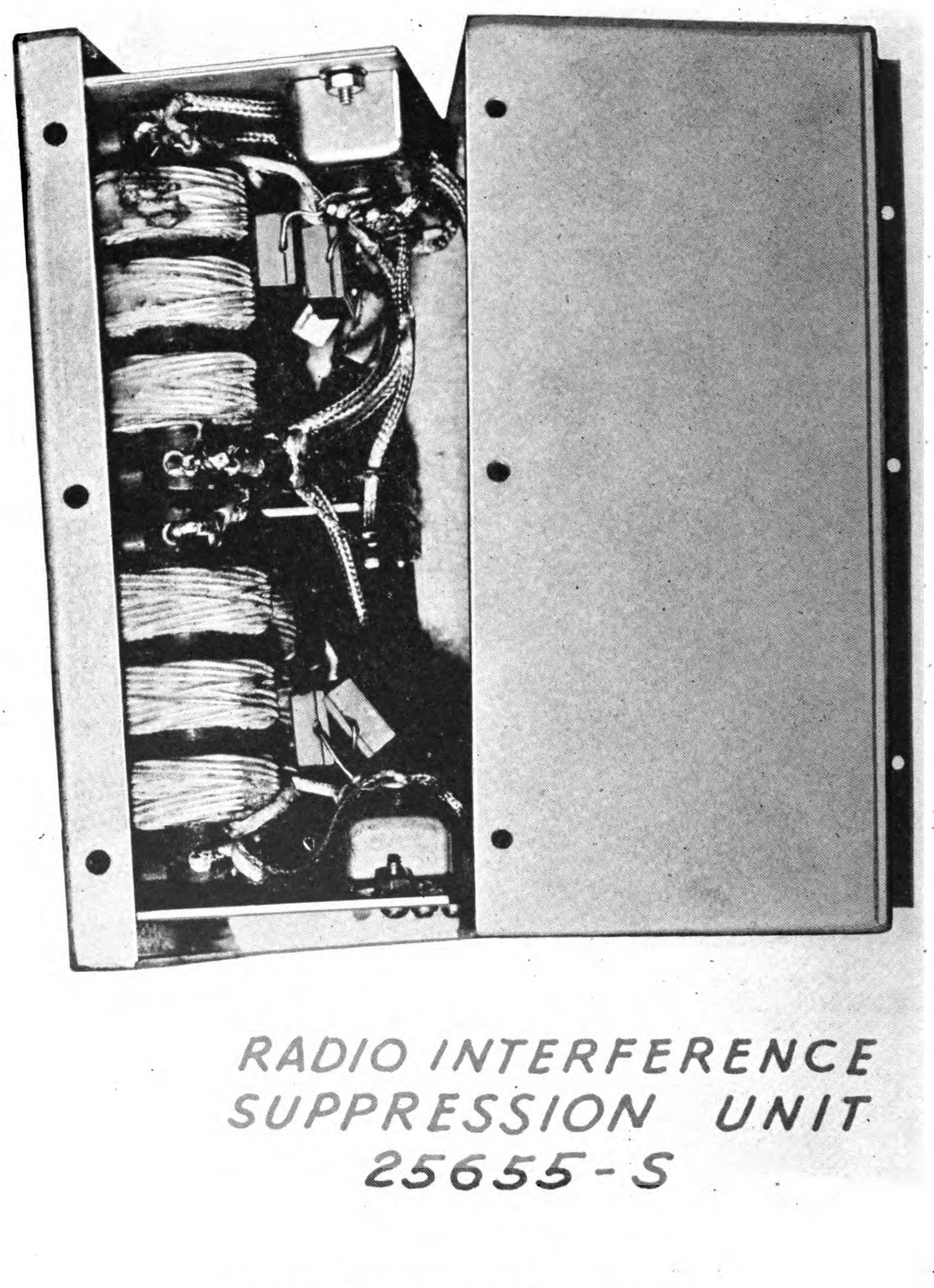
RADIO INTERFERENCE SUPPRESSION

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25600-1S	....	Voltage Regulator complete, with Suppression	EM	1	$243.75
EM-25655-S	....	Radio Interference Suppression Unit	EM	1	36.25
EM-25656-S	....	Radio Interference Suppression Cover	EM	1	1.10
EM-25630-1S	....	Regulator Frame—Shielded	EM	1	5.65
EM-25630-2S	....	Sub Assembly Frame	EM	1	1.90
EM-25657	....	Condenser, .01 MFD., 1000 volt	....	4	.63
EM-25658	....	Condenser, .10 MFD., 600 volt	....	7	.50
EM-25659	....	Mounting Bracket	EM	1	1.10
EM-25660	....	Mounting Clamps and Screws	EM	3	.07
EM-25661	....	Mounting Clamps and Screws	EM	2	.10
EM-25662	....	Mounting Bracket	EM	1	1.45

RADIO INTERFERENCE SUPPRESSION
FIG. 106

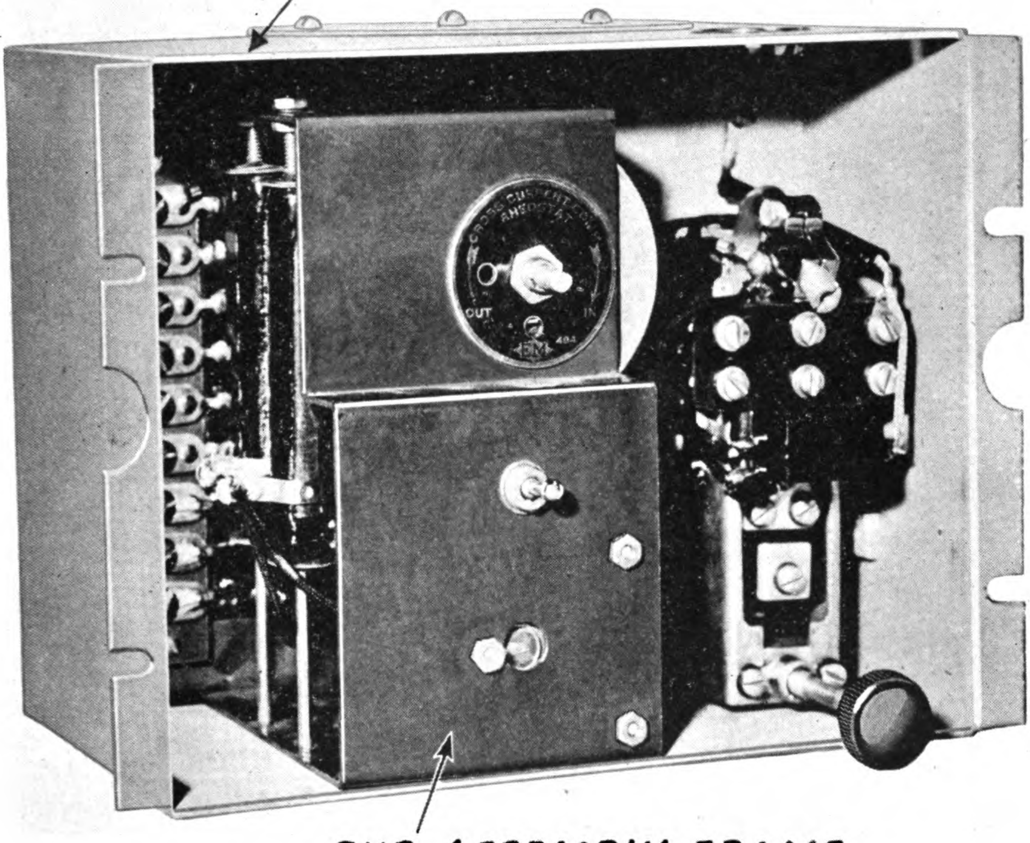


RADIO INTERFERENCE SUPPRESSION
FIG. 107



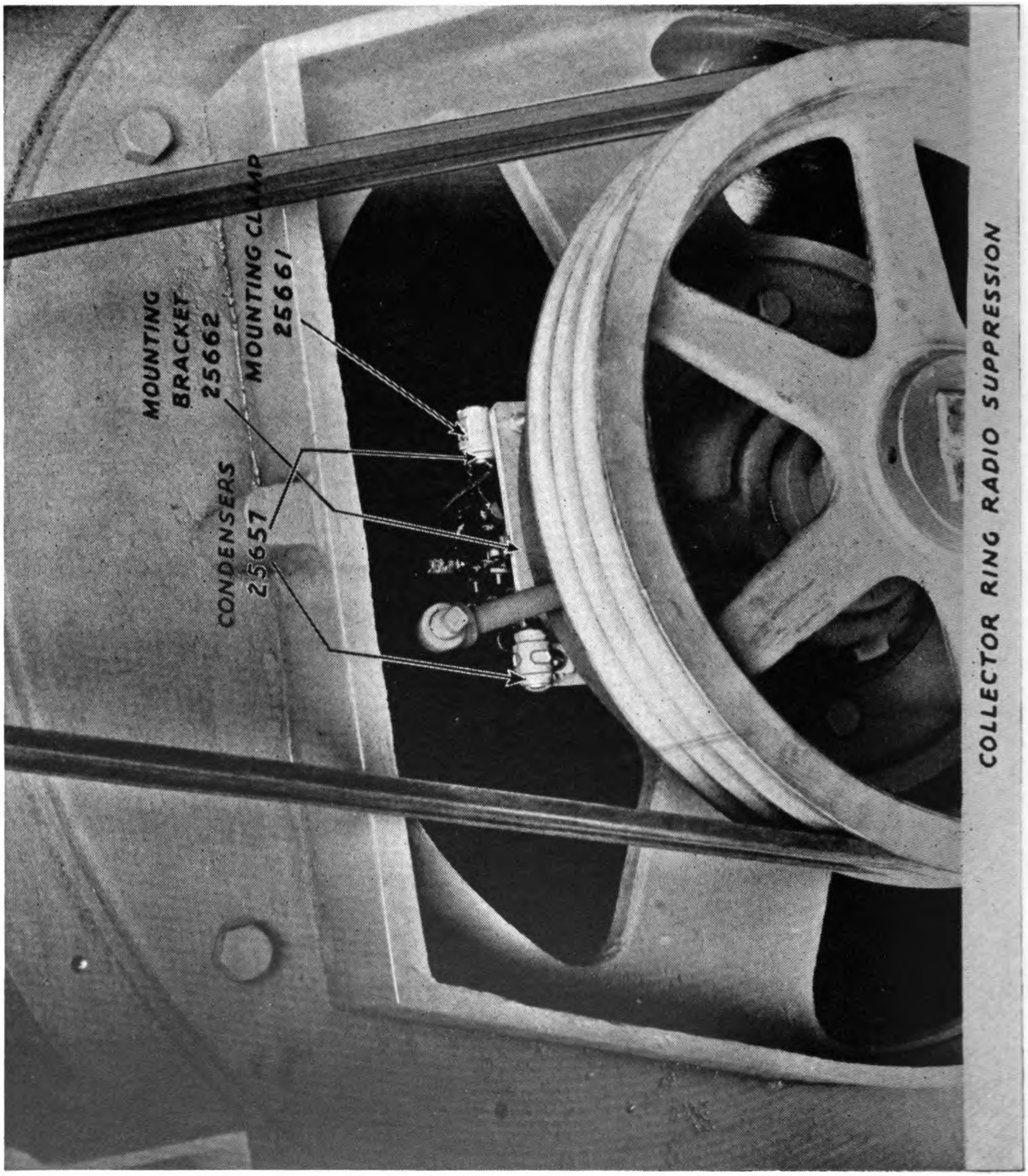
RADIO INTERFERENCE SUPPRESSION
FIG. 108

REGULATOR FRAME
25630-1S

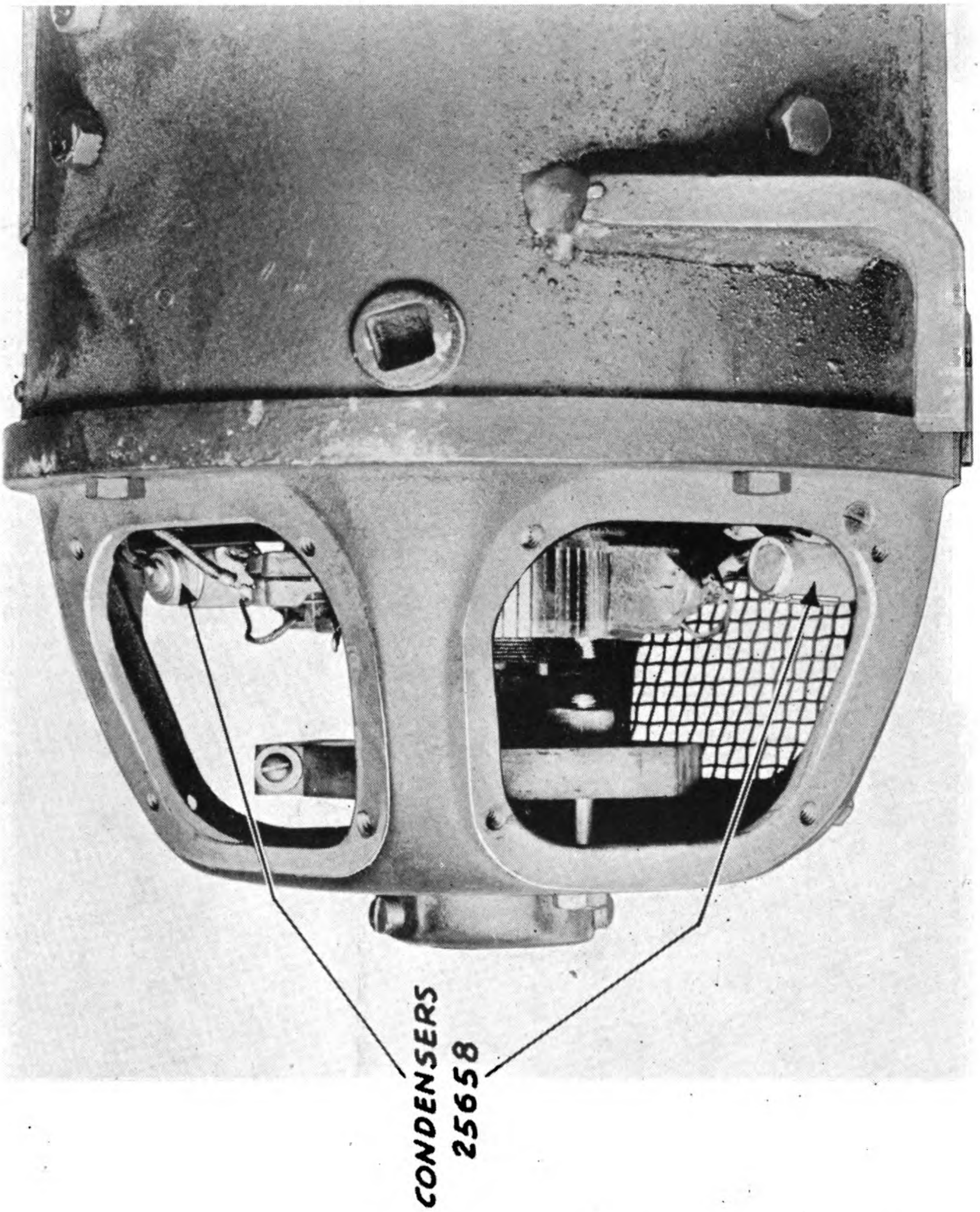


SUB ASSEMBLY FRAME
25630-2S

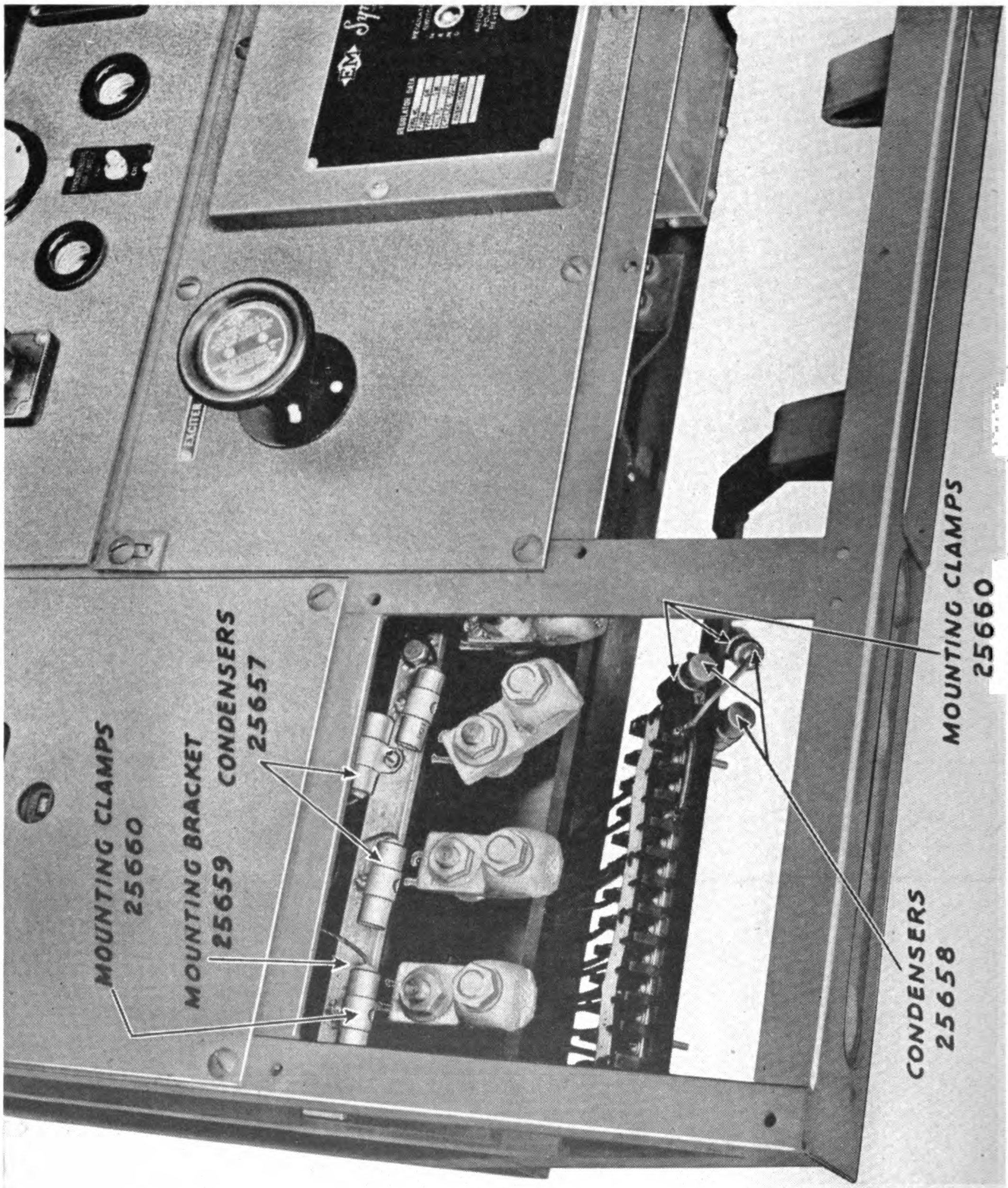
RADIO INTERFERENCE SUPPRESSION
FIG. 109



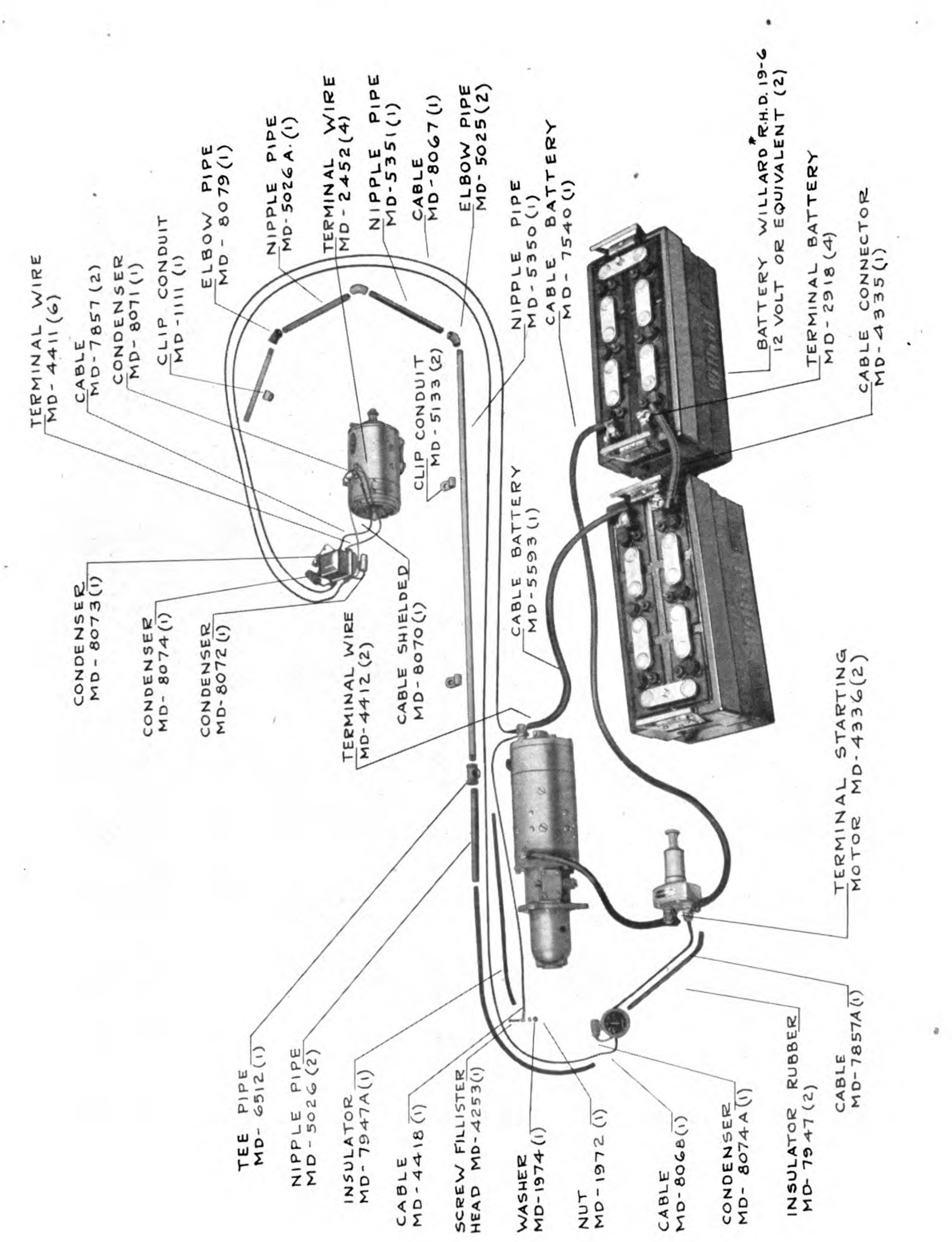
RADIO INTERFERENCE SUPPRESSION
FIG. 110



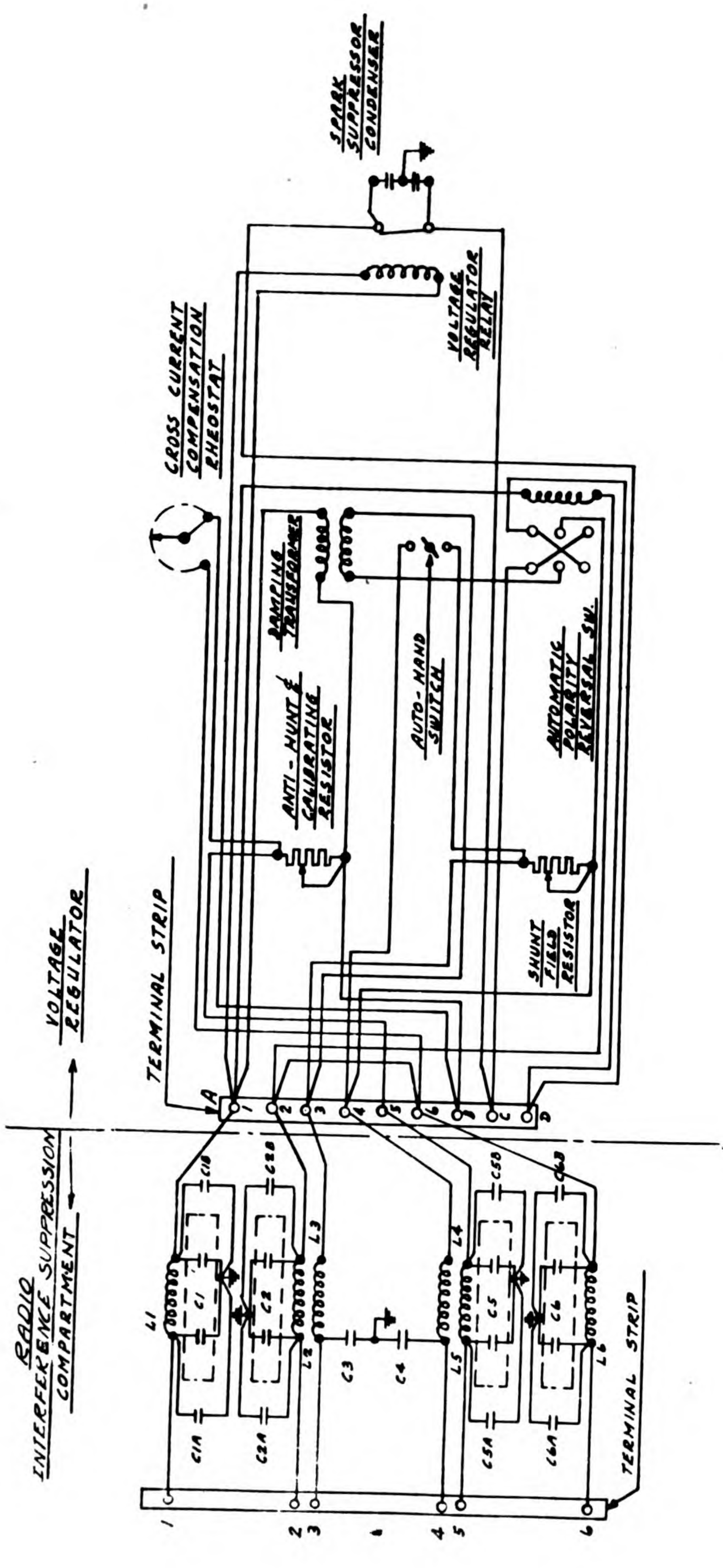
RADIO INTERFERENCE SUPPRESSION
FIG. 111



RADIO INTERFERENCE SUPPRESSION
FIG. 112



GENERATOR WIRE ASSEMBLY MD-5221B and BATTERY CABLE ASSEMBLY MD-6373
FIG. 113



REF. DRWG. NO'S - C-8619 & 0-8618

NOTE - THIS DRAWING IS ONLY FOR 352 UNITS EQUIPPED WITH RADIO INTERFERENCE SUPPRESSION - CUSTOMERS ORD # 6-2206 OUR SALE NO - 7118I

OPERATING AND MAINTENANCE INSTRUCTIONS

SPARE PARTS PRICE LIST

FOR

SYNCHRONOUS GENERATOR

NOTE

This section is subdivided into sections A and B which cover different generators. Refer to list of engine Nos. in front of book to insure ordering correct parts.

ILLUSTRATIONS

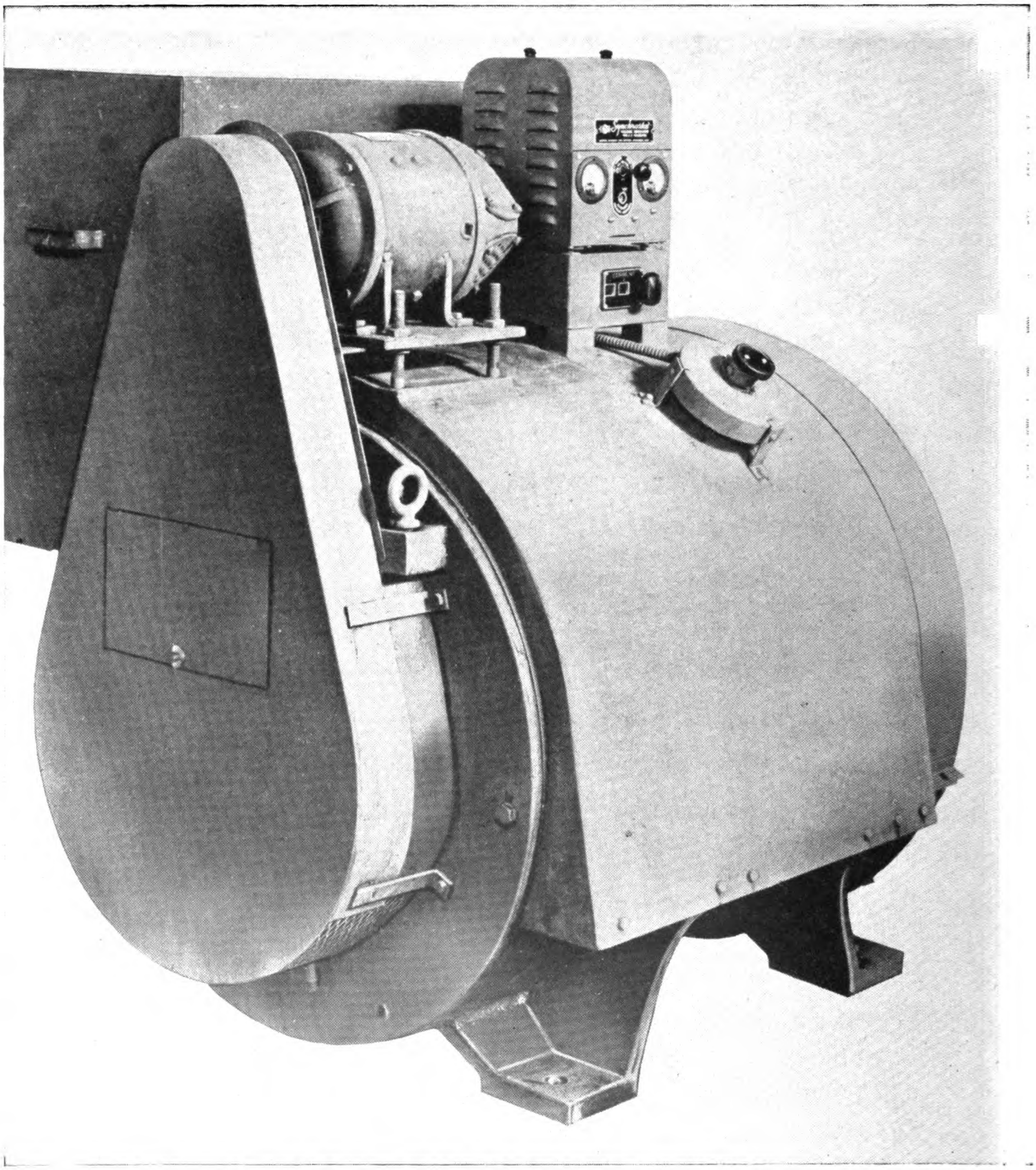


FIG. 1—Synchronous Generator Complete

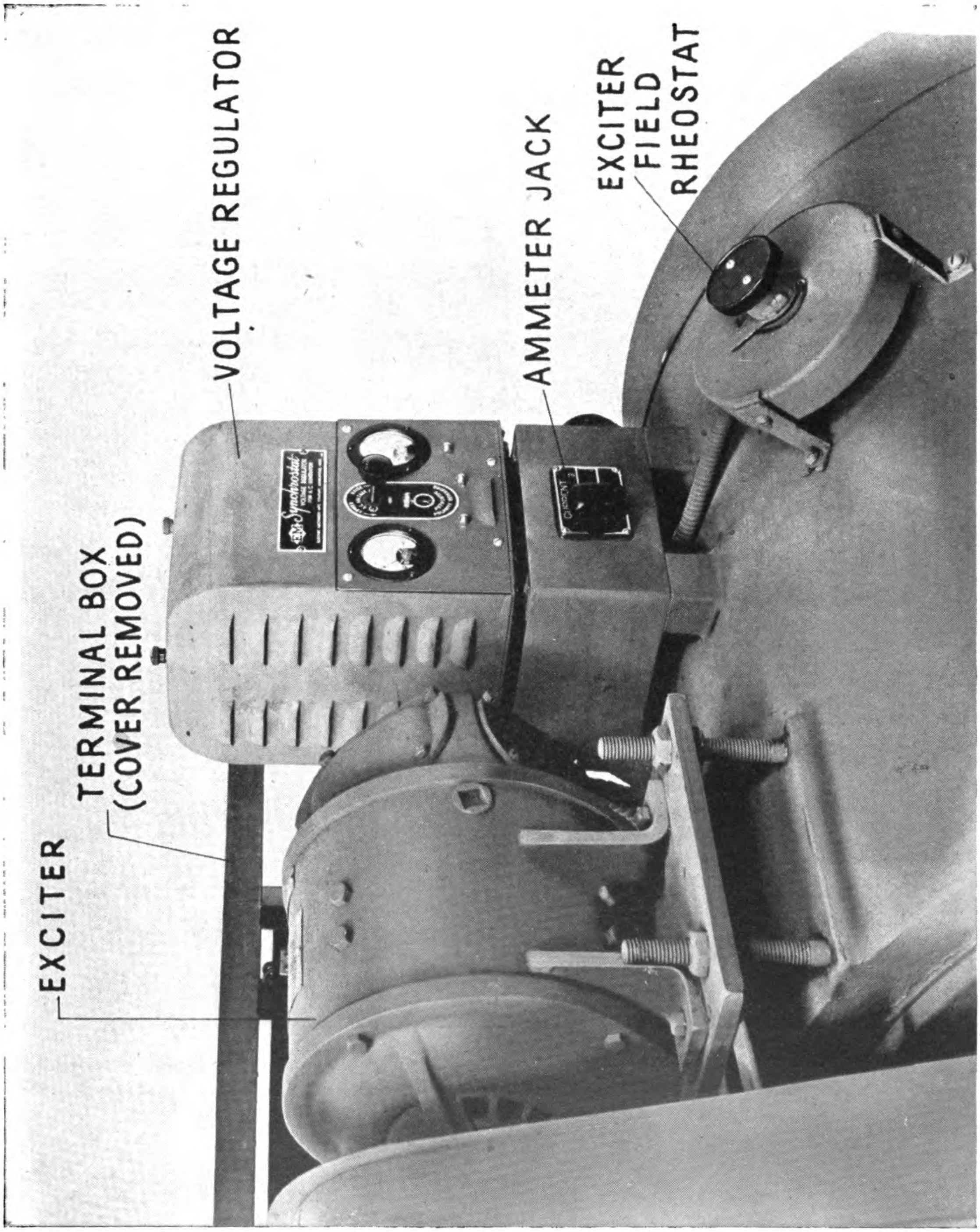


FIG. 2—Voltage Regulator, Exciter and Exciter Field Rheostat

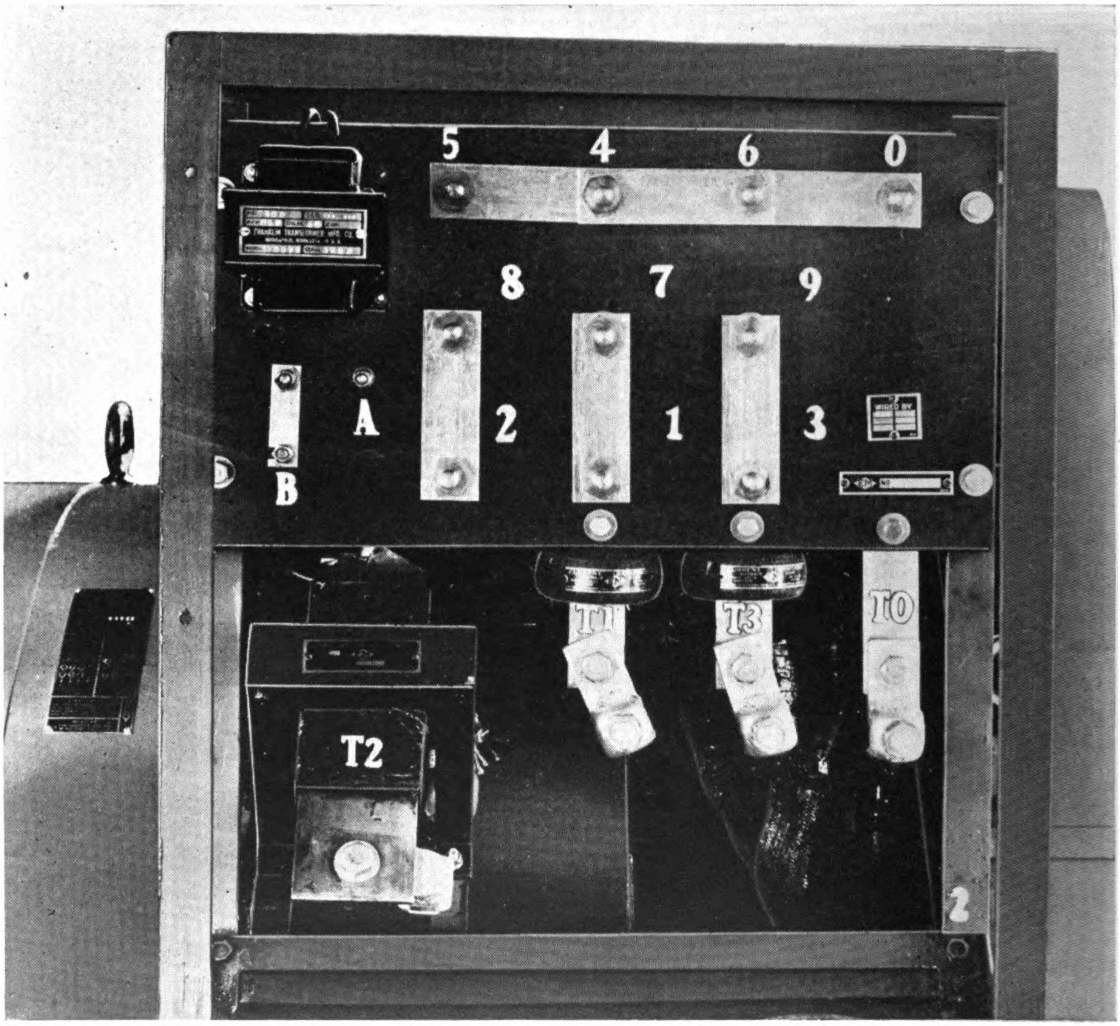


FIG. 3—Terminal Box Connections for 400/230 Volt, 60 Cycle, 1200 Rpm. Operation
(Note: Transformer shown upper left is mounted on rear of panel board on some units.)

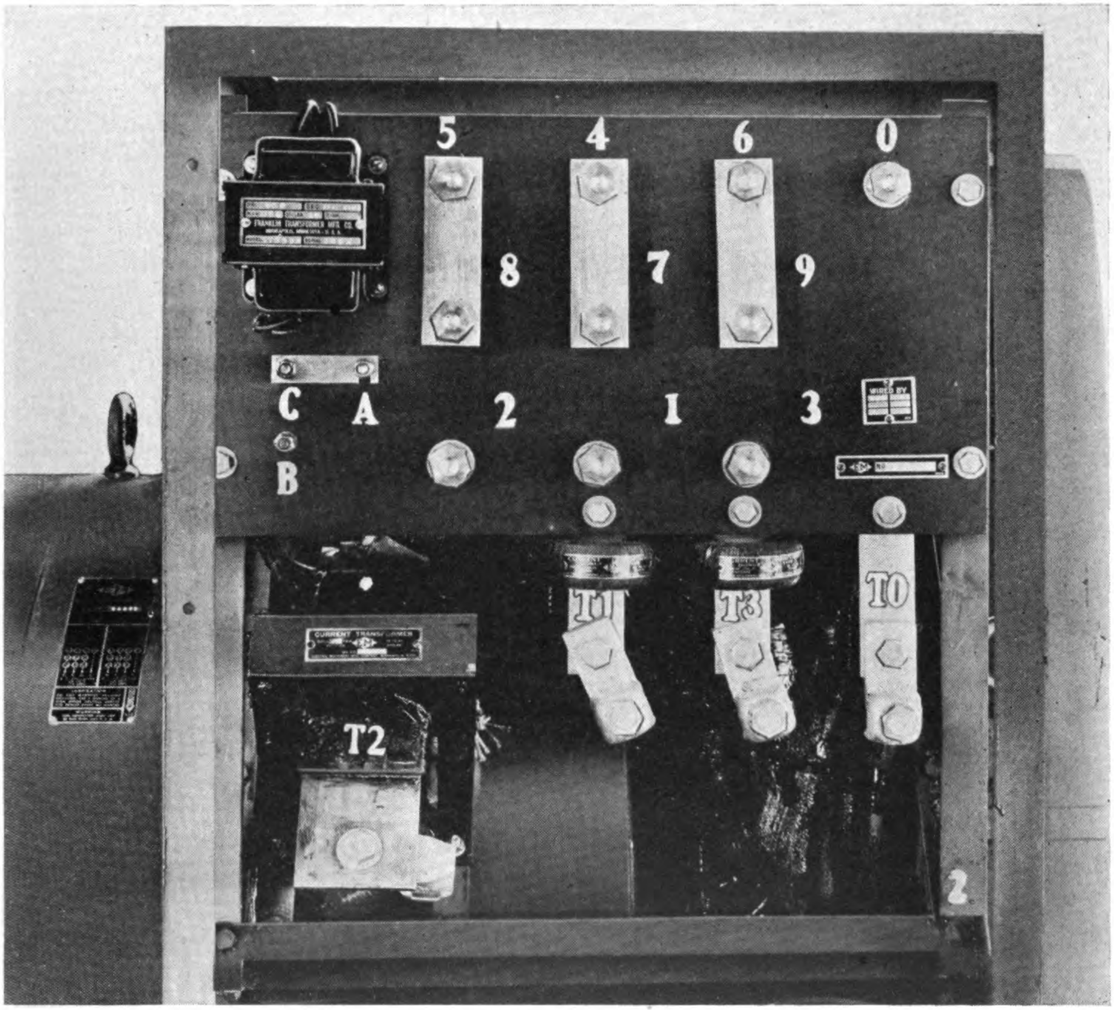


FIG. 4—Terminal Box Connections for 220/127 Volt, 50 Cycle, 1000 Rpm. Operation
(Note: Transformer shown upper left is mounted on rear of panel board on some units.)

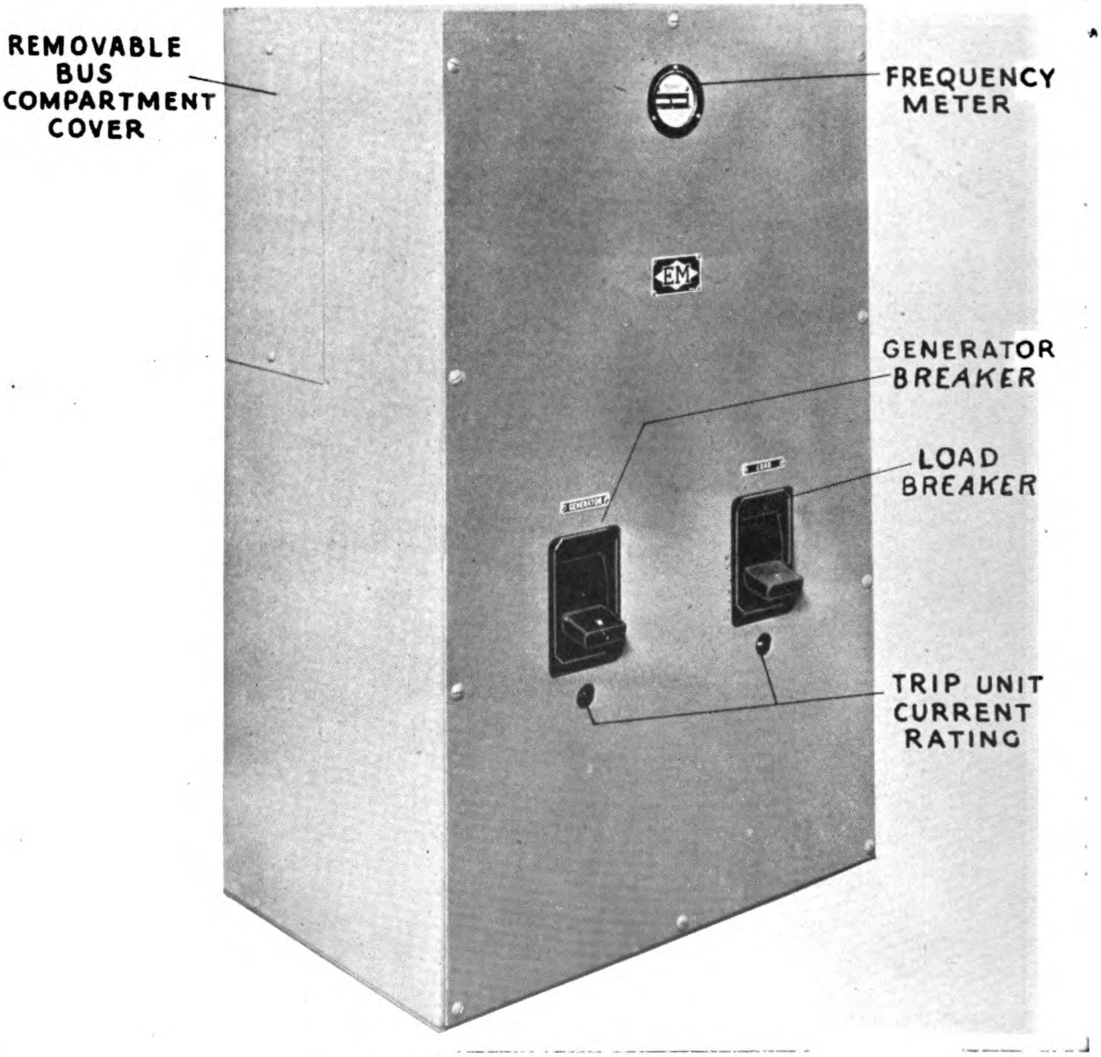


FIG. 5—Switch Cabinet—Non Synchronizing

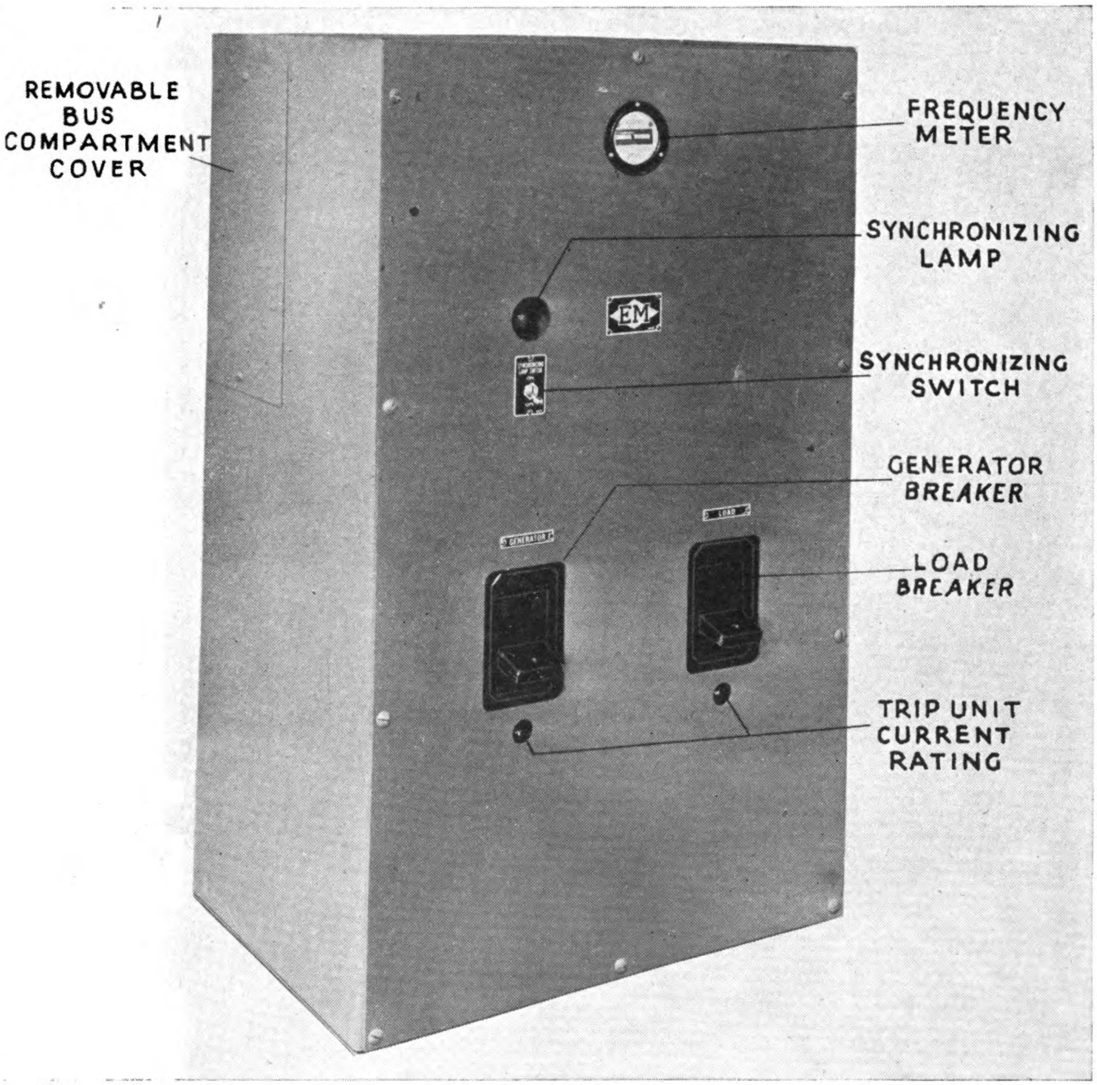


FIG. 6—Switch Cabinet—Synchronizing

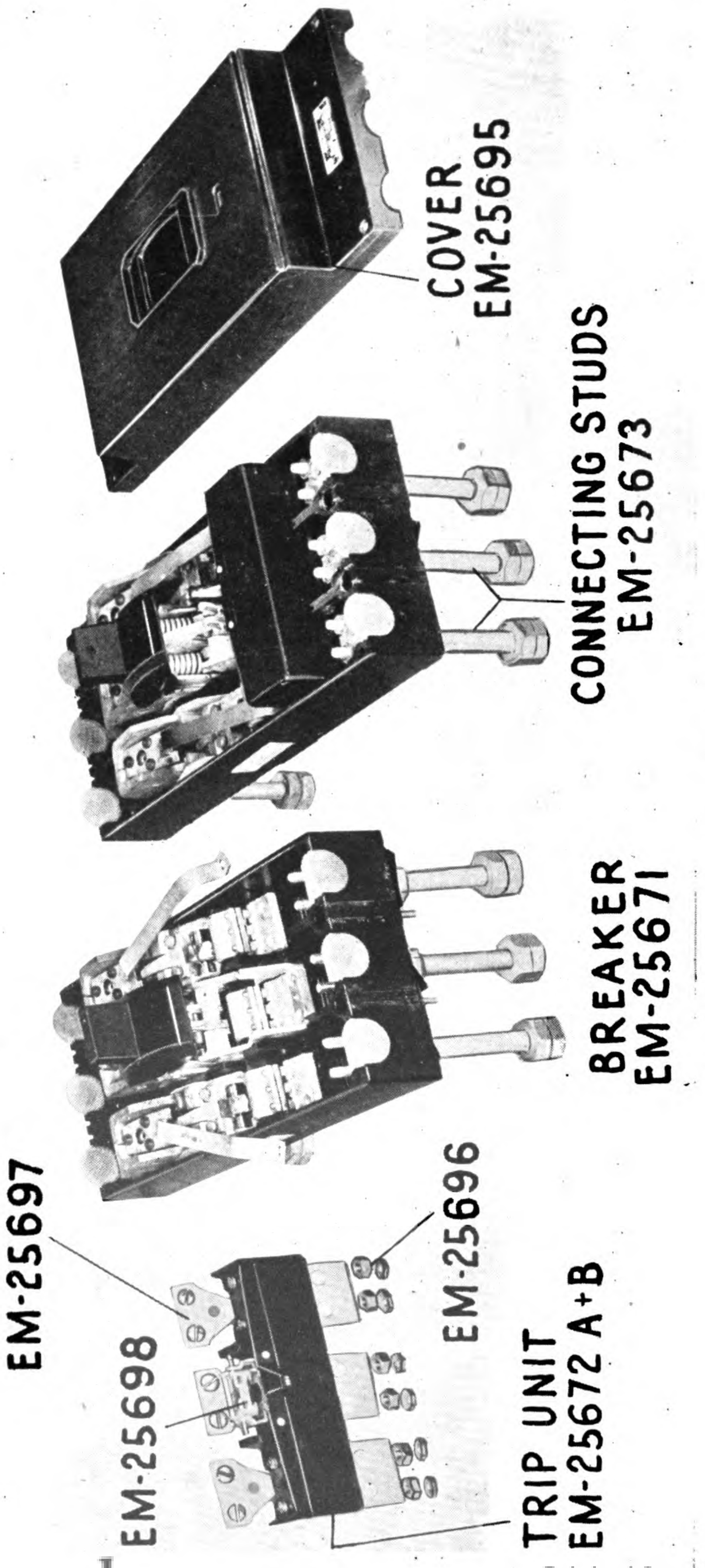


FIG. 7—Breaker Overload Trip Unit Arrangement

FIG. 8—Complete Generator and Accessories—Exploded View

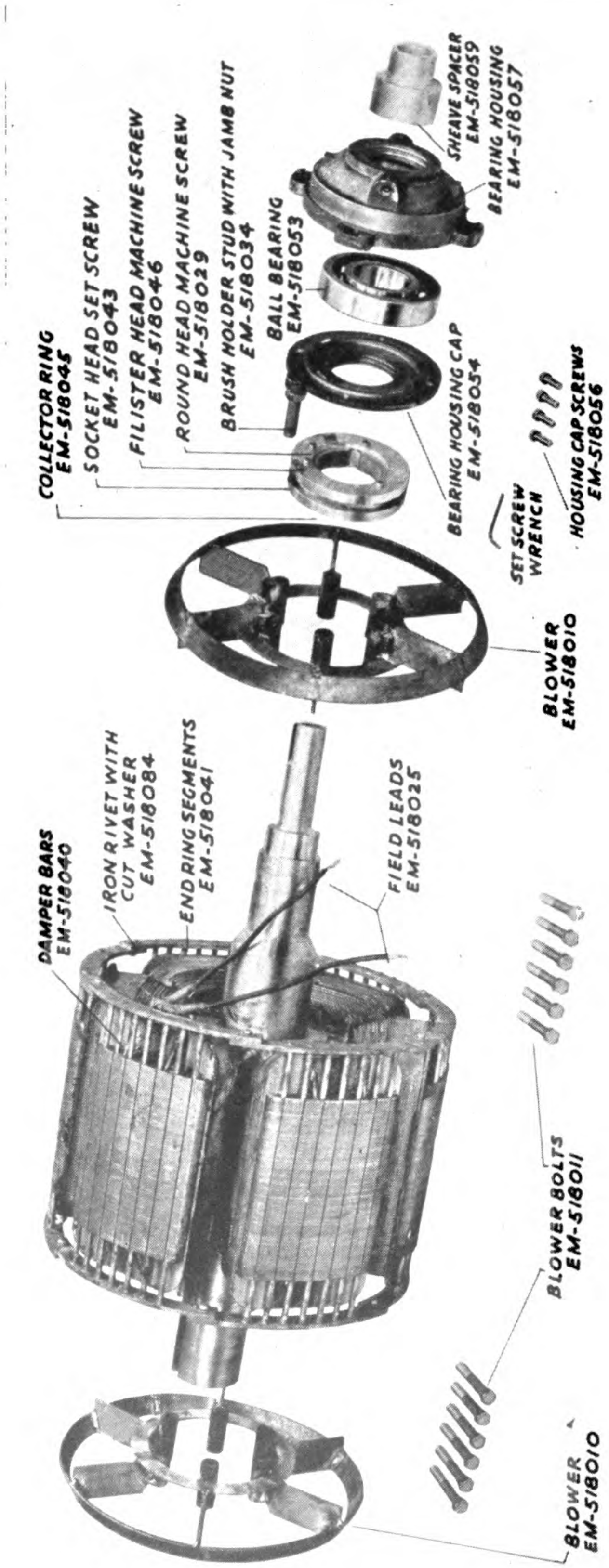


FIG. 9—Generator Rotor—Exploded View

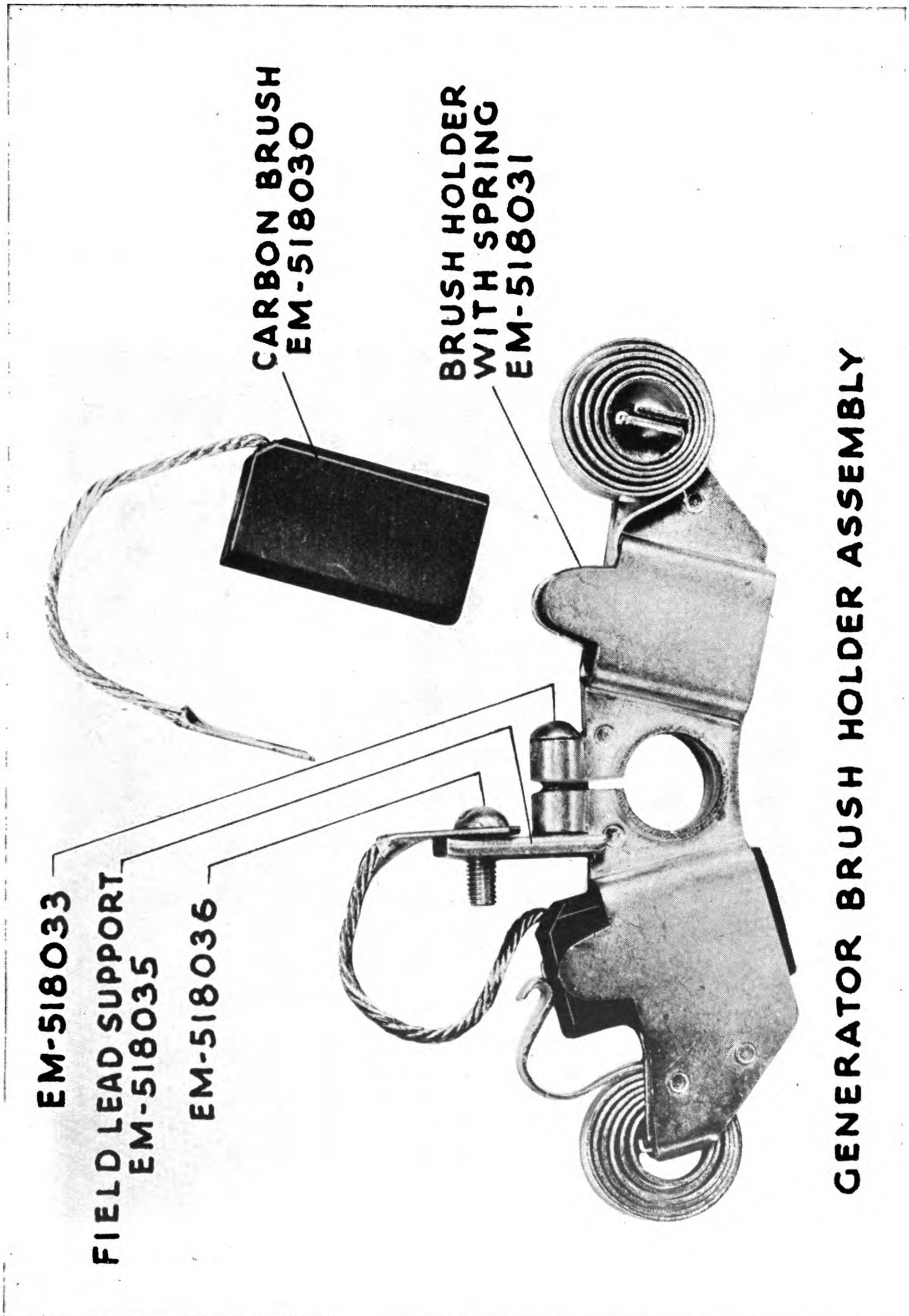


FIG. 10—Generator Brush Holder Assembly

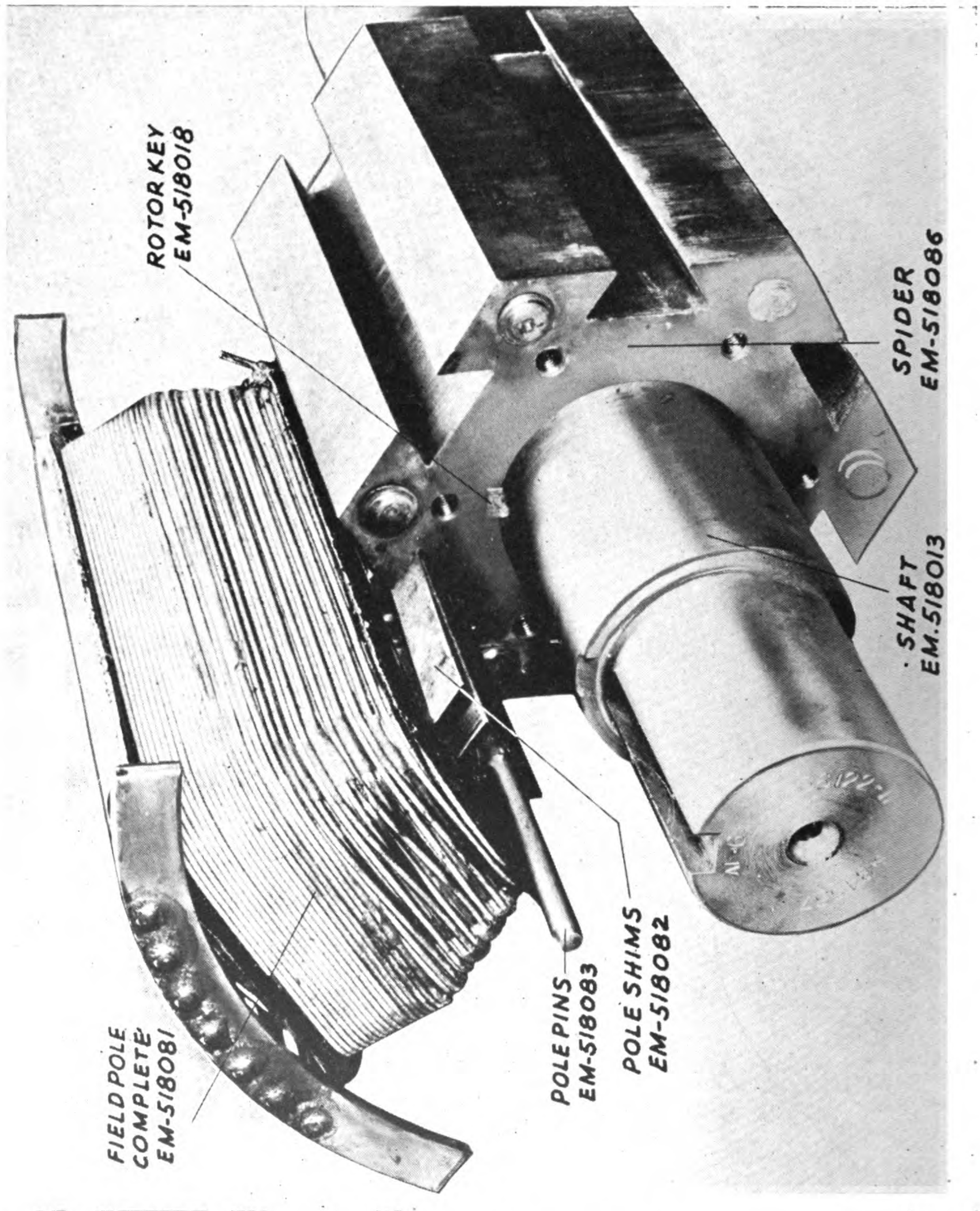


FIG. 11—Generator Shaft, Spider and Field Pole—Assembly Procedure

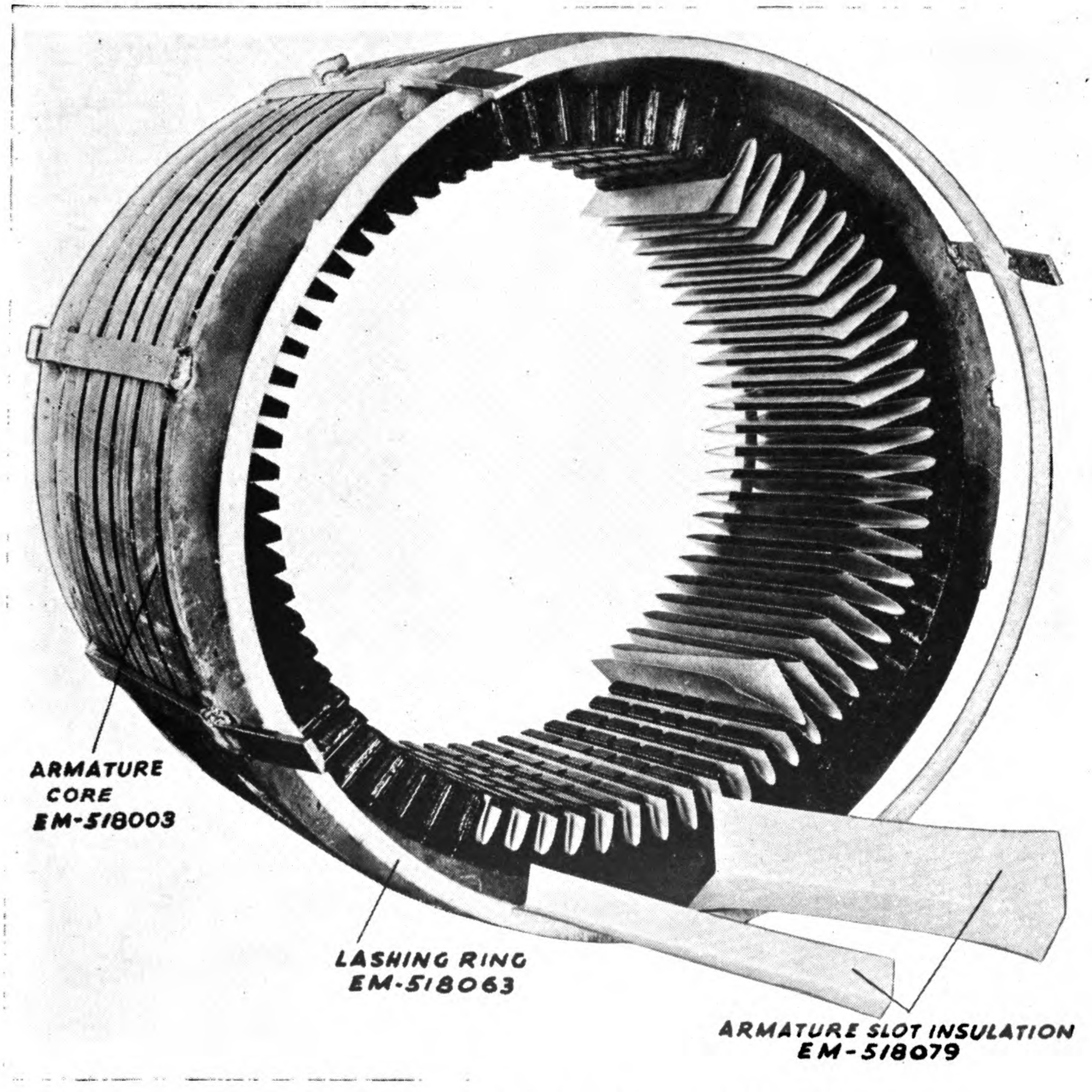


FIG. 12—Generator Armature Core and Insulation

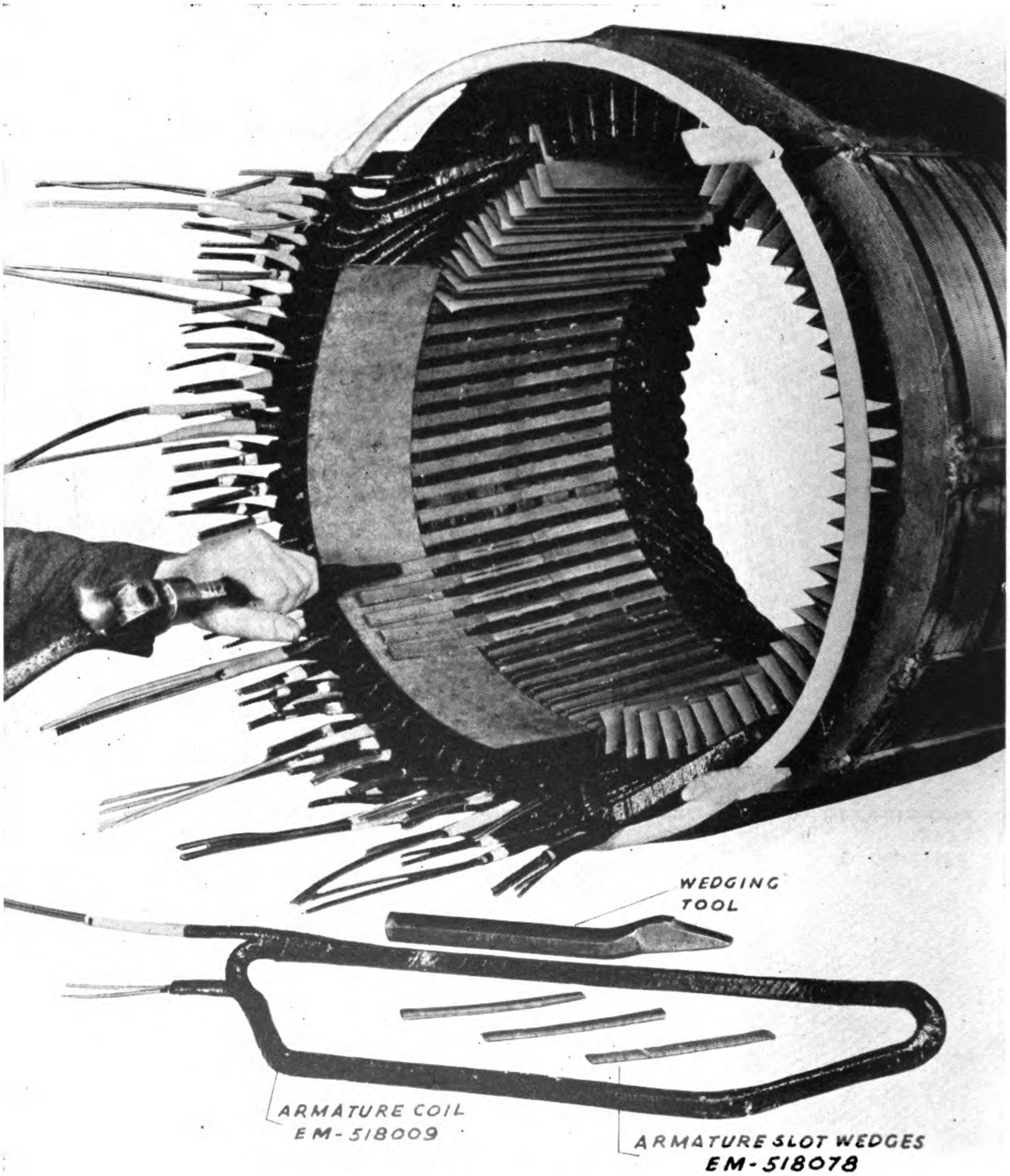


FIG. 13—Generator Armature Coil Assembly Procedure

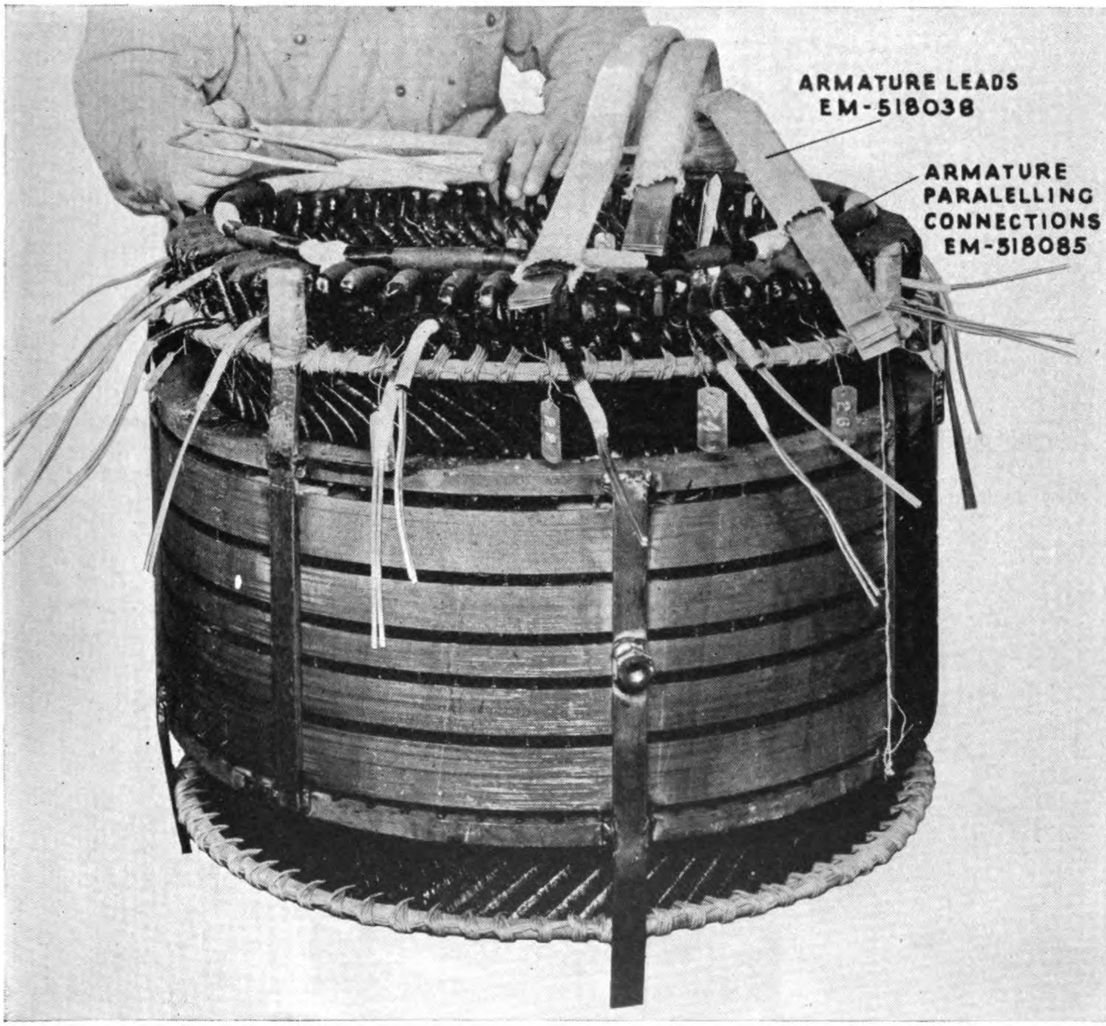


FIG. 14—Generator Armature Connection Procedure

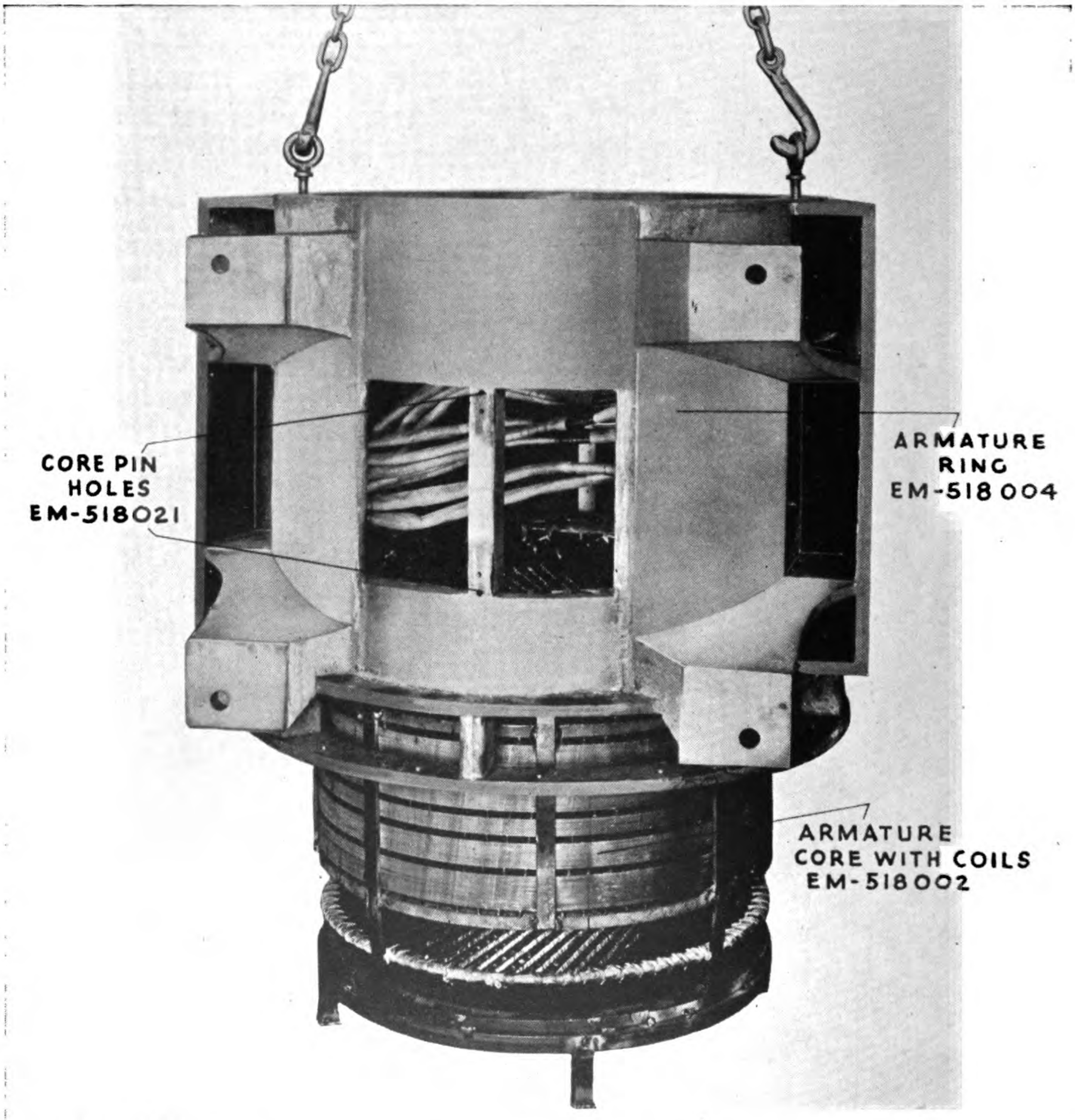


FIG. 15—Generator Armature Core and Ring Assembly Procedure

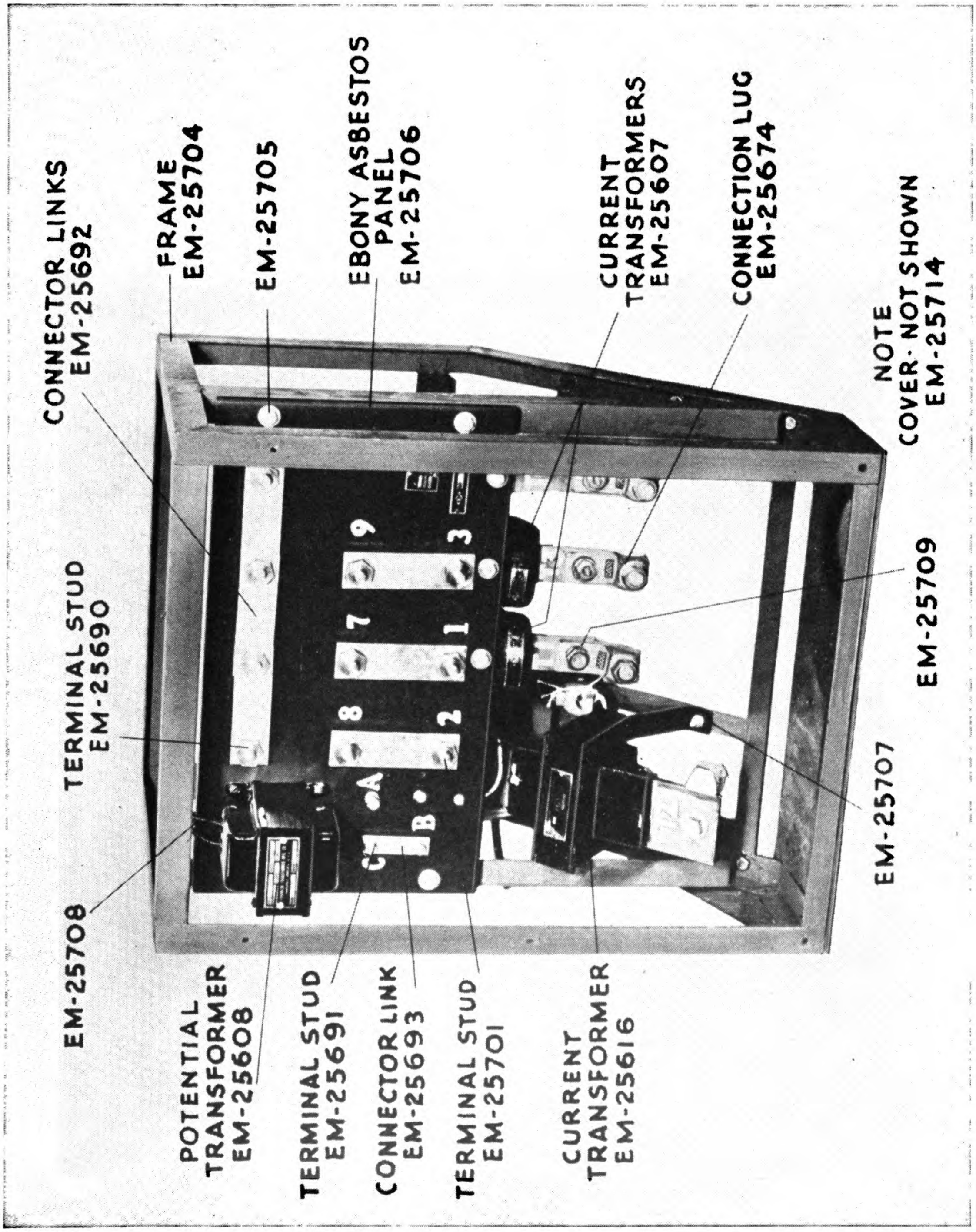


FIG. 16—Terminal Box—Front View

(Note: Transformer shown at upper left is mounted on rear of panel board on some units.)

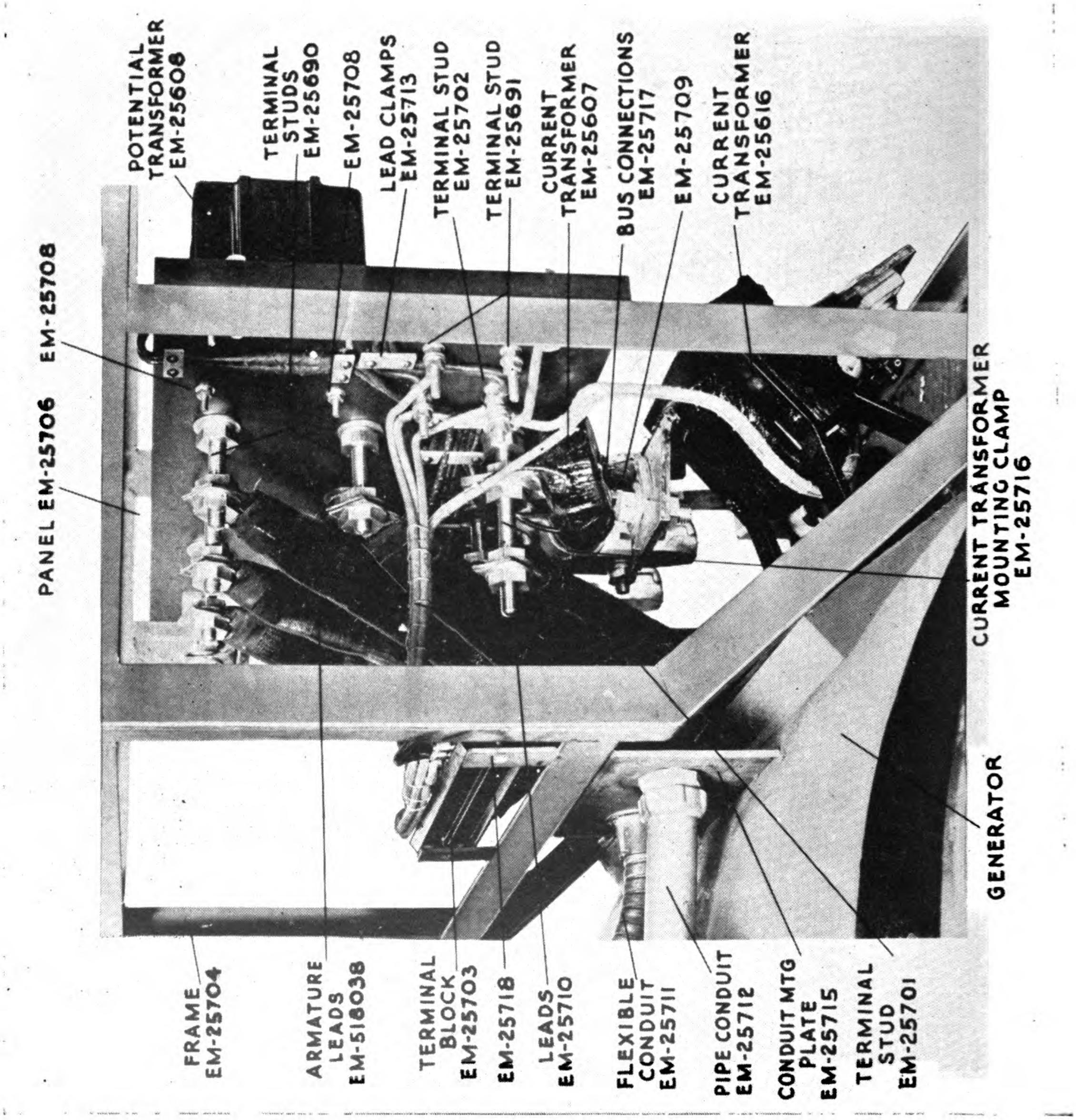


FIG. 17—Terminal Box—Side View

(Note: Transformer shown at upper left is mounted on rear of panel board on some units.)

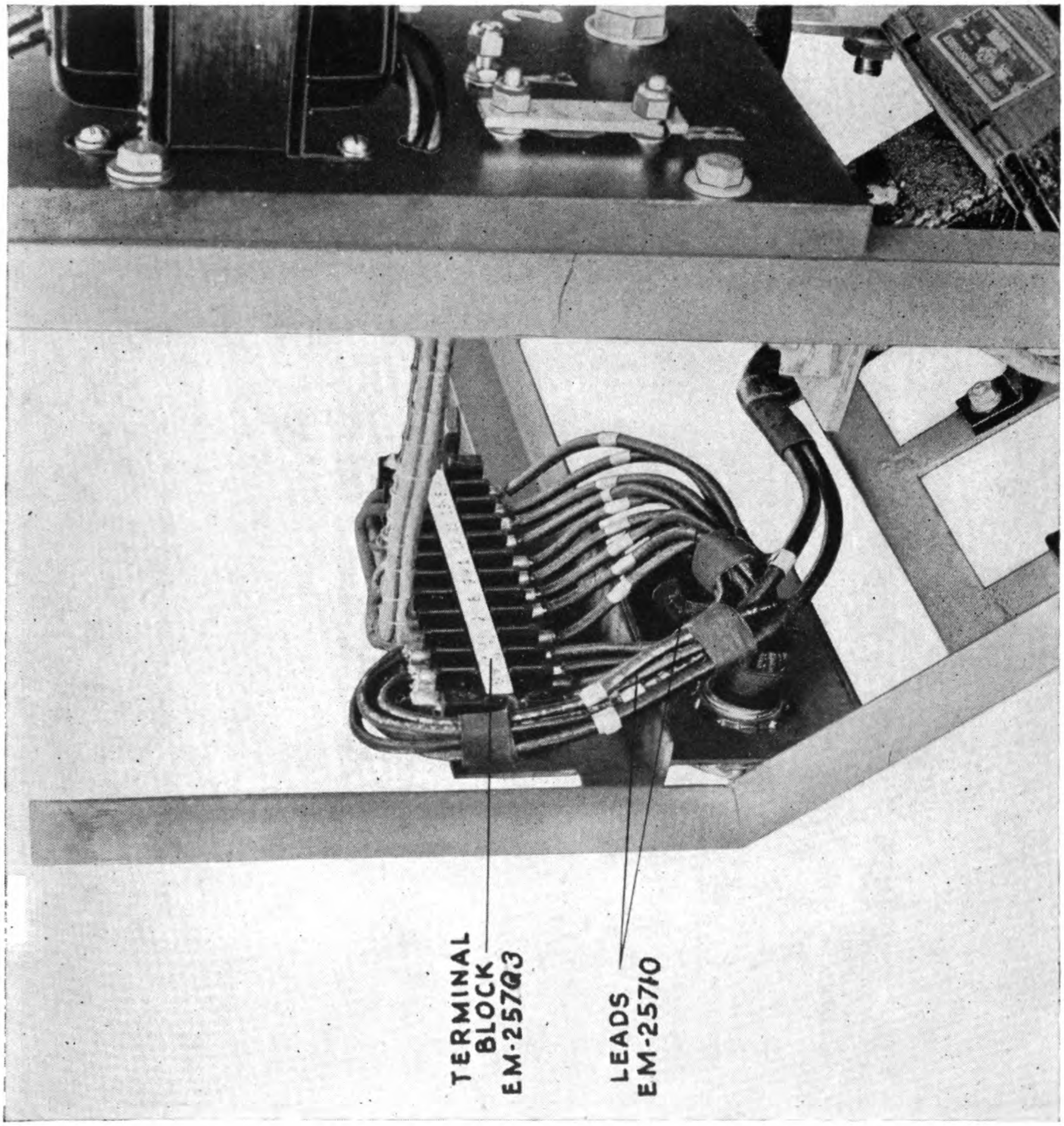


FIG. 18—Terminal Box Terminal Block

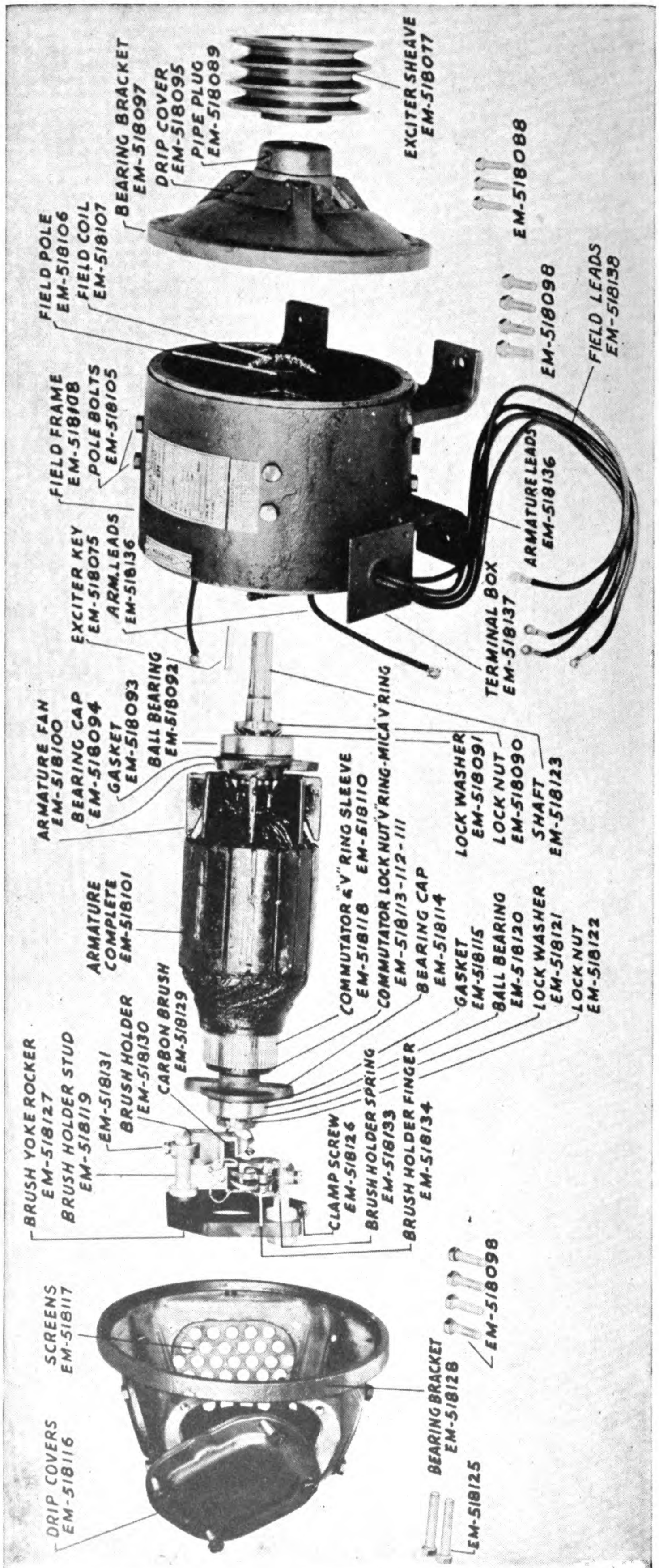


FIG. 19—Exciter—Exploded View

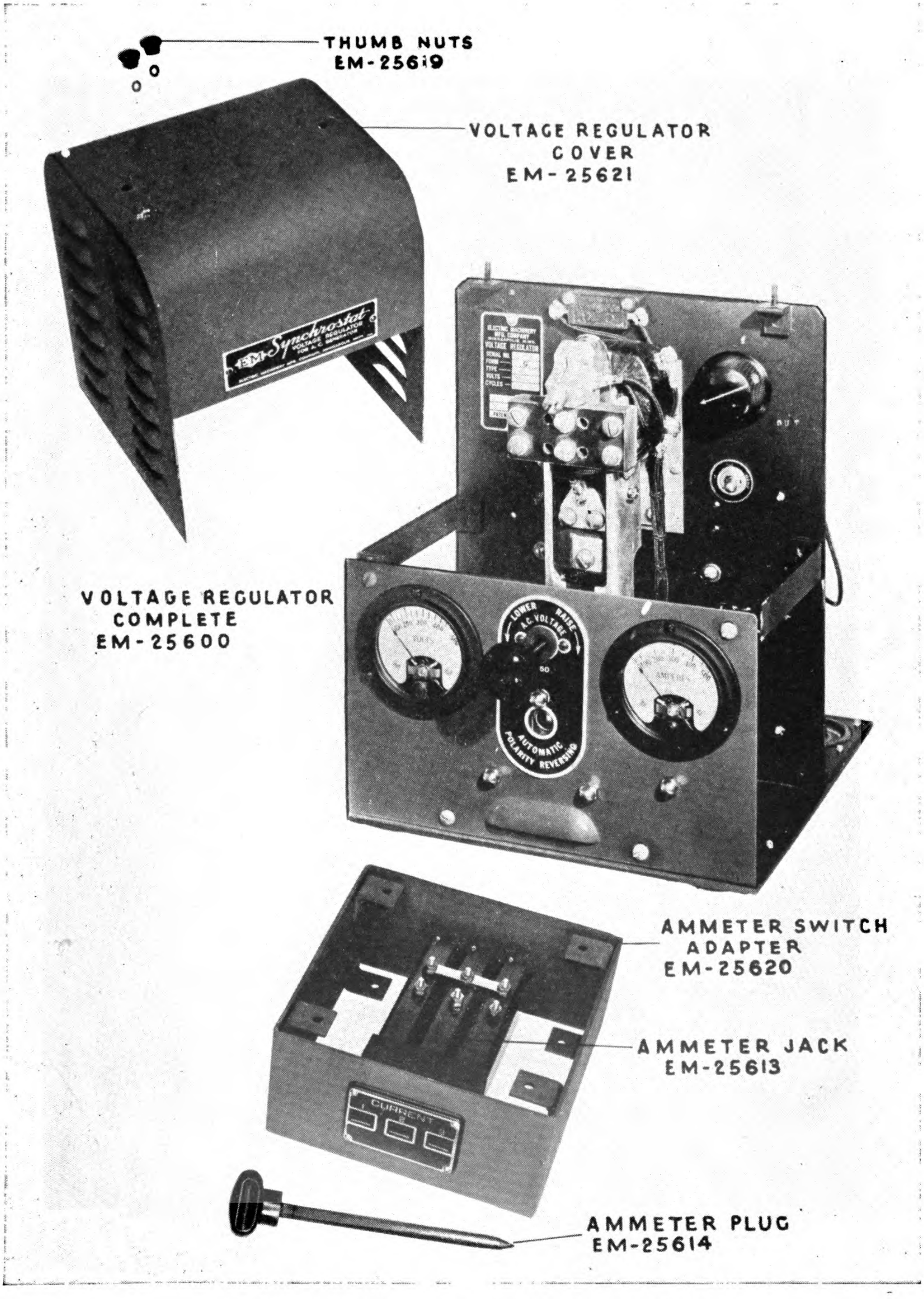


FIG. 20—Voltage Regulator and Ammeter Switch

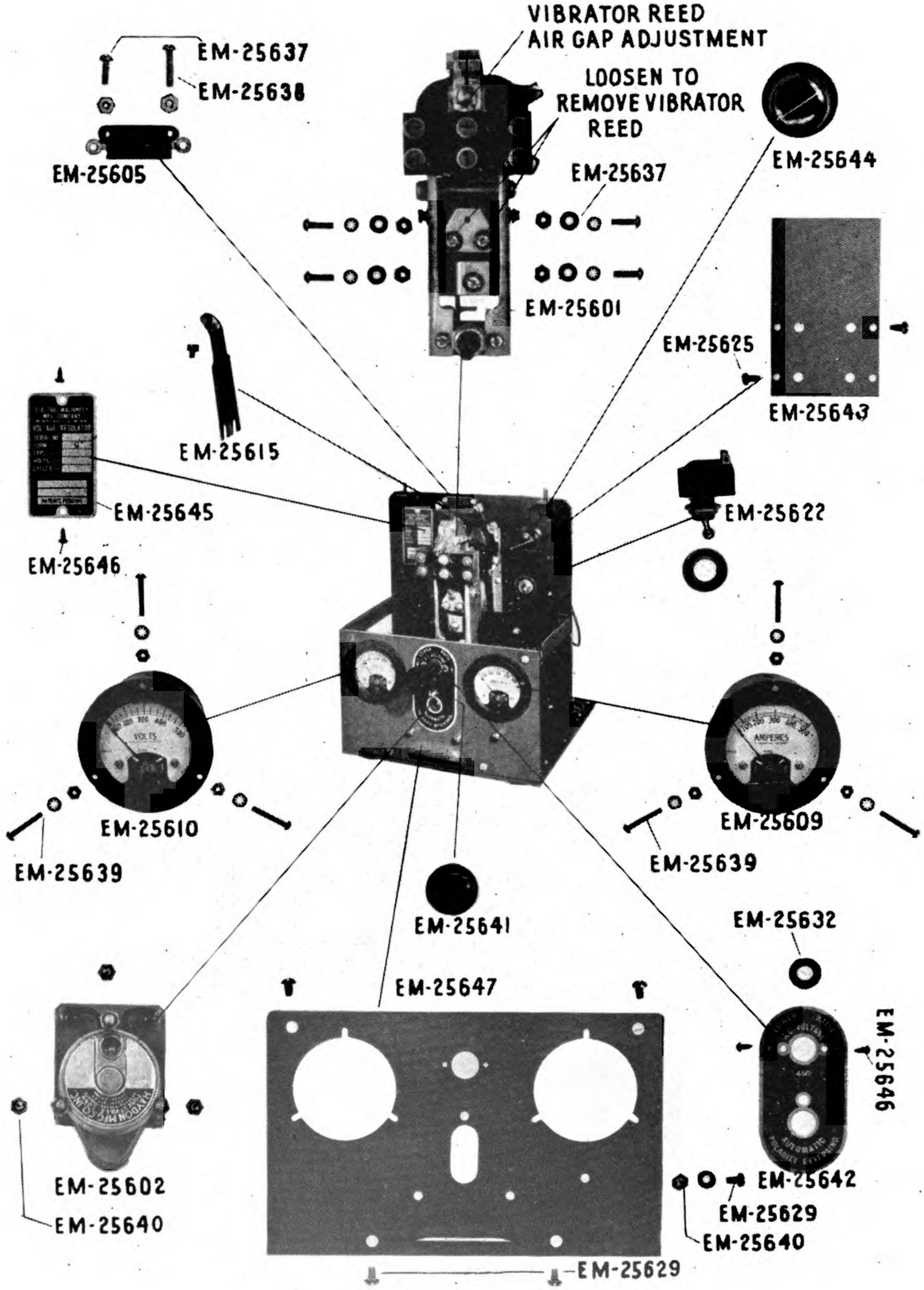


FIG. 21—Voltage Regulator Parts

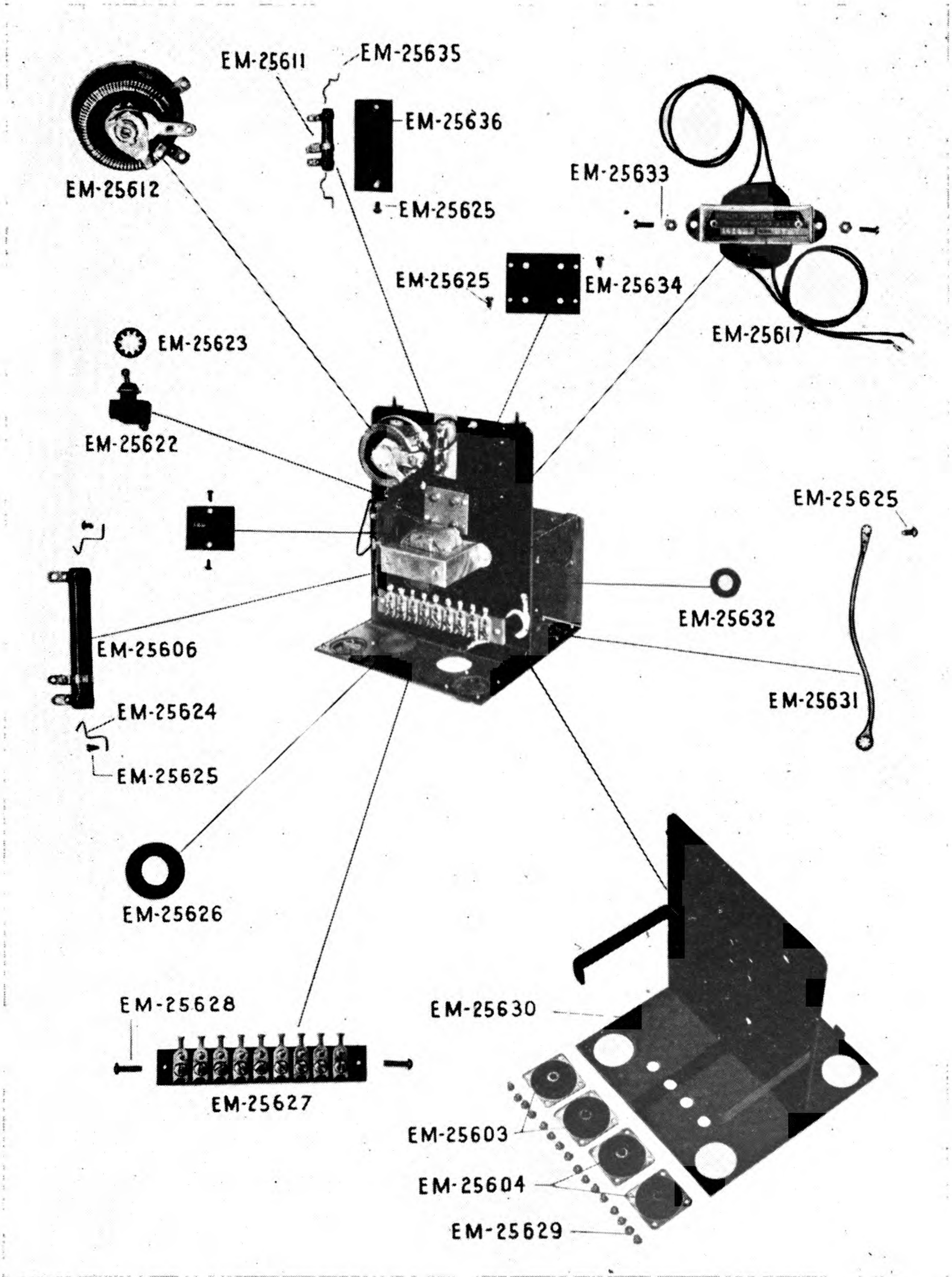


FIG. 22—Voltage Regulator Parts—(Cont'd)

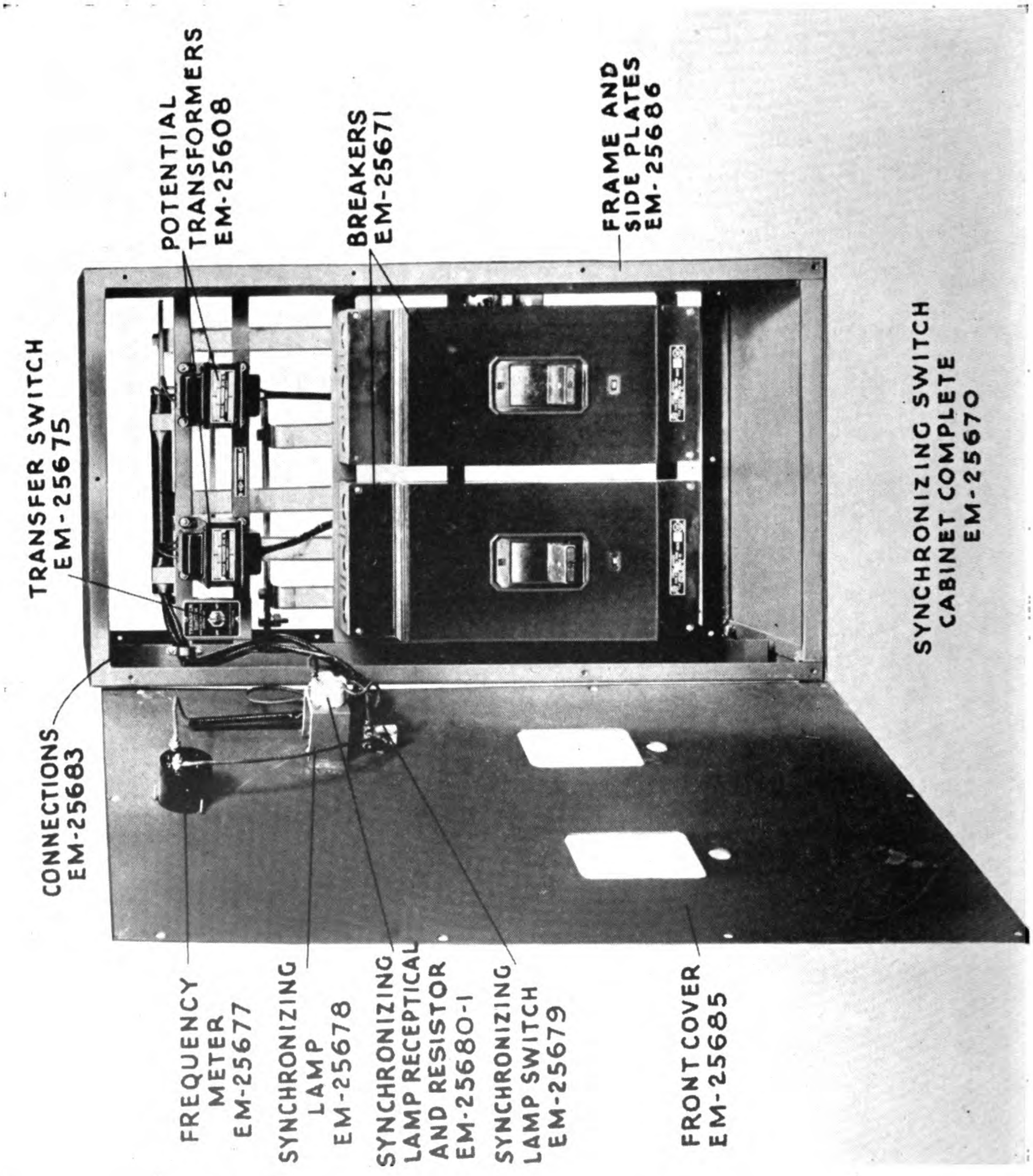
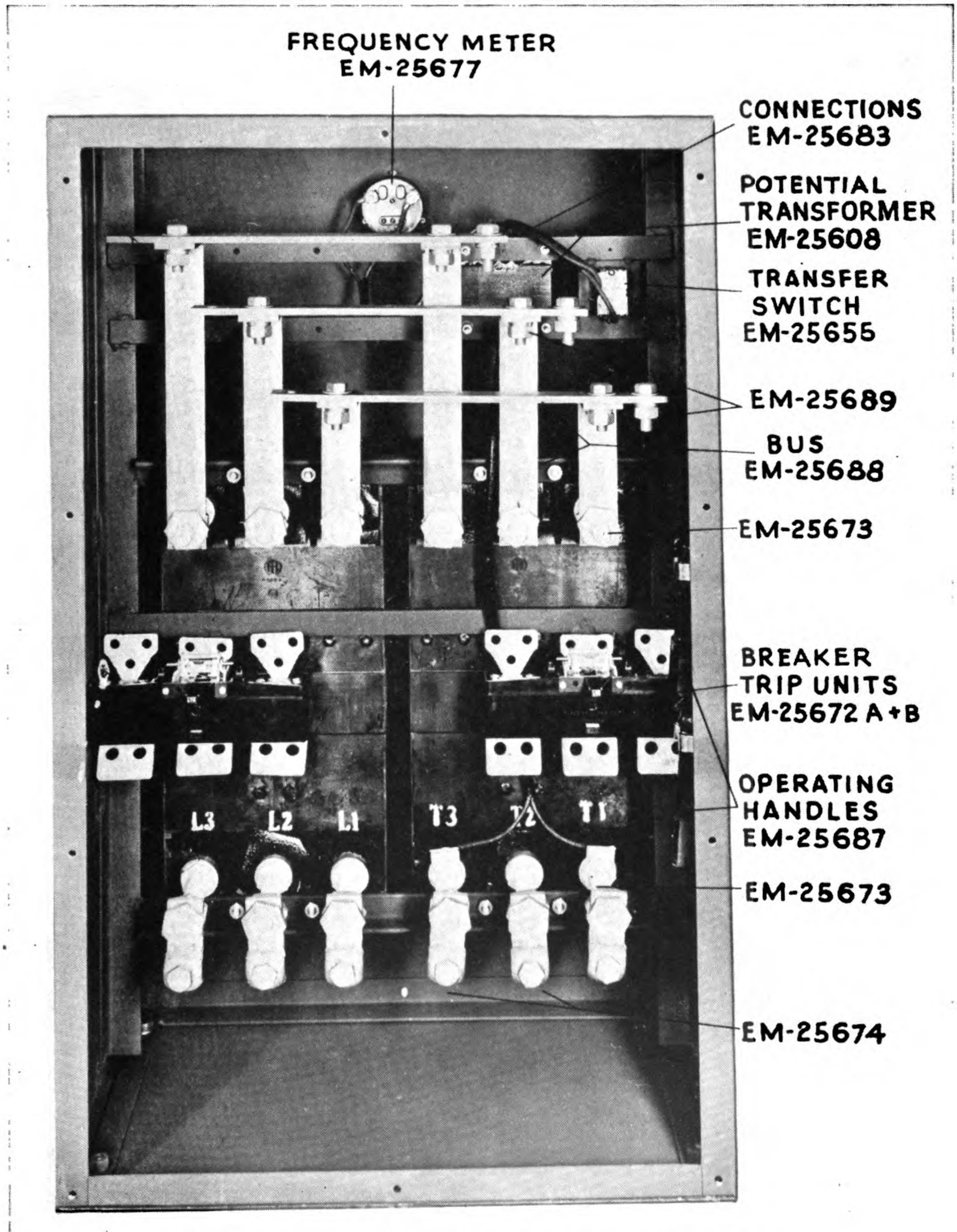
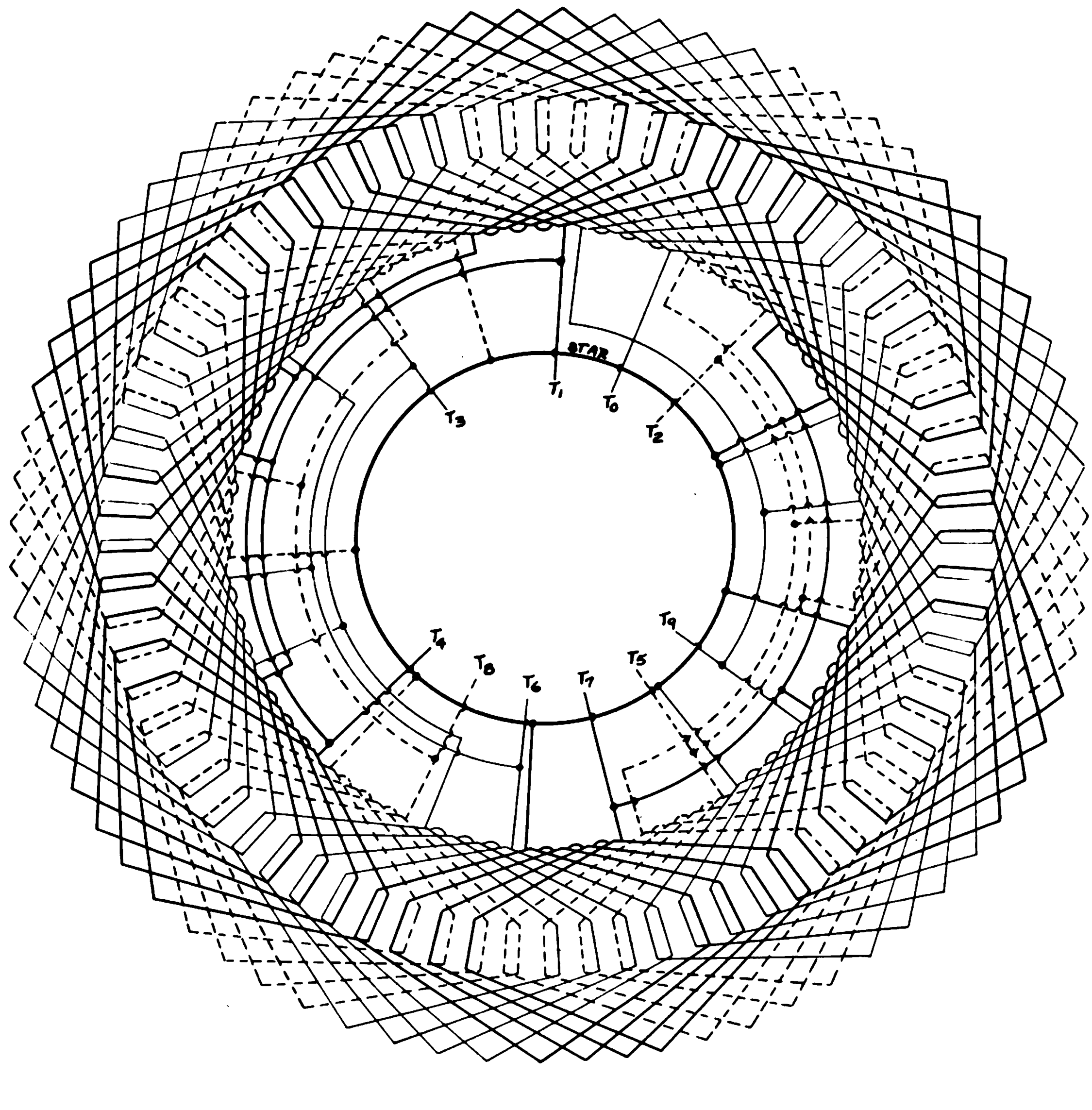


FIG. 23—Synchronizing Switch Cabinet Complete



NON-SYNCHRONIZING SWITCH CABINET EM-25650
NUMBERED PARTS ARE SAME ON SYNCHRONIZING SWITCH CABINET

FIG. 24—Non-synchronizing Switch Cabinet Complete



6-POLE CONNECTION DIAGRAM
3-PHASE STAR 3 and 6 CIRCUIT

SPARE PARTS

VOLTAGE REGULATOR

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Regulator	Price each
EM-25600	20	Voltage Regulator, Complete	EM	1	$361.00
EM-25601	21	Voltage Regulator relay, including coil	EM	1	16.88
EM-25602	21	Polarity Reversing switch	Hayden Mfg. Co. (EM special)	1	9.19
EM-25603	22	Rubber mountings, front	Lord No. 150P-6	2	.29
EM-25604	22	Rubber mountings, rear	Lord No. 150P-4	2	.29
EM-25605	21	Spark condenser, 0.01 mfd., 1000 volts dc test	Solar, Type MH-1049	1	.93
EM-25606	22	Anti-Hunt resistor	Ohmite No. 0569	1	1.04
EM-25607	16–17	Current transformer, Do-nut ratio 500/5 (Mounted on terminal box)	EM	3	3.13
EM-25608	16	Potential transformer, ratio 400/120/218, 100 volt ampere capacity, 50-60 cycles (Mounted on terminal box)	Franklin Trans. No. 17099A	1	......
EM-25609	21	A-C ammeter, 5 amperes, scale 0-500 amperes	Westinghouse MA No. 1163599	1	9.50
EM-25610	21	A-C voltmeter, 150 volt, scale 0-500 volts	Westinghouse MA No. W937528	1	12.25
EM-25611	22	A-C voltmeter resistor	Ohmite No. 1025	1	.69
EM-25612	22	Cross Current Compensation rheostat	Ohmite No. 0446	1	4.58
EM-25613	20	Ammeter Jack	General Electric No. 6052309G-2	1	18.56
EM-25614	20	Ammeter Plug	General Electric No. 2874991G-1	1	3.26
EM-25615	21	Vibrator reed and contacts (regulator contacts)	EM	1	4.38
EM-25616	16–17	Current transformer for cross current compensation, Type RB, ratio 800/5 (Mounted on terminal box)	EM	1	32.00
EM-25617	22	Damping transformer	Franklin No. A16142A	1	3.09
EM-25618	8	Exciter field rheostat (mounted on generator frame)	Ward Leonard 6"	1	16.25
EM-25619	20	Thumb, nuts and washers	Dayton Co. No. 117	2	.54
EM-25620	20	Ammeter switch adapter	EM	1	1.38
EM-25621	20	Voltage regulator cover	EM	1	5.88
EM-25622	21–22	Auto-Hand switch	Cutler Hammer No. 8381	1	.32
EM-25623	22	Lock washer	Shake Proof No. 1228	1	.01
EM-25624	22	Resistor mounting clip	Ohmite No. 6	2	.....
EM-25625	22	No. 6-32 x 1/4" self tapping slotted CP MS	Std.	6	.01
EM-25626	22	Rubber grommet	Continental Rubber No. 2410	1	.04
EM-25627	22	Terminal blocks	Howard B. Jones Spcl. 9-12	1	.94
EM-25628	22	No. 6-32 x 3/8" RH MS	Std.	2	.01
EM-25629	21	No. 8-32 x 1/4" self tapping slotted CP MS	Std.	21	.01
EM-25630	22	Voltage Regulator frame	EM	1	4.88
EM-25631	22	Ground lead	EM	1	.25
EM-25632	22	Rubber grommet	Continental Rubber No. 2476	3	.04
EM-25633	22	No. 8-32 x 1/2" CP RH MS and hex nut	Std.	2	.01

Note:—See under Voltage Regulator Spares—1 required on non-synchronizing switch cabinet and 2 required on synchronizing switch cabinet.

SPARE PARTS

VOLTAGE REGULATOR — (Cont'd)

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Regulator	Price each
EM-25634	22	Micarta Insulating strip	EM	1	.03
EM-25635	22	Resistor mounting clip	Ohmite No. 5	2	.....
EM-25636	22	Micarta Insulating strip	EM	1	.03
EM-25637	21	No. 6-32 x ½" CP RH MS and hex nuts	Std.	5	.01
EM-25638	21	No. 6-32 x ¾" CP RH MS and hex nuts	Std.	1	.01
EM-25639	21	No. 4-36 x ¾" RH MS and hex nuts	Std.	6	.01
EM-25640	21	No. 8-32 acorn nuts NP	Std.	4	.06
EM-25641	21	Voltage adjusting knob	Dayton No. 119 Thumb Nut	1	.12
EM-25642	21	Name plate	EM	1	.13
EM-25643	21	Micarta insulating strip	EM	1	.04
EM-25644	21	Cross current compensation rheostat knob	Ohmite No. 5100	1	.05
EM-25645	21	Name plate	EM	1	.08
EM-25646	21	No. 4-32 x ¼" self tapping screw	Std.	4	.01
EM-25647	21	Regulator face plate	EM	1	.35

SWITCH CABINETS AND TERMINAL BOX

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25607	16	Current transformer (See voltage regulator parts)	....	....	9.38
EM-25608	24	(See note)	....	....	....
EM-25616	16	Current transformers (See voltage regulator parts)	....	....	32.00
EM-25650	5	Non synchronizing switch cabinet complete	EM	1	930.00
EM-25655	23–24	Transfer switch	Arrow No. 80638	1	3.50
EM-25670*	6	Synchronizing switch cabinet complete	EM	1	1042.00
EM-25671	23–24	3 pole breaker	ITE No. ET1877	2	150.00
EM-25672A	24	Breaker trip units 175 amp	ITE No. ET2468	2	41.88
EM-25672B	24	Breaker trip units 350 amp	ITE No. ET2583	2	41.88
EM-25673	24	Stud for rear connection on air circuit breaker, 400 amp. ¾-20x 5½"	ITE No. ET0923	12	.45
EM-25674	24–16	Lug for generator and load connections (5 on term. box)	Burndy No. QA-34	10	.40
EM-25675*	23	Transfer switch	Arrow No. 80983	1	5.20
EM-25677	23–24	Frequency meter, 4" round	Roller Smith No. FA-4	1	115.25
EM-25678*	23	Synchronizing lamp	GE No. 10S-14	1	.29
EM-25679*	23	Synchronizing lamp switch 15 amps, 125 volts	Arrow No. 8721-N SPST	1	2.01
EM-25680*	23	Synchronizing lamp receptacle	GE No. 49x866	1	1.04
EM-25681*	23	Synchronizing lamp resistor 25 watts, 1500 ohms	Ohmite, Dividohm	1	1.40
EM-25683	23–24	Connection — No. 12 flexible switchboard wire	Std.	....	....

* These parts used on sychronizing switch cabinets only.

SWITCH CABINETS AND TERMINAL BOX — *(Cont'd)*

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25685	23	Front cover plate	EM	1	7.50
EM-25686	23	Frame and side plates	EM	1	31.25
EM-25687	24	Operation handles	ITE Extended Handles	2	2.50
EM-25688	24	Bus	EM	....	10.00
EM-25689	24	½"-13 x 1½" hex head with nut and lock washer	Std.	9	.08
EM-25690	16–17	Terminal stud, (½"-13, 5¼" long) with 5 nuts, 3 washers and 1 lock washer	EM	9	.35
EM-25691	16–17	Terminal stud, (¼"-20, 3" long) with 4 nuts, 2 washers and 1 lock washer	EM	3	.17
EM-25692	16	Connector links, large, 3/16" x 1½" x 5⅛"	EM	6	.18
EM-25693	16	Connector link, small, 1/16" x ¾" x 2¾"	EM	1	.10
EM-25695	7	Breaker cover	ITE No. 98501-A	2	10.00
EM-25696	7	⅜"-16 HH nut and cup washer	Std.	12	.02
EM-25697	7	⅜"-16 x 1" FH mach. screw	Std.	12	.02
EM-25698	7	⅜"-16 x ¾" FH mach. screw	Std.	2	.02
EM-25700	8–16	Terminal box complete	EM	1	173.75
EM-25701	16–17	Terminal stud, (½"-13, 7½" long) with 7 nuts, 6 washers and 1 lock washer	EM	1	3.44
EM-25702	17	Terminal stud, (¼"-20, 2" long) with 2 nuts, 2 washers and 1 lock washer	EM	1	.25
EM-25703	17–18	Terminal block	C. H. 80-434.14, 12 point	1	2.63
EM-25704	16	Frame	EM	1	32.50
EM-25705	16	⅜"-16 x 1½" HH Cap Screw, lock washer, nut and cut washer	Std.	7	.04
EM-25706	16	Ebony Asbestos Panel ¾" x 11½" x 21"	EM	1	5.40
EM-25707	16	¼"-20 x 1" HH cap screws	Std.	4	.05
EM-25708	16	¼"-20 x 1½" HH cap screws	Std.	4	.05
EM-25709	16	½"-13 x 1¼" HH cap screws	Std.	5	.05
EM-25710	17	Leads No. 12 flexible	Std.	....	.....
EM-25711	17	1" flexible conduit, BX cable and fittings	EM	1	.69
EM-25712	17	1" pipe conduit and fittings	EM	1	.57
EM-25713	17	Lead clamps with two (No. 8 x ¾" self tapping RH) bolts	EM	7	.04
EM-25714	....	Cover	EM	1	22.50
EM-25715	17	Conduit mtg. plate and 2¼"-20 x 1" bolts	EM	1	.40
EM-25716	17	CT mtg. clamp with ¼"-20 x 2" HH	EM	2	.07
EM-25717	17	Bus connections ¼" x 1½" copper	EM	4	.13
EM-25718	17	¼"-20 x ¾" FH machine screw with nuts	Std.	2	.05

GENERATOR

Item No.	Fig.	Description	Required per Generator	Price each
EM-518001	8	¼"-20 studs 1¼" long with jamb nuts	4	$ 0.09
EM-518002	15	Armature core with coils	1	741.25
EM-518003	12	Armature core without coils	1	308.75
EM-518004	15	Armature Ring	1	133.75
EM-518005	8	⅝"-11 Lifting Eyebolt	3	.55
EM-518006	8	Drip cover—coupling end	1	10.31
EM-518007	8	5/16"-18 Hex. Head cap screw ½" long	20	.02
EM-518008	8	Baffle—coupling end	1	6.69
EM-518009	13	Armature coil	72	3.88
EM-518010	9	Blower	2	9.29
EM-518011	9	½"-13 Hex. Head cap screw 3½" long	12	.13
EM-518012	8	¾" x ¾" x 4½" coupling key	1	.61
EM-518013	11	Shaft only	1	61.88
EM-518014	8	5/16"-18 machine screw ¾" long	16	.02
EM-518015	8	Guard Screen—coupling end	1	7.20
EM-518016	8	Exhaust screen—coupling end	2	4.38
EM-518017	....	Rotor spider with shaft	1	61.88
EM-518018	11	⅝" x ⅝" x 10¾" rotor key	1	.69
EM-518019	8	Exhaust screen center	2	3.61
EM-518020	8	Bottom screen	1	7.23
EM-518021	15	⅜" x 3¼" core pin	2	.18
EM-518022	8	Rotor complete with shaft	1	850.00
EM-518023	8	1/16" x ⅝" gasket—28" long	2	.41
EM-518024	....	Exhaust screen—sheave end	2	4.38
EM-518025	9	Field leads—No. 10 flexible cable	2	.80
EM-518026	8	Field lead clip AM-2	1	.15
EM-518027	8	¼"-20 RH machine screw ½" long	5	.02
EM-518028	....	Field lead lug—35 amp. solder type	4	.16
EM-518029	9	10-24 RH machine screw ⅝" long with hex. nut	2	.02
EM-518030	10	Carbon brushes	4	.48
EM-518031	10	Brush holder complete with spring	2	.79
EM-518033	10	10-32 RH machine screw ¾" long	2	.02
EM-518034	9	Brush holder stud with jamb nut	1	1.13
EM-518035	10	Field lead support	2	.04
EM-518036	10	10-32 RH machine screw ½" long	2	.02
EM-518038	8–14	Armature leads—4 laminations .031" x 1¼"	10	1.24
EM-518039	8	Baffle—sheave end	1	6.69
EM-518040	9	Damper bars	42	.51
EM-518041	9	Cage end ring segments	12	1.65
EM-518042	....	Collector ring assembly complete	1	20.13
EM-518043	9	5/16"-18 socket head set screw ¾" long	2	.10
EM-518044	....	Collector ring sleeve	1	6.79
EM-518045	9	Collector ring	2	8.66
EM-518046	9	¼"-20 filister head machine screws ¾" long	6	.02
EM-518047	8	Bearing bracket	1	49.25
EM-518048	8	⅝"-11 hex. head cap screw 1½" long	6	.10
EM-518049	8	¼" pipe plug for the greasing and drain plugs	2	.09
EM-518050	8	¼" pipe coupling for the drain plug	1	.09
EM-518051	8	¼" pipe nipple 9" long for the drain plug	1	.11
EM-518052	8	⅜"-16 hex. head cap screw ¾" long	6	.03
EM-518053	9	Ball bearing	1	8.25
EM-518054	9	Bearing housing cap	1	12.38
EM-518056	9	Housing cap screws ⅜"-16 hex. head cap screw 1" long	15	.04
EM-518057	9	Bearing housing	1	18.56
EM-518058	8	½"-13 hex. head cap screw 1¾" long	4	.07
EM-518059	9	Sheave spacer	1	5.44
EM-518060	8	½"-13 flat head cap screw 1¼" long	1	.14
EM-518061	8	Retaining washer	1	2.23
EM-518062	....	⅜" x ⅜" x 1⅞" drive sheave key	1	.13
EM-518063	12	Lashing ring	....	.20
EM-518064	8	Drive sheave	1	20.63
EM-518065	8	5/16"-18 Wing nut	1	.03
EM-518066	8	Hand hole cover	1	5.56
EM-518067	8	¼" nipple 5½" long for greasing plug	1	.11
EM-518068	8	¼" x 90° pipe elbow for greasing plug	1	.13

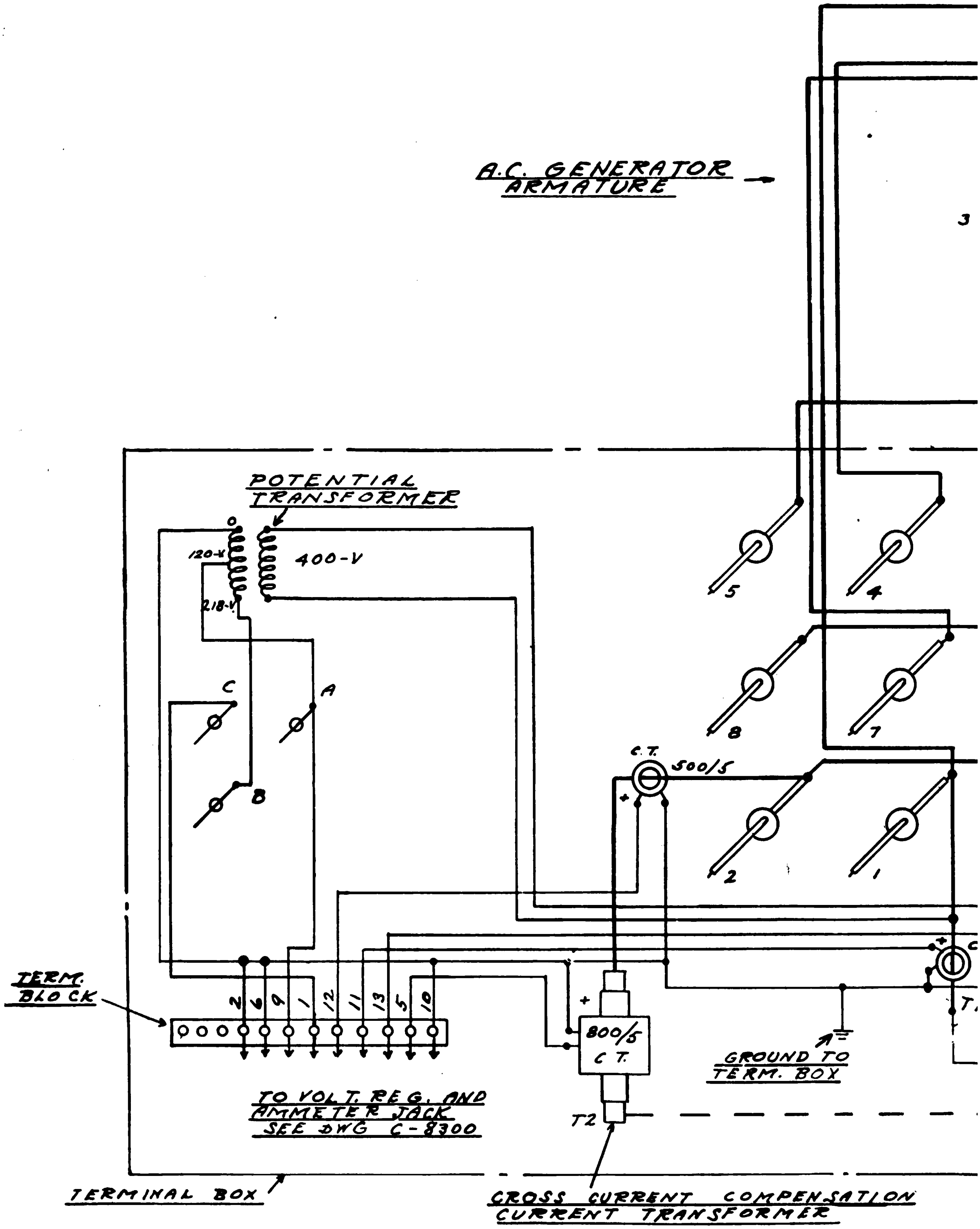
GENERATOR — (Cont'd)

Item No.	Fig.	Description	Required per Generator	Price each
EM-518069	9	3/8"-16 hex. head cap screw with cut washer and jamb nut	1	.09
EM-518070	8	V-belt guard—back	1	7.21
EM-518071	8	V-belt guard—front	1	28.88
EM-518072	8	V-belts	3	2.33
EM-518073	8	Exciter mounting plate	1	5.15
EM-518074	8	5/8"-11 special stud 5½" long with jamb nuts	4	.38
EM-518075	19	3/16" x 3/16" x 2" exciter key	1	.11
EM-518077	8–19	Exciter sheave	1	7.84
EM-518078	13	Armature slot wedges	1 set	9.16
EM-518079	12	Armature slot insulation	1 set	6.80
EM-518081	11	Field pole complete with coil, cages, pins and shims	6	76.25
EM-518082	11	Pole shims	6 sets	.15
EM-518083	11	Pole pins	6	.66
EM-518084	9	5/16" x 7.8" iron rivet with cut washer	12	.02
EM-518085	14	Armature paralleling connections	....	.....

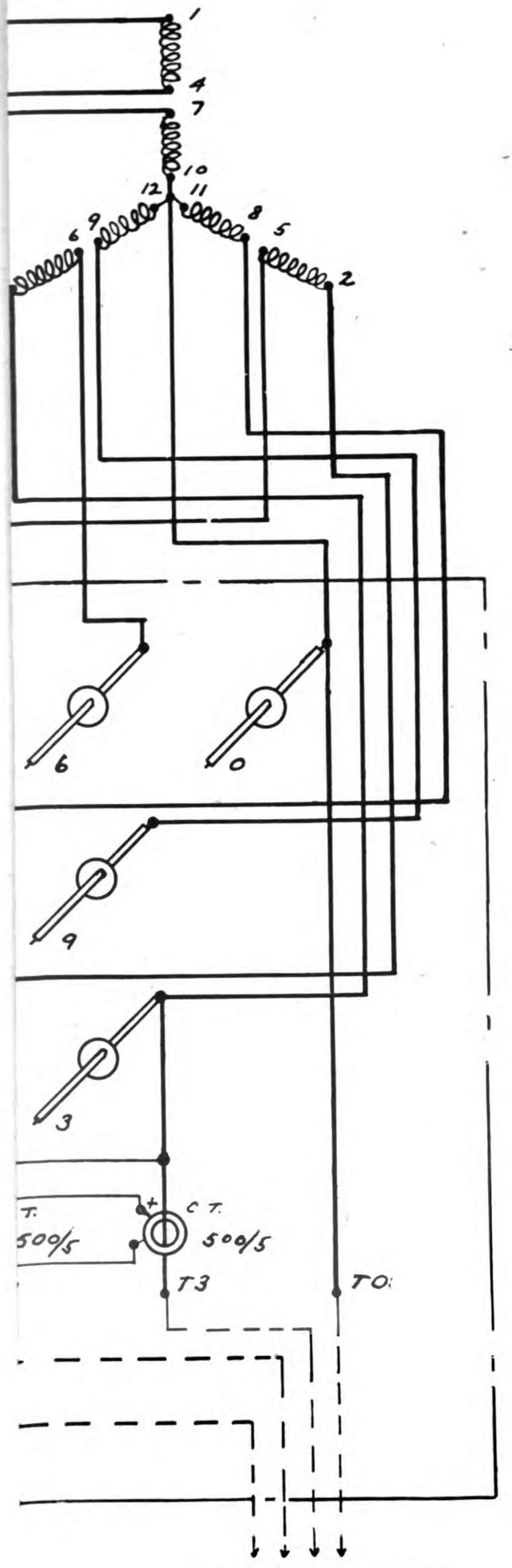
EXCITER

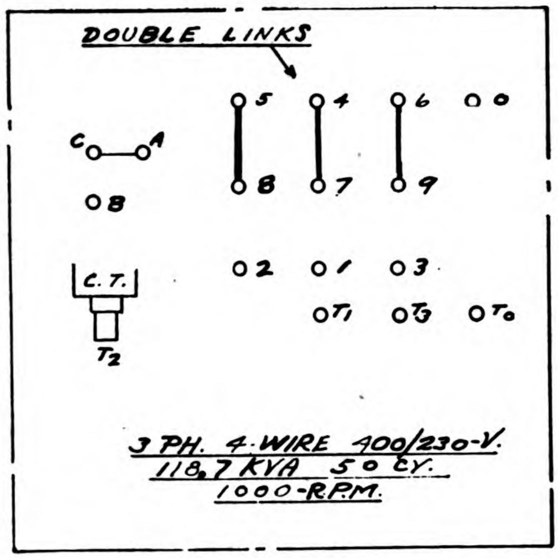
Item No.	Fig.	Description	Required per Exciter	Price each
EM-518087	8	Exciter complete	1	239.00
EM-518088	19	1/4"-20 hex. head cap screw 1" long	3	.02
EM-518089	19	1/8" pipe plug with slotted head	4	.07
EM-518090*	19	Locknut sheave end	1	.58
EM-518091*	19	Lockwasher—sheave end	1	.15
EM-518092	19	Ball bearing No. 305 sheave end	1	4.33
EM-518093	19	Gasket sheave end	1	.51
EM-518094	19	Bearing cap sheave end	1	2.16
EM-518095	19	Drip cover and hold-down screws—sheave end	1	8.65
EM-518097	19	Bearing bracket—sheave end	1	5.78
EM-518098	19	5/16"-18 hex. head cap screw 1" long	8	.03
EM-518099	....	Set screw, fan	1	.10
EM-518100	19	Armature fan	1	8.25
EM-518101	19	Armature complete with coils, fan and shaft	1	86.63
EM-518103	....	Interpole coil with insulation	2	8.65
EM-518104	....	Interpole	2	8.65
EM-518105	19	Pole bolts 3/8"-16 hex. head cap screw 1/2" long	8	.03
EM-518106	19	Field pole	2	11.50
EM-518107	19	Field coil with insulation	2	7.58
EM-518108	19	Field frame	1	101.25
EM-518110	19	Commutator V-ring sleeve	1	4.90
EM-518111	19	Mica V-ring	2	4.01
EM-518112	19	Commutator V-ring	1	3.05
EM-518113	19	Commutator locknut	1	1.20
EM-518114	19	Bearing cap—commutator end	1	1.81
EM-518115	19	Gasket—commutator end	1	.83
EM-518116	19	Drip covers and hold-down screws—commutator end	1 set	8.65
EM-518117	19	Screens and hold-down screws—commutator end	1 set	8.65
EM-518119	19	Brush holder stud with jamb nut	2	1.74
EM-518120	19	Ball bearing No. 304—commutator end	1	3.61
EM-518121*	19	Lock washer—commutator end	1	.18
EM-518122*	19	Locknut—commutator end	1	1.20
EM-518123	19	Shaft	1	7.58
EM-518125	19	5/16"-18 hex. head cap screws 2" long	2	.03
EM-518126	19	Clamp scr. and nut 10-24 rd. hd. M.S. cut wash. and hex. nut	1	.10
EM-518127	19	Brush yoke rocker	1	3.61
EM-518128	19	Bearing bracket—commutator end	1	6.85
EM-518129	19	Carbon brush	4	.46
EM-518130	19	Brush holder	2	4.33
EM-518131	19	1/4"-20 hex. hd. cap screw—5/8" long with lock washer	2	.09
EM-518133	19	Brush holder spring	4	.09
EM-518134	19	Brush holder finger	4	.14
EM-518136	19	Armature leads No. 10 flexible cable	....	.....
EM-518137	19	Terminal box	1	.50
EM-518138	19	Field leads No. 12 flexible cable	....	.....

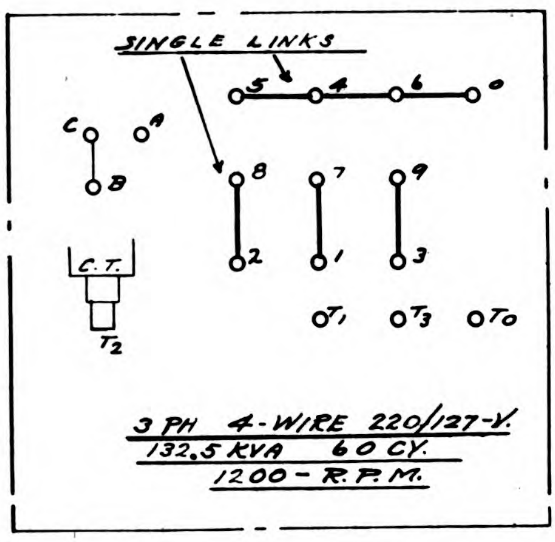
*** Some exciters are furnished with a snap ring instead of lock nut and washers. Snap rings may be furnished for 7c each.**



A.C. GENERATOR ARMATURE
3
POTENTIAL TRANSFORMER
120-V
218-V
400-V
C
A
B
5
4
8
7
C.T.
500/5
2
1
TERM. BLOCK
2 6 9 1 12 11 13 5 10
800/5 C.T.
T2
GROUND TO TERM. BOX
TO VOLT. REG. AND AMMETER JACK SEE DWG C-8300
TERMINAL BOX
CROSS CURRENT COMPENSATION CURRENT TRANSFORMER







TO LINE UNIT
SEE DWG. CO-8304

REF. DWG 0-8283
C-8300

ILLUSTRATIONS

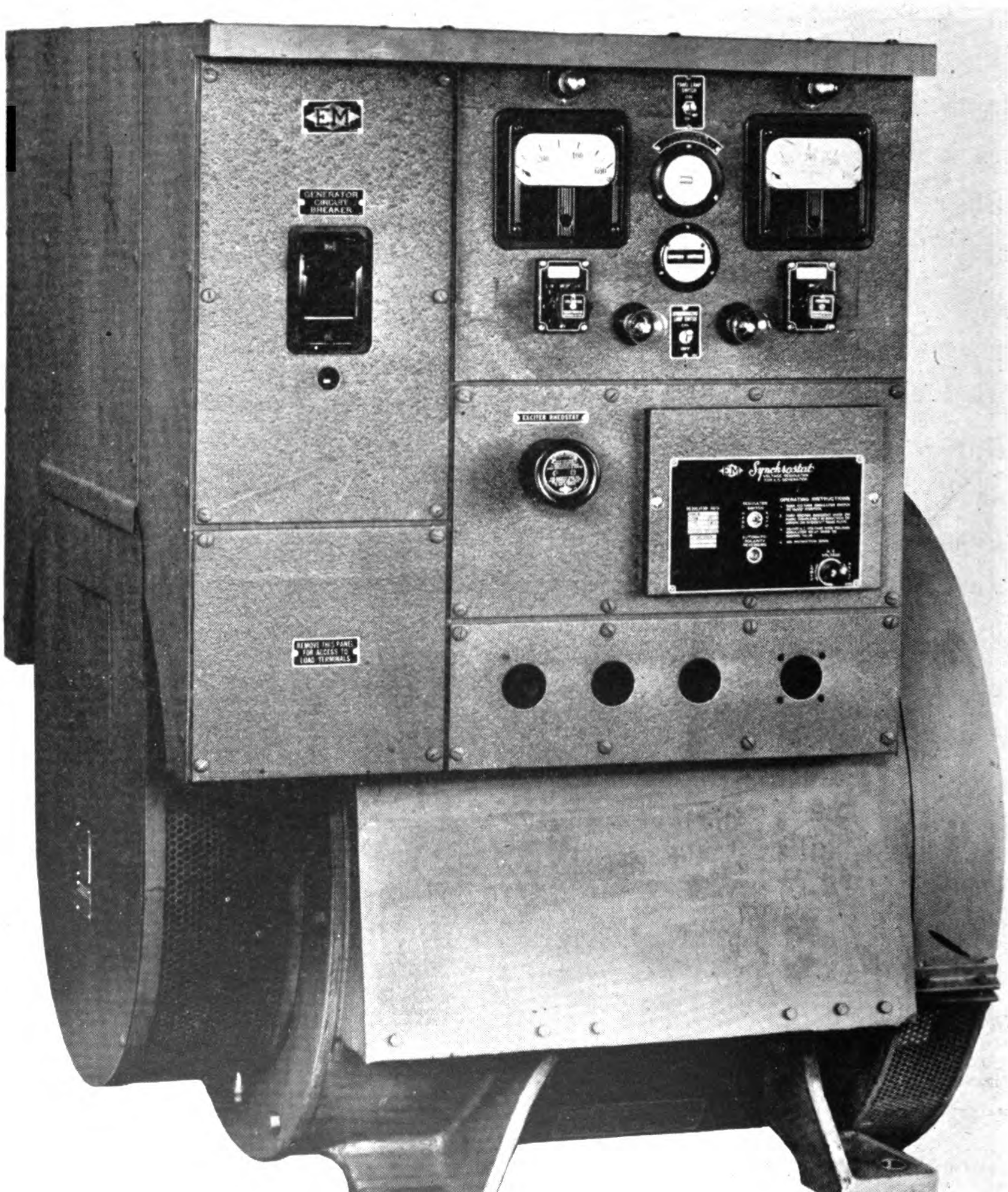


FIG. 25—Generator and Controls Complete

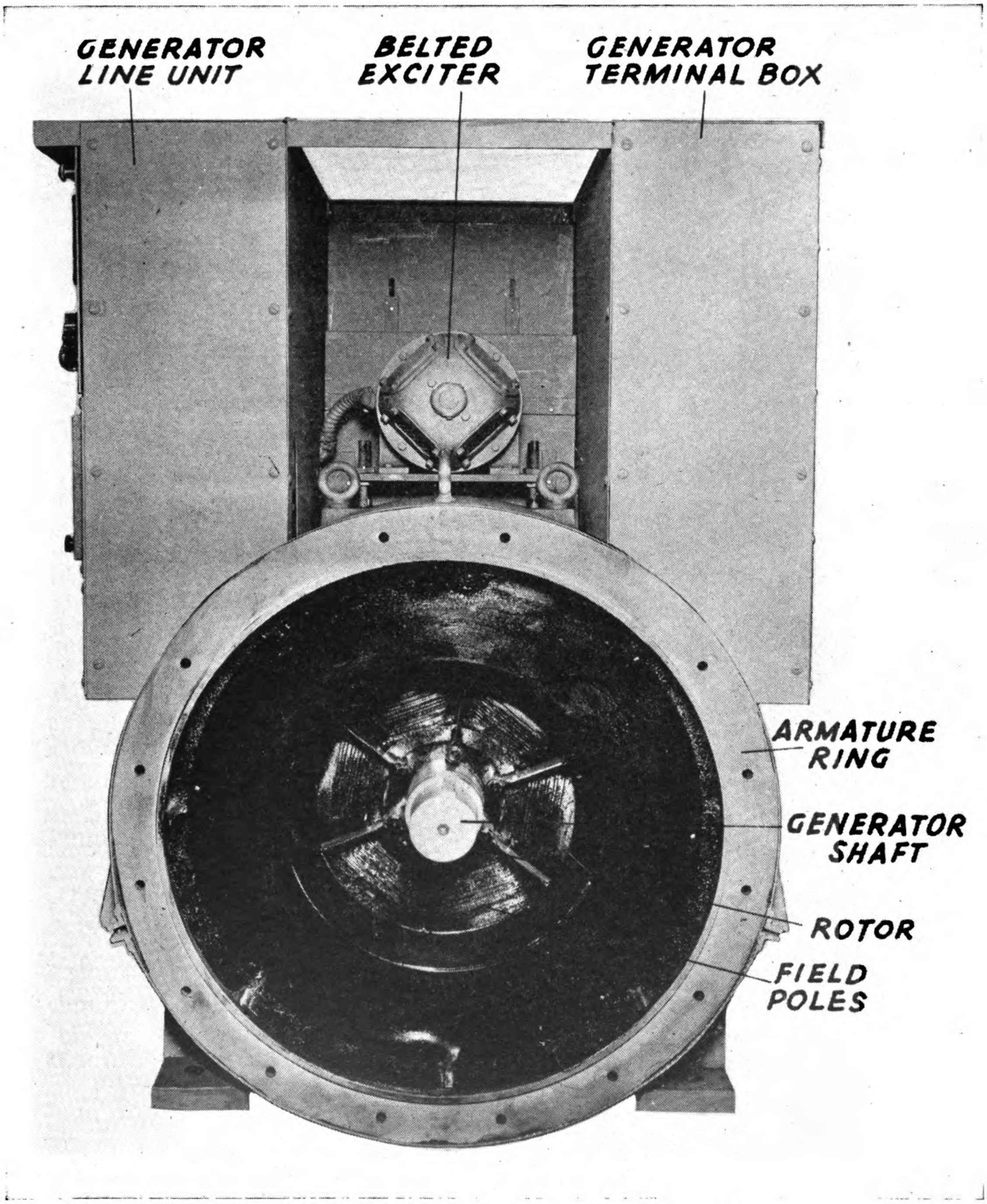


FIG. 26—Generator from Shaft Extension End

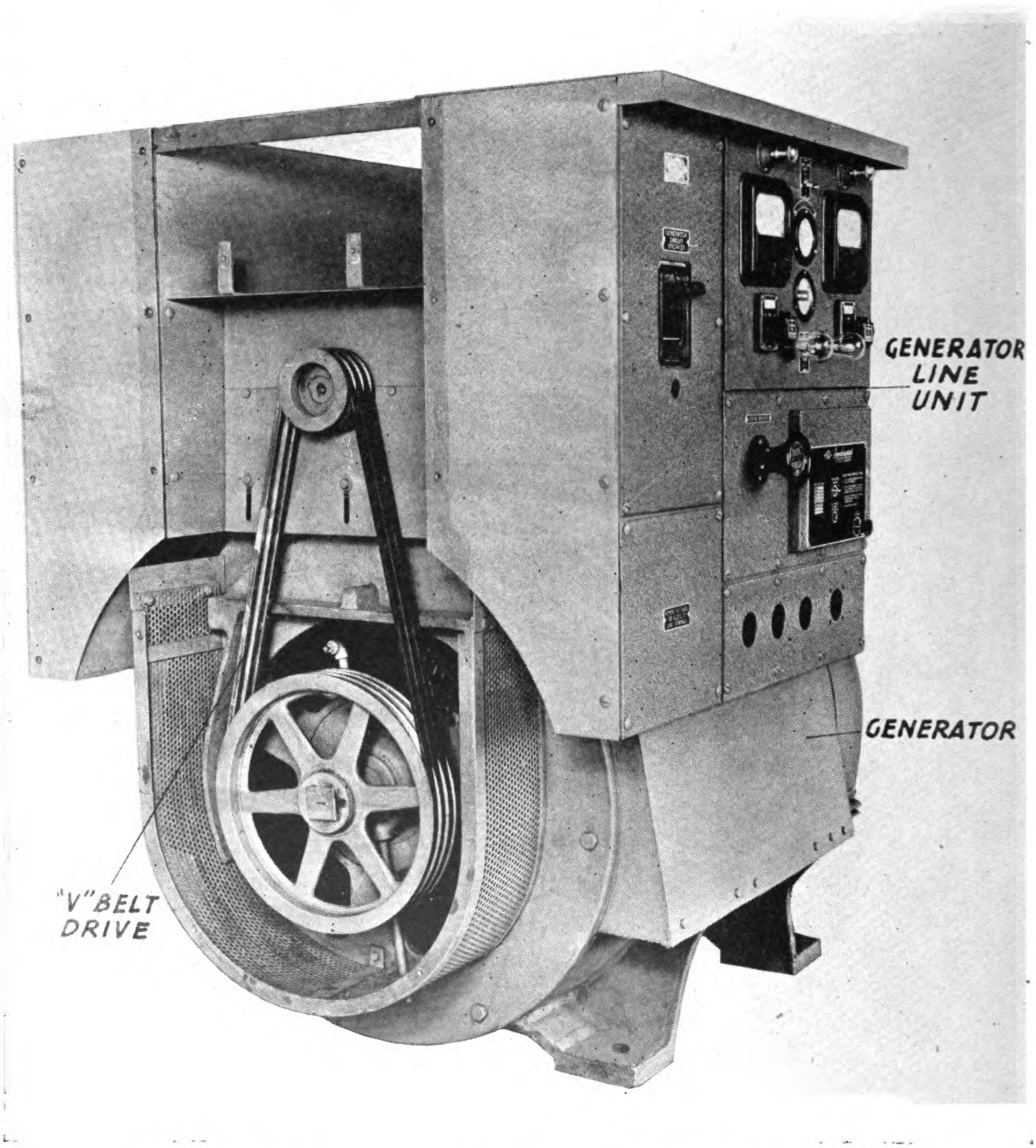


FIG. 27—Generator from Drive Sheave End—Back Plates Removed

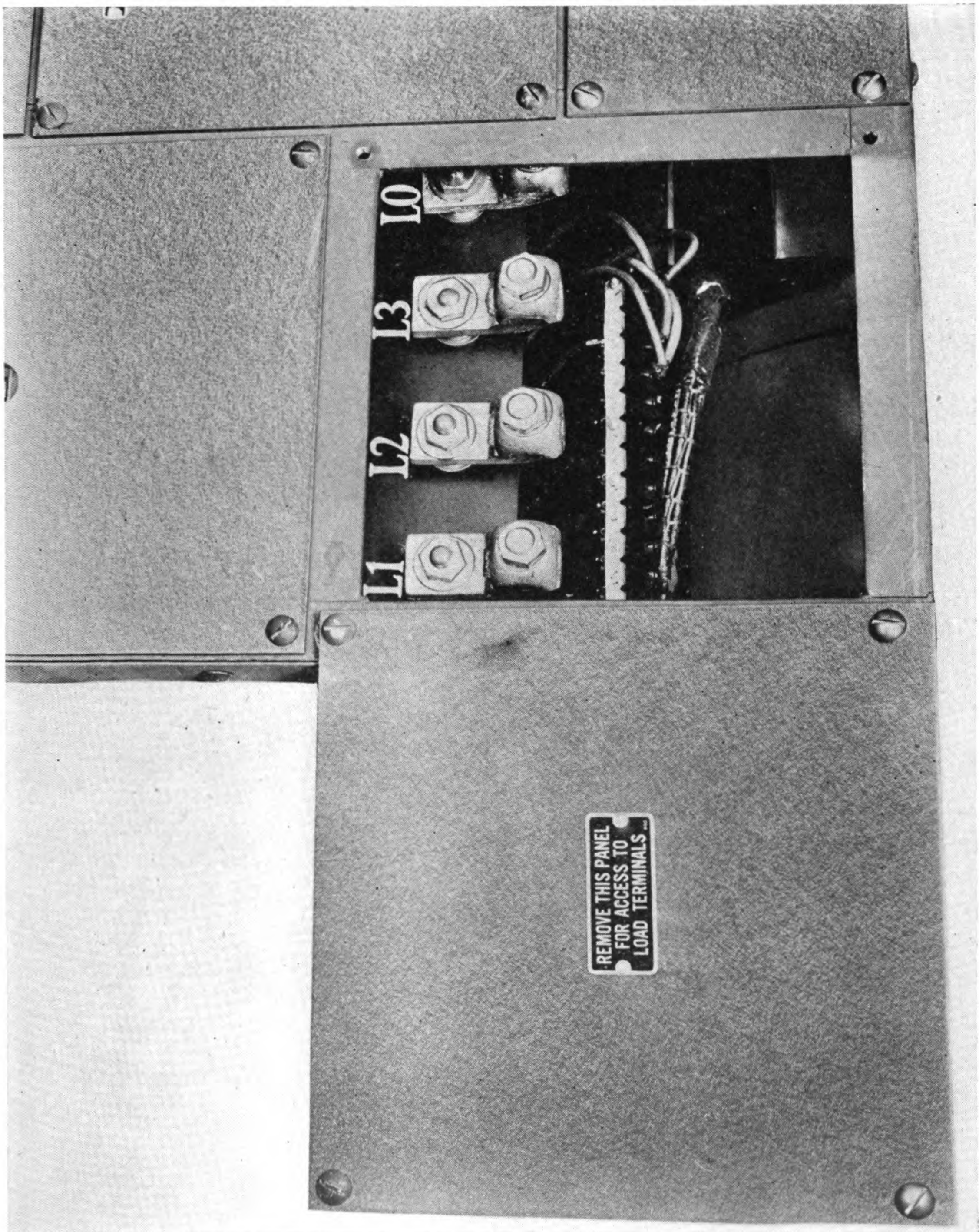


FIG. 28—Load Terminal Connections

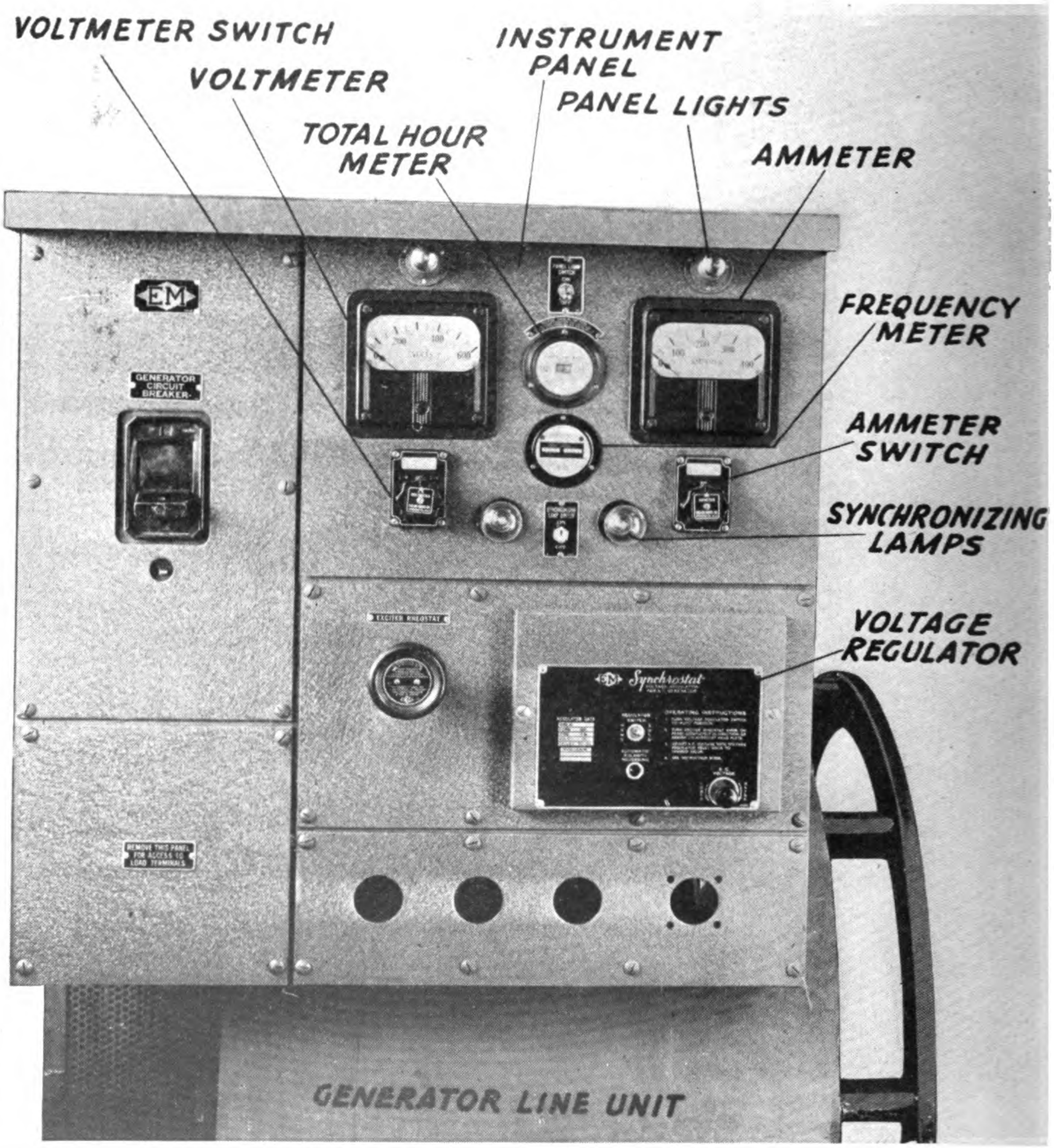


FIG. 29—Generator Line Unit

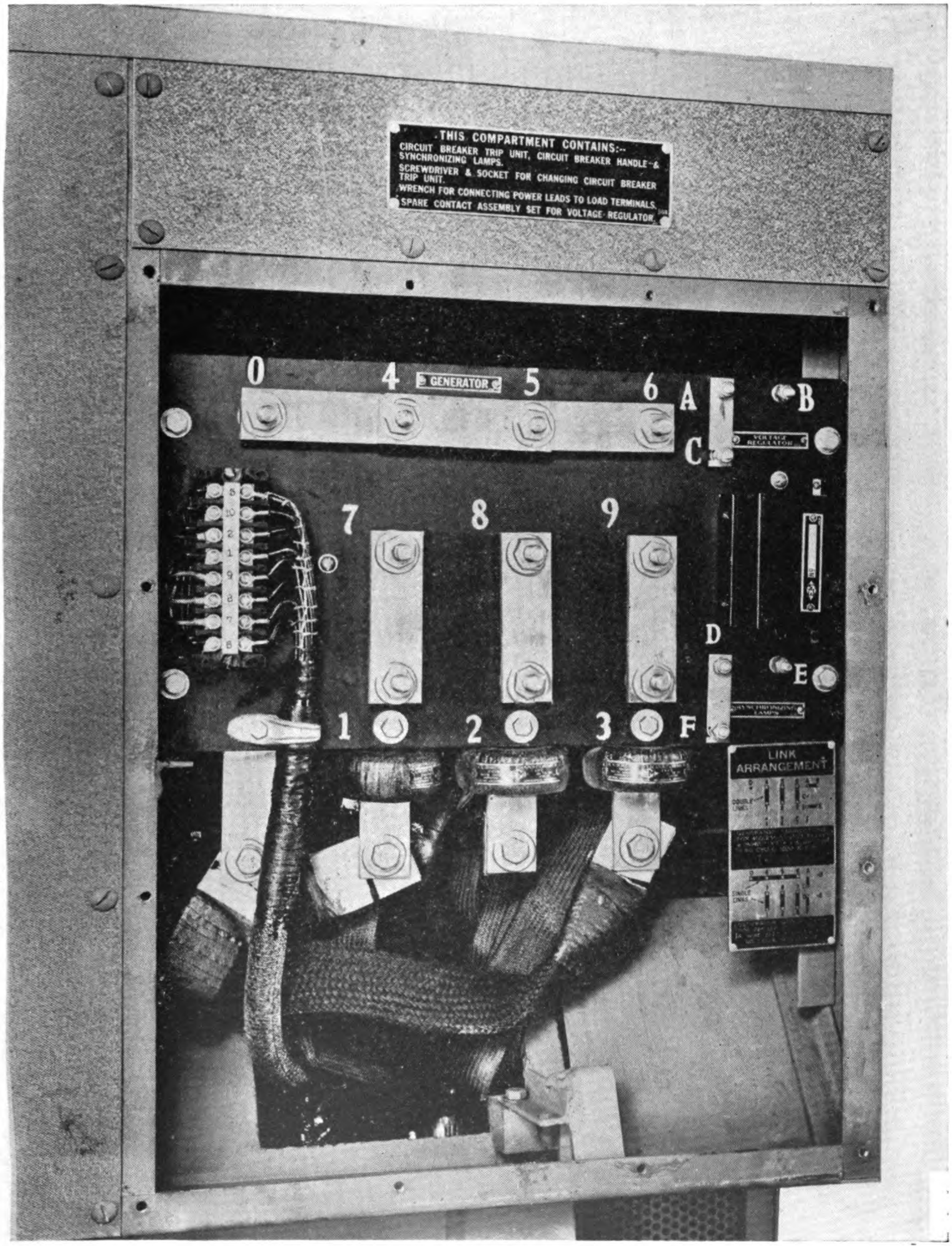


FIG. 30—Terminal Box, 220/126 Volt, 60 Cycle, 1200 RPM Connections

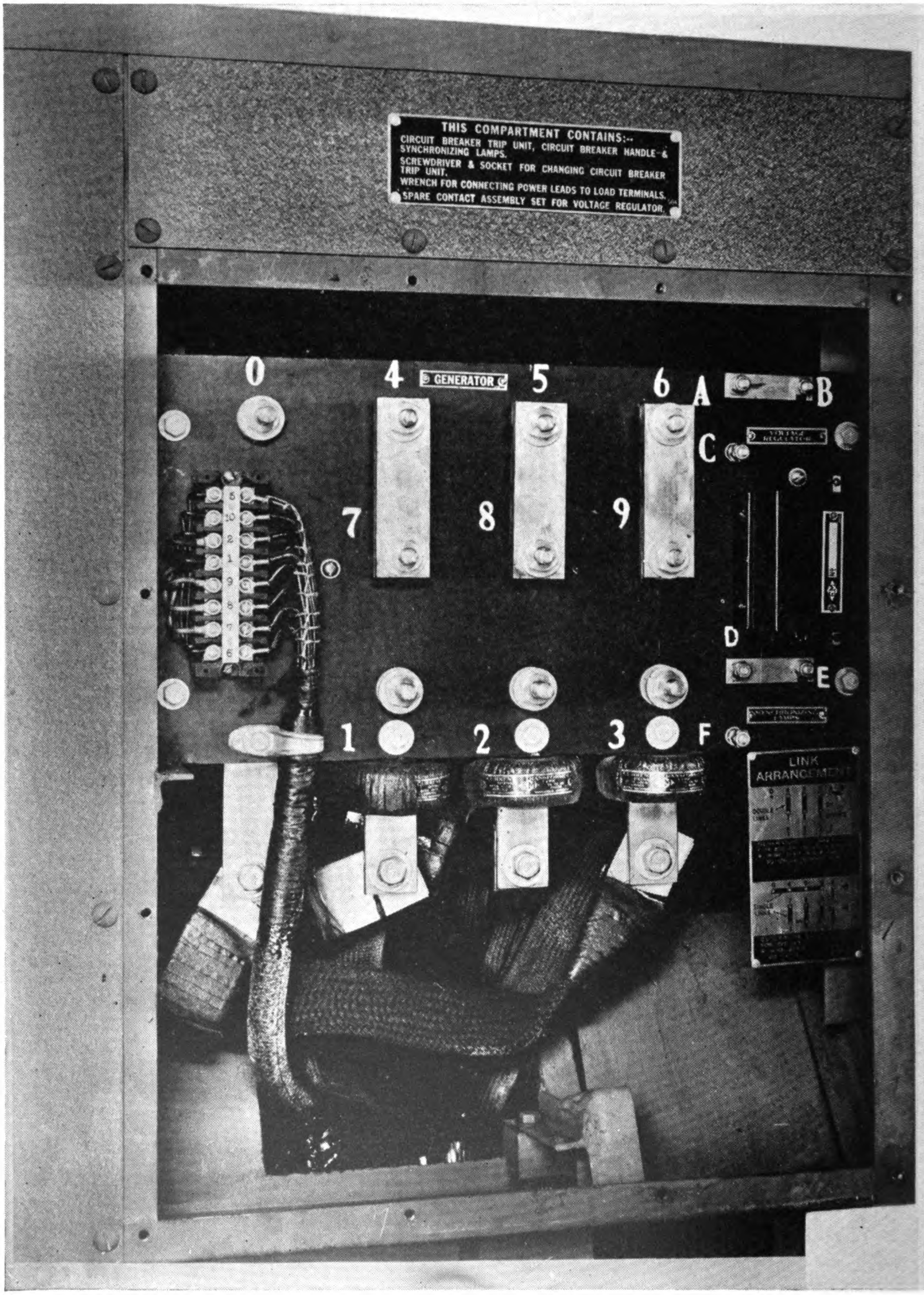


FIG. 31—Terminal Box, 400/230 Volt, 50 Cycle, 1000 RPM Connections

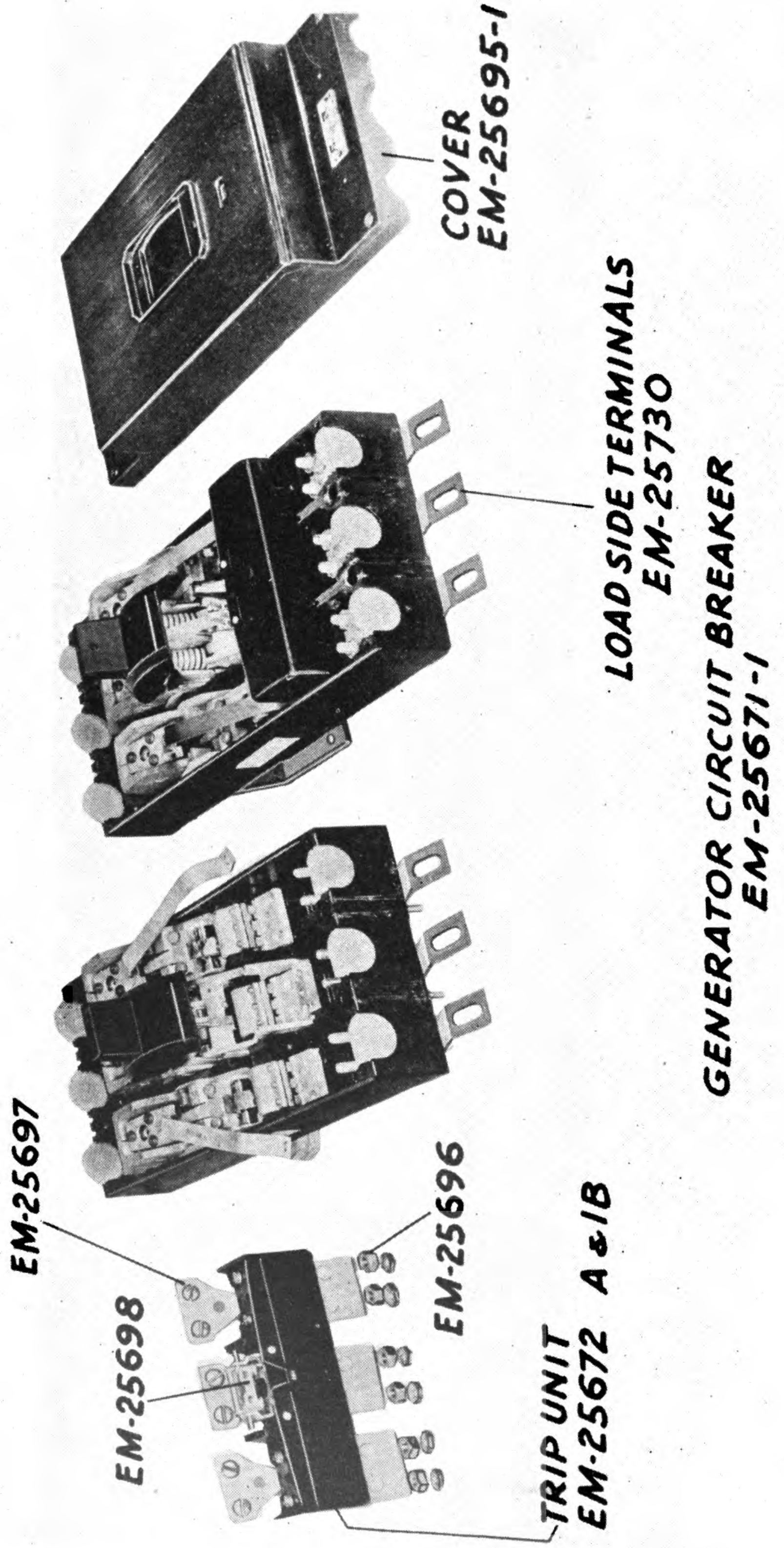


FIG. 32—Generator Circuit Breaker and Trip Unit

FIG. 33—Generator—Exploded View

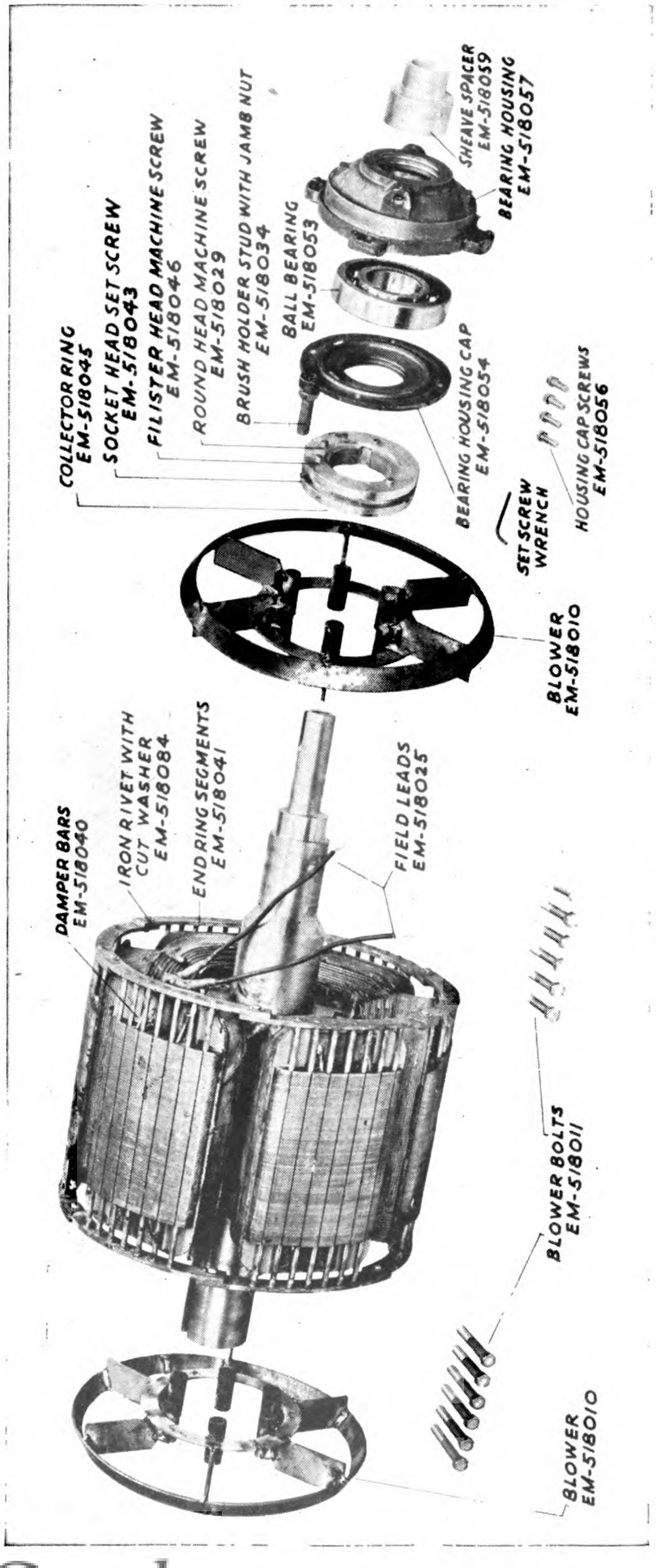


FIG. 34—Rotor—Exploded View

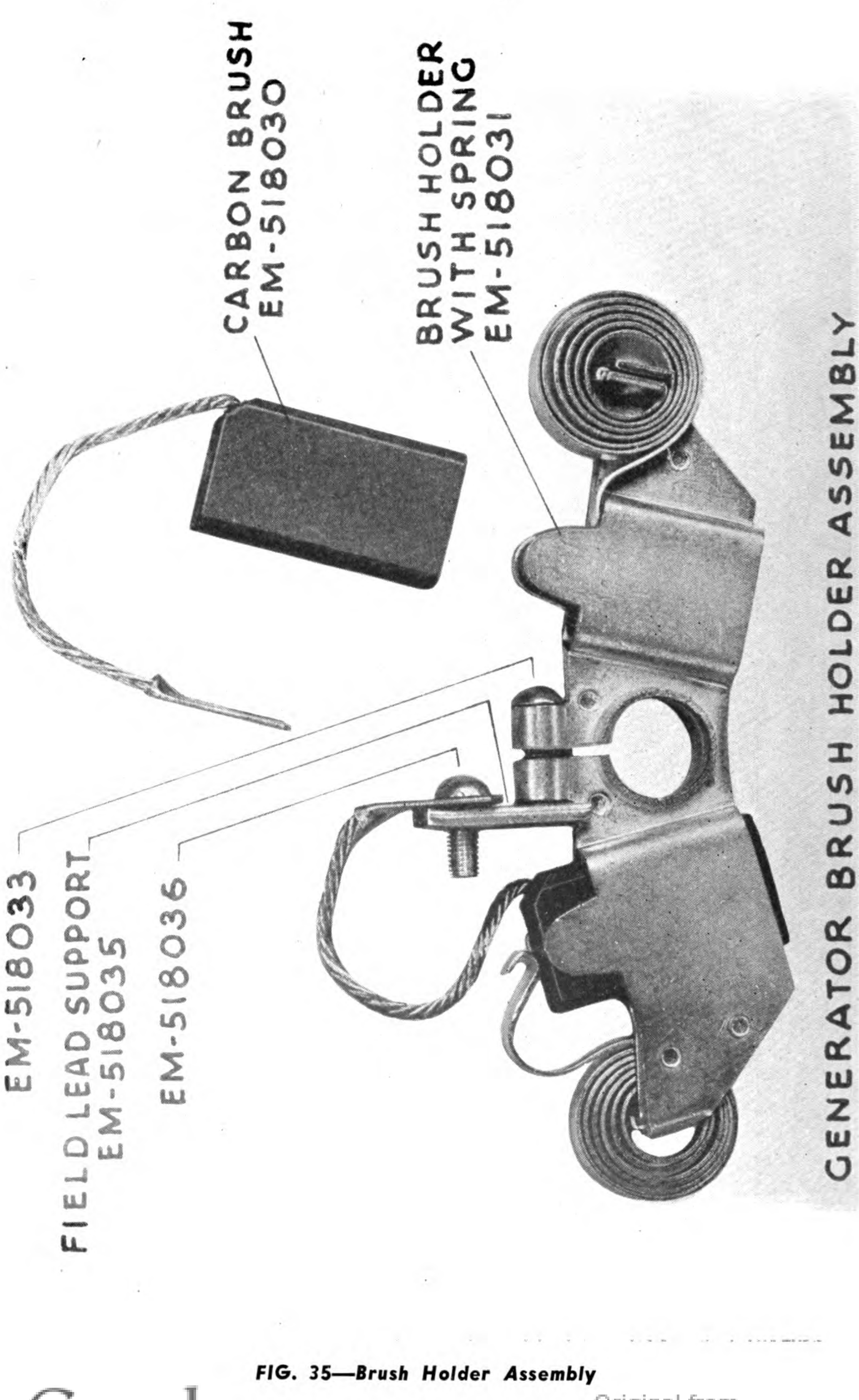


FIG. 35—Brush Holder Assembly

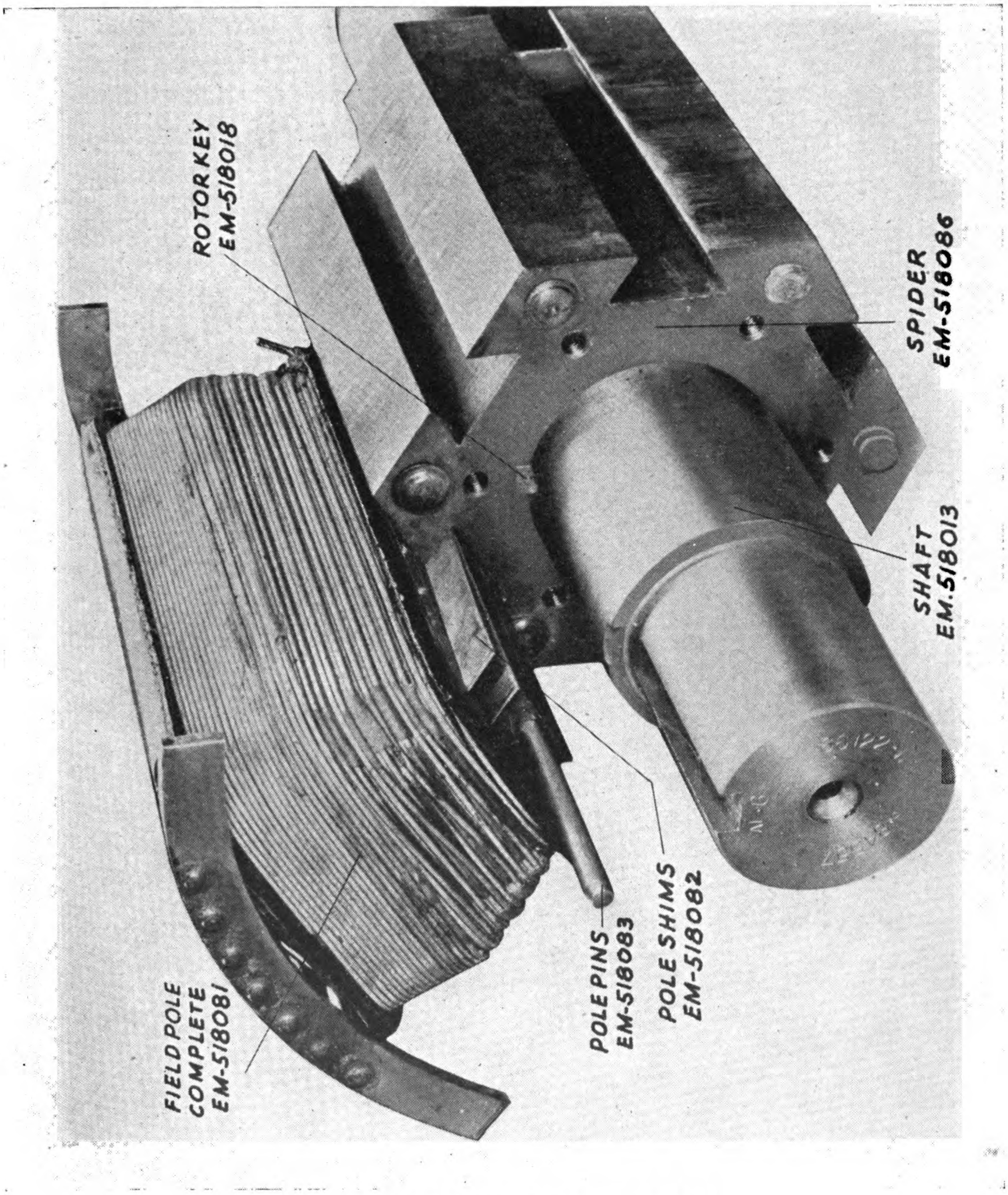


FIG. 36—Field Pole, Spider and Shaft

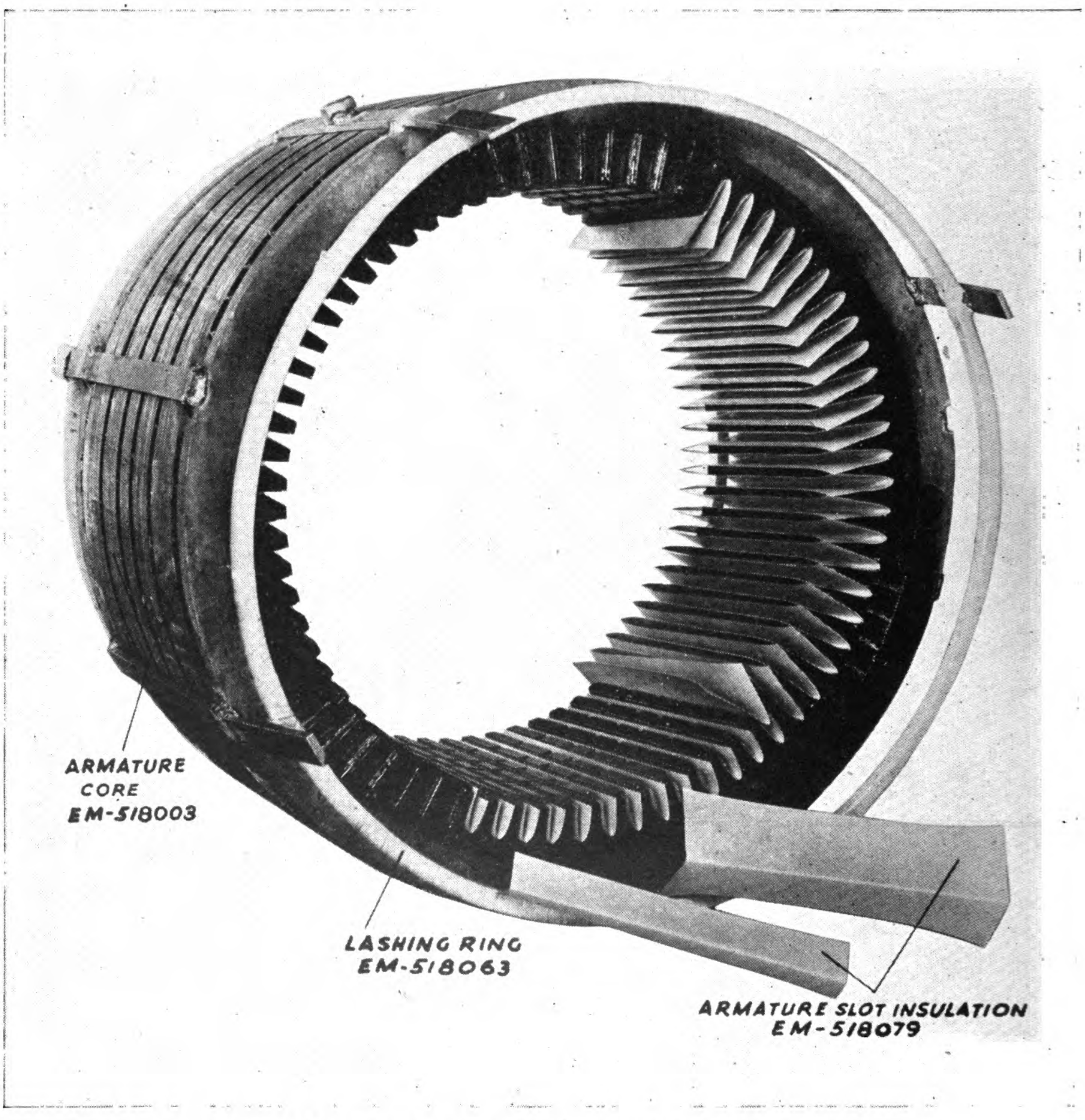


FIG. 37—Armature Core and Insulation

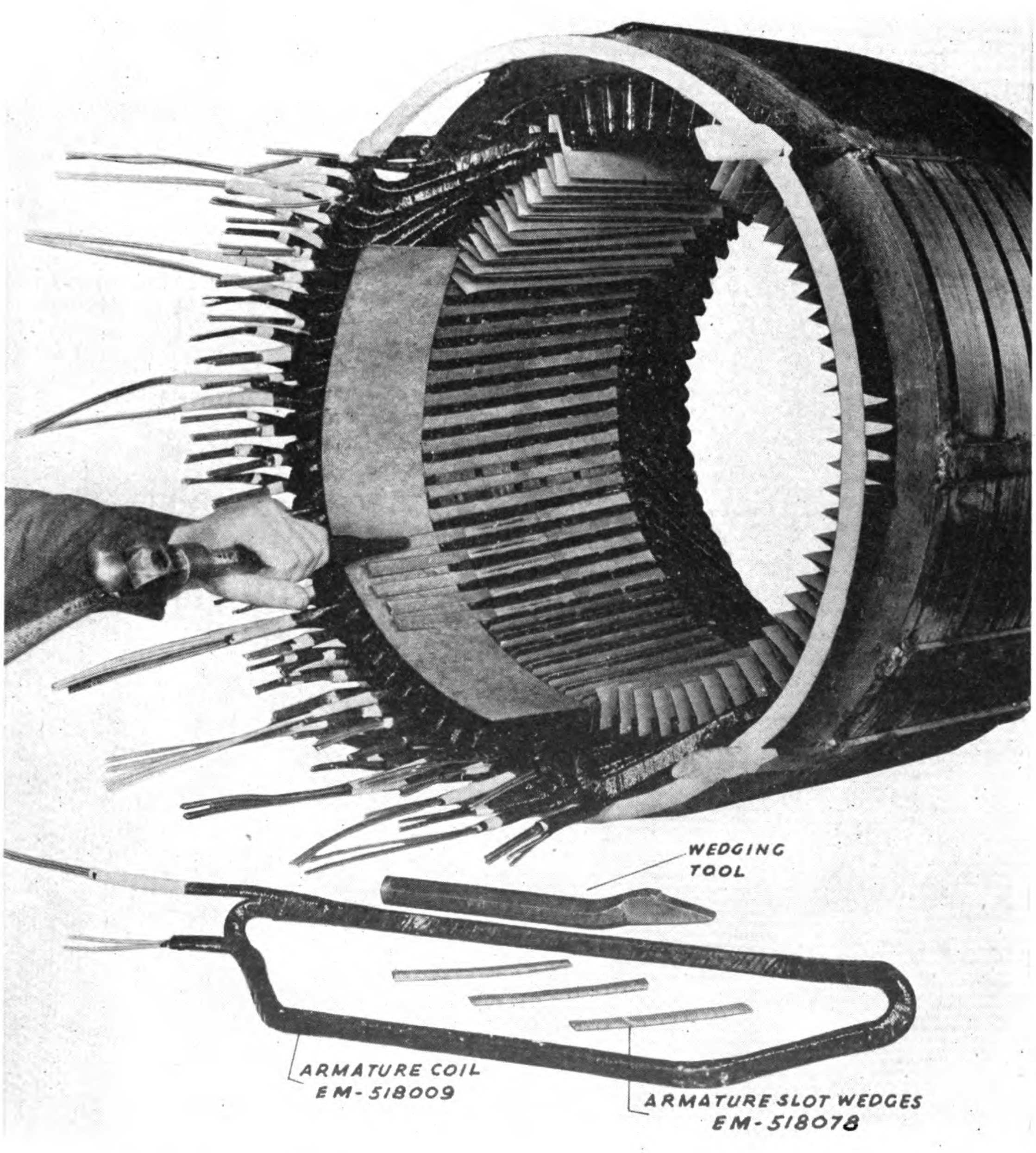


FIG. 38—Armature Coils and Core

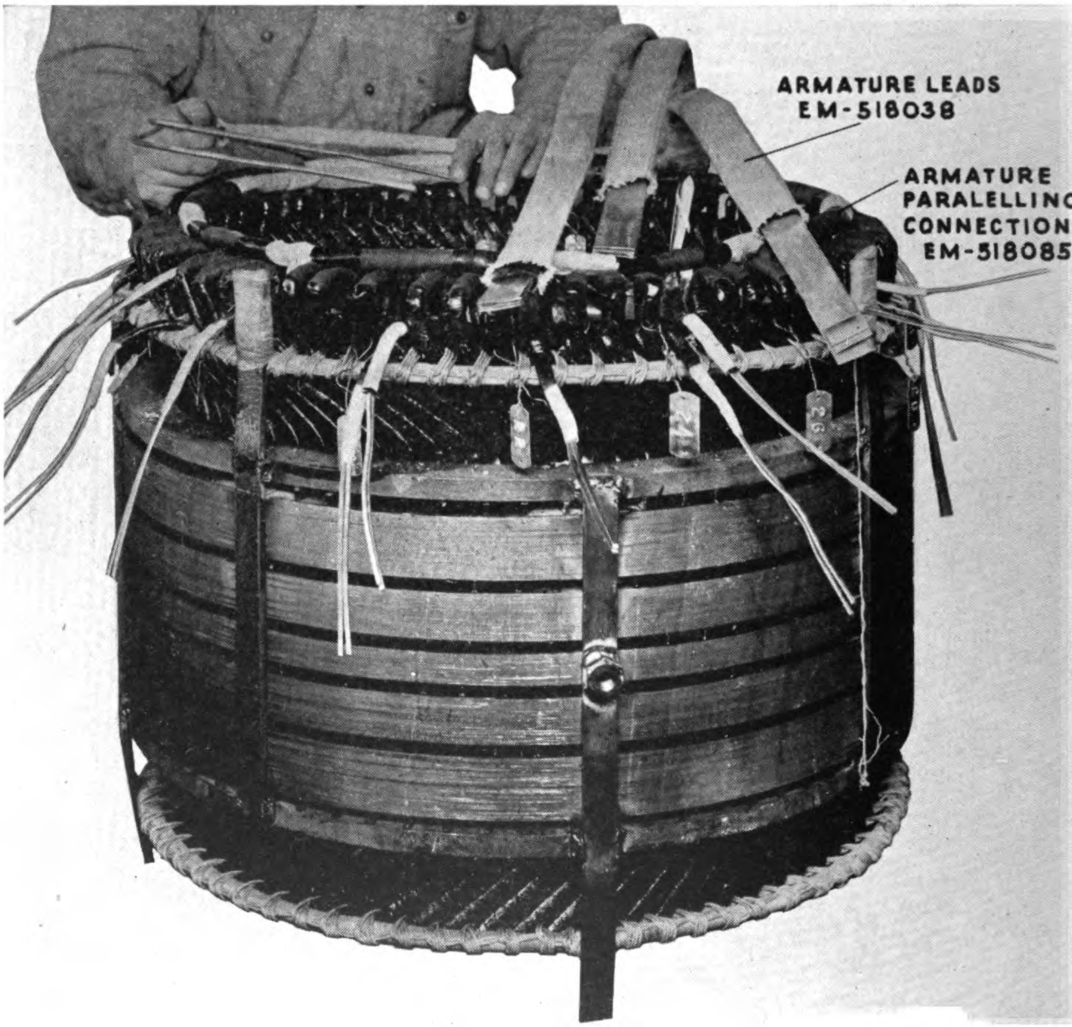


FIG. 39—Armature Core and Connections

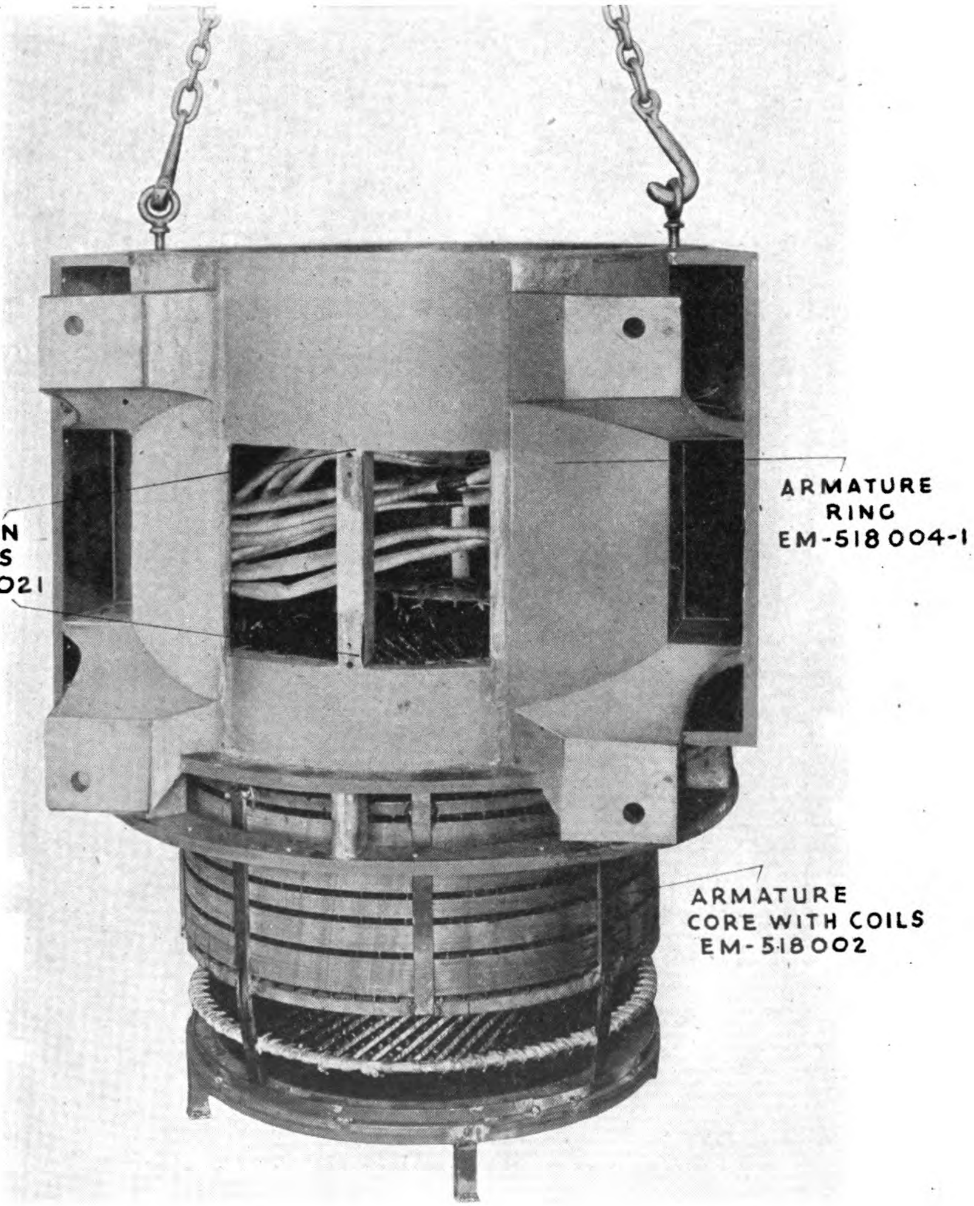


FIG. 40—Armature Ring and Core

FIG. 41—Exciter Exploded

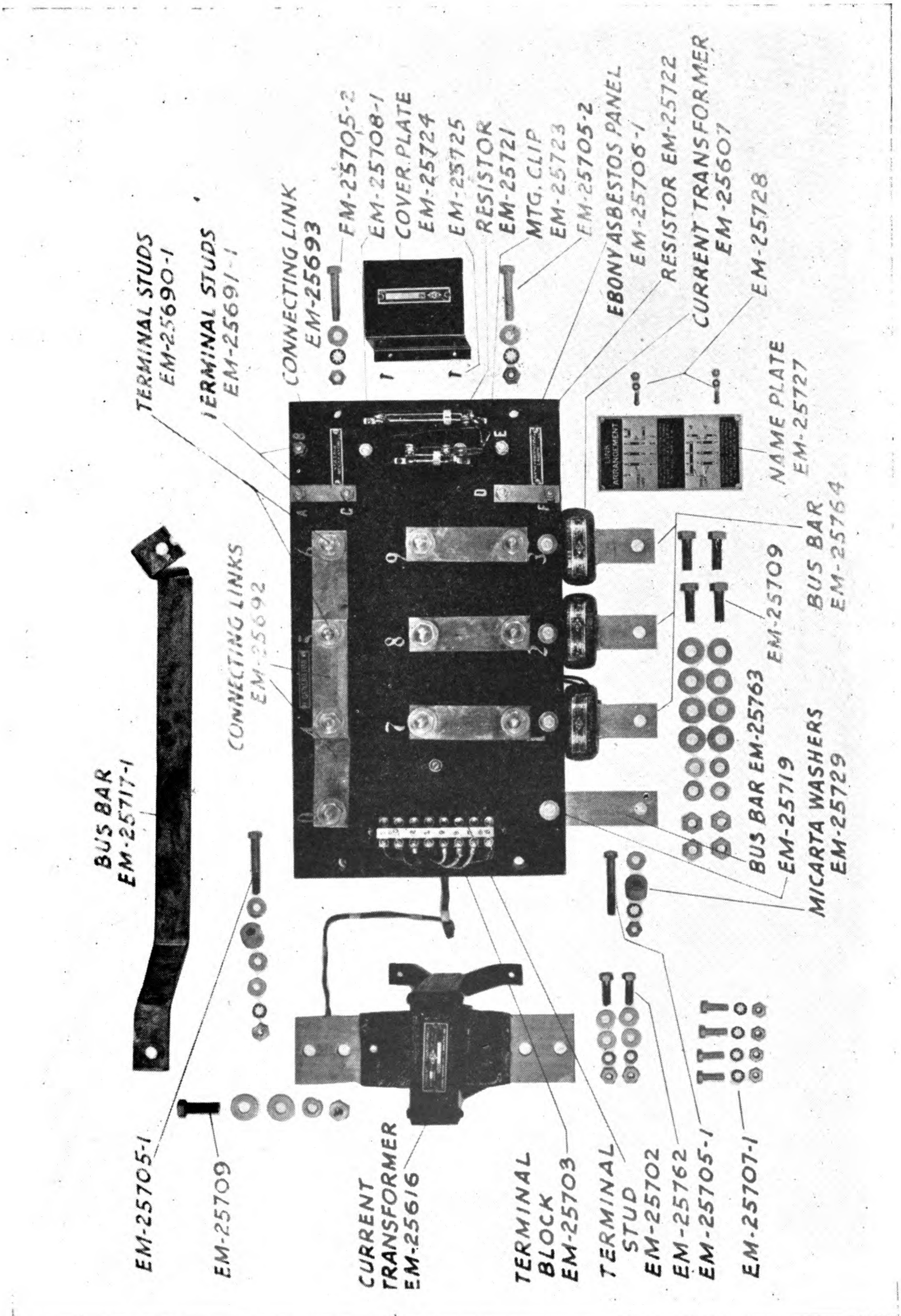


FIG. 42—Terminal Box Parts

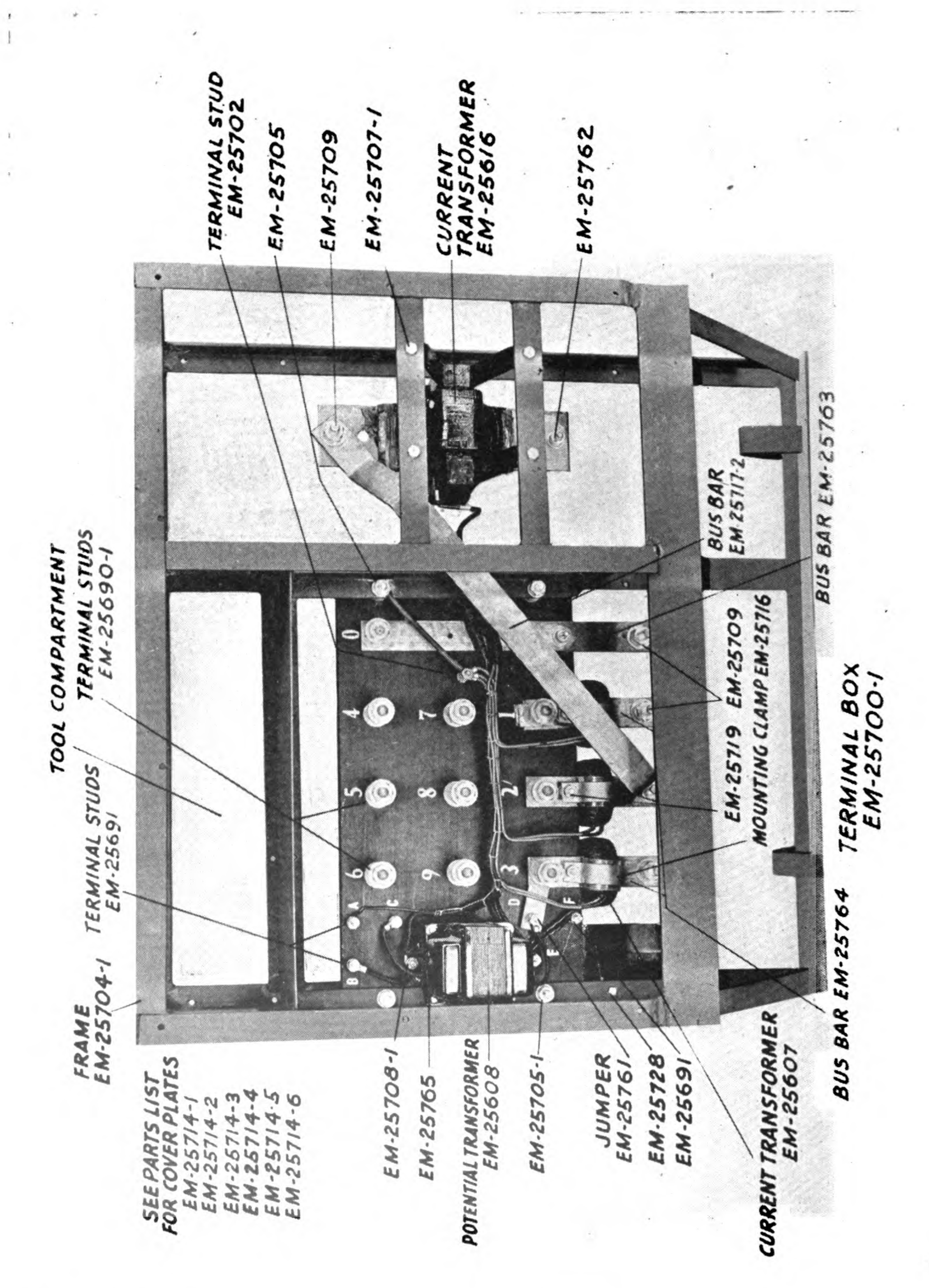


FIG. 43—Terminal Box, Rear View

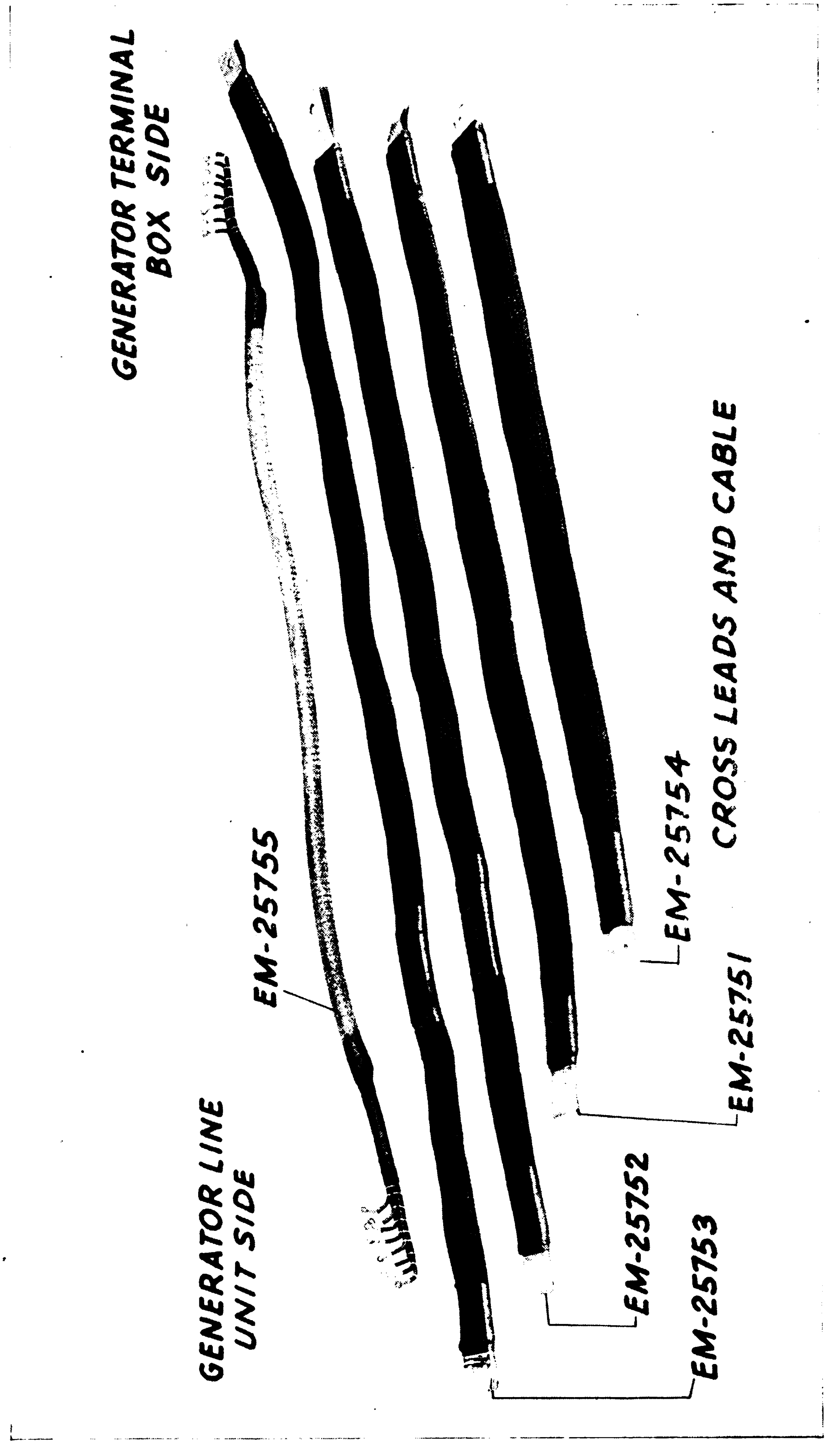


FIG. 44—Cross Leads and Cable

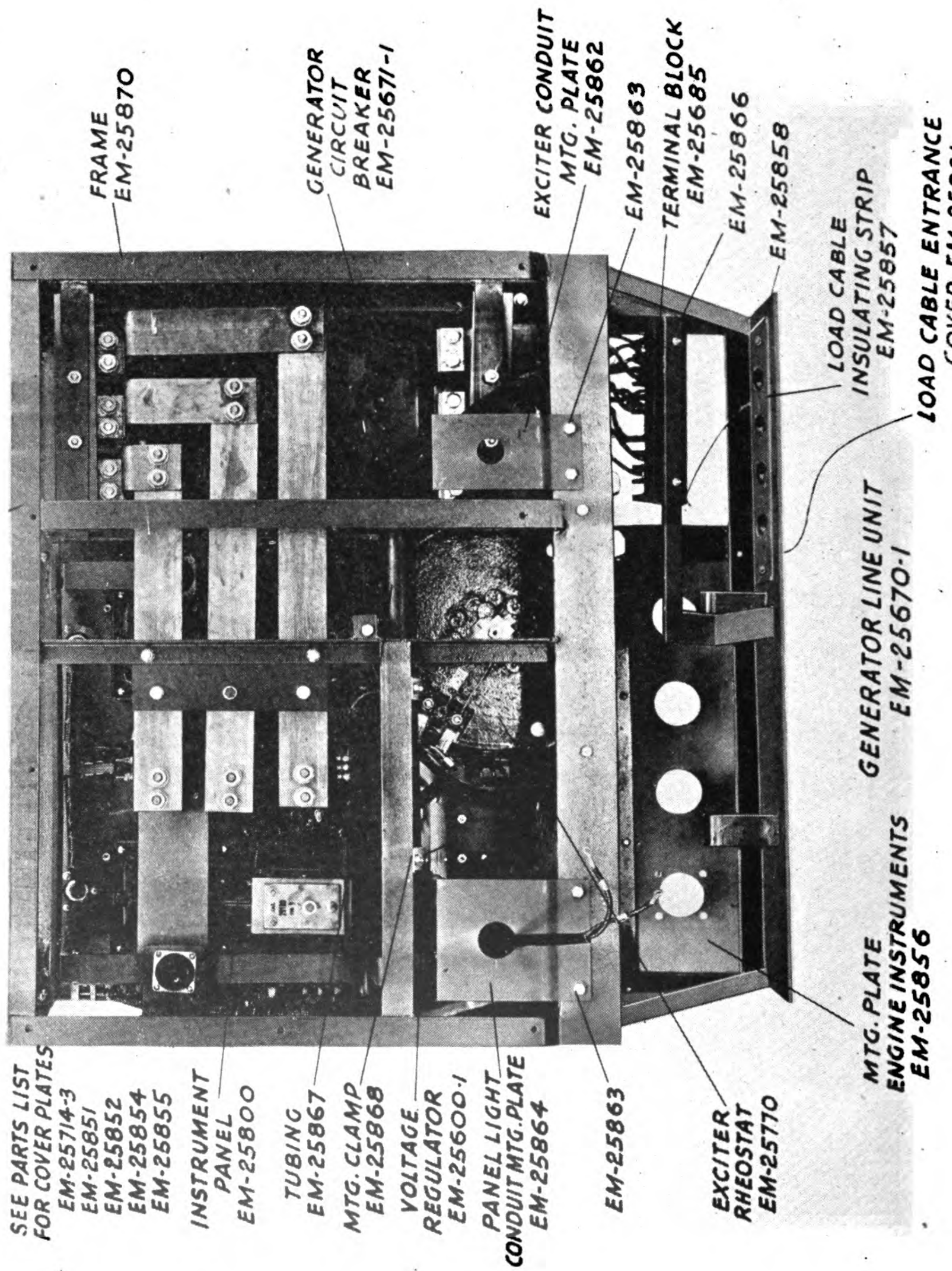


FIG. 45—Generator Line Unit, Rear View

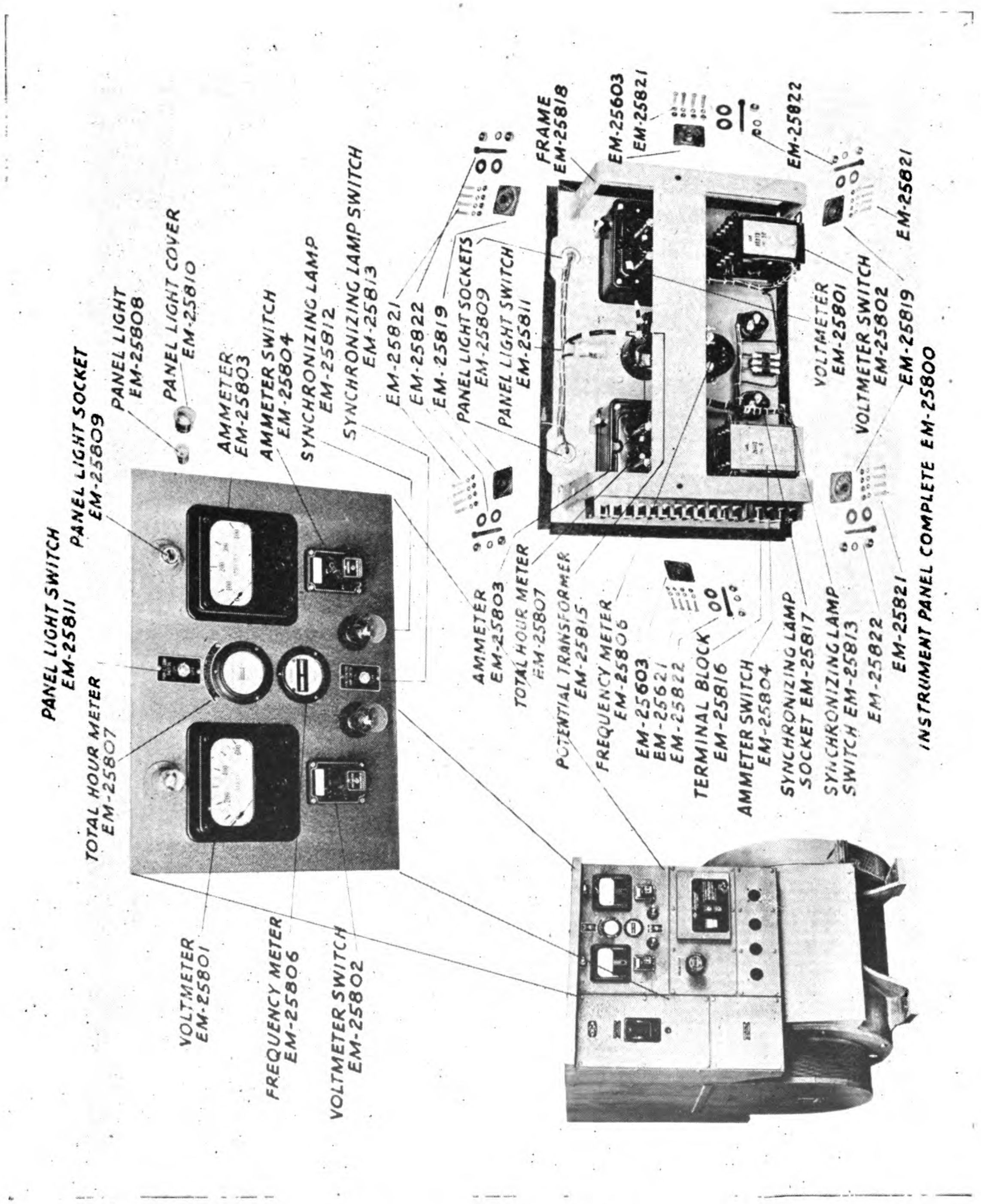


FIG. 46—Instrument Panel

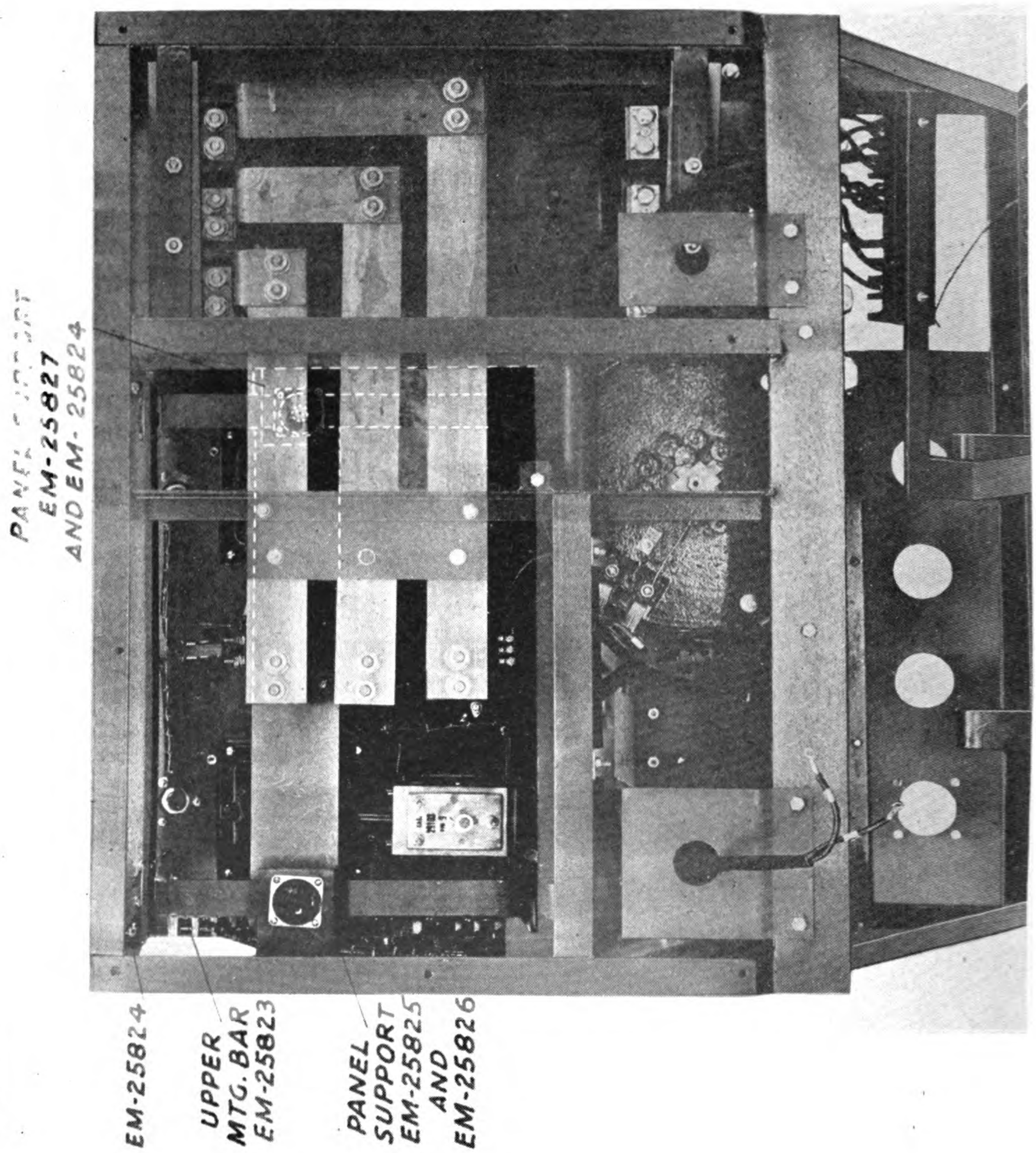


FIG. 47—Instrument Panel in Rear of Line Unit

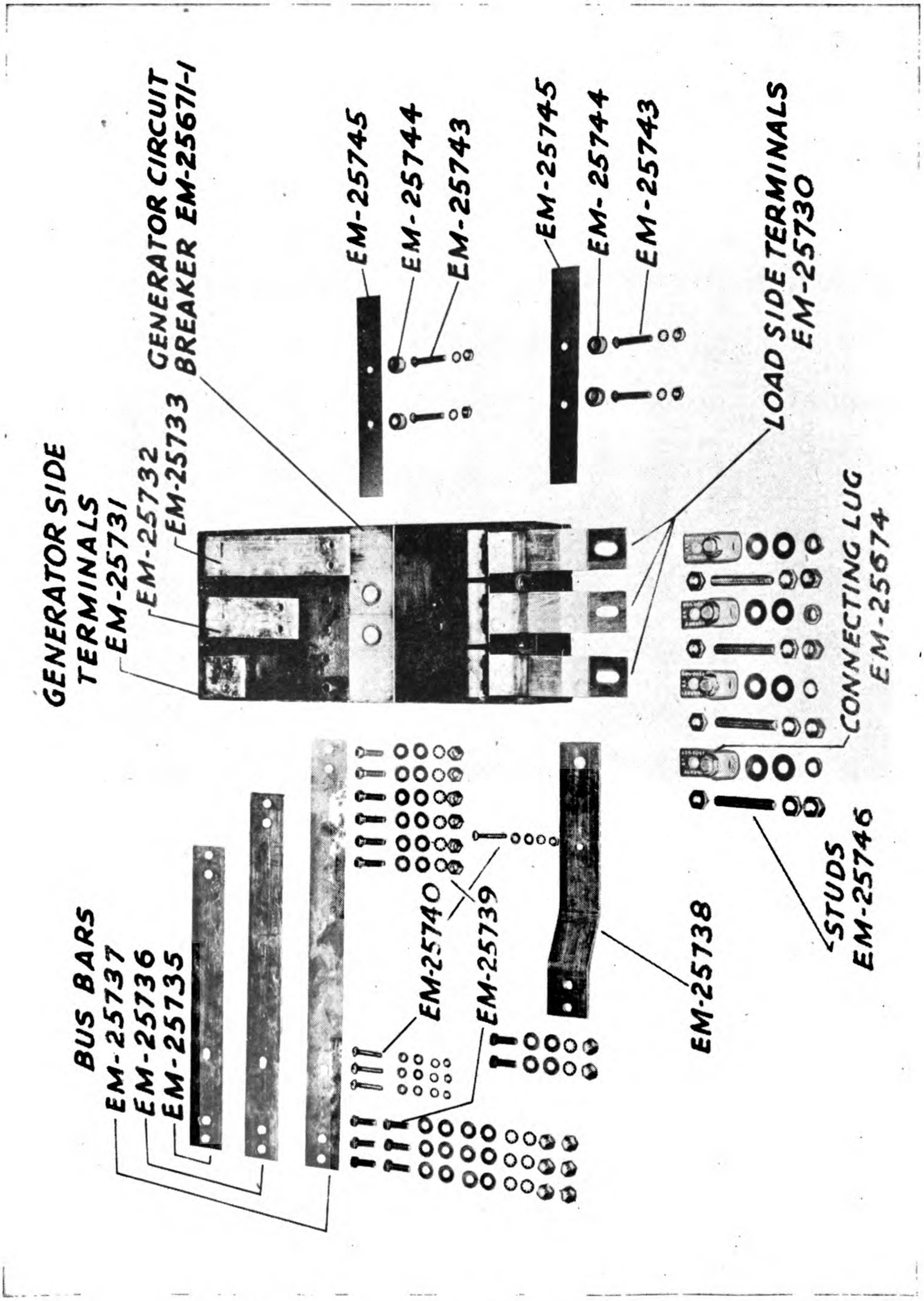


FIG. 48—Generator Circuit Breaker and Connections

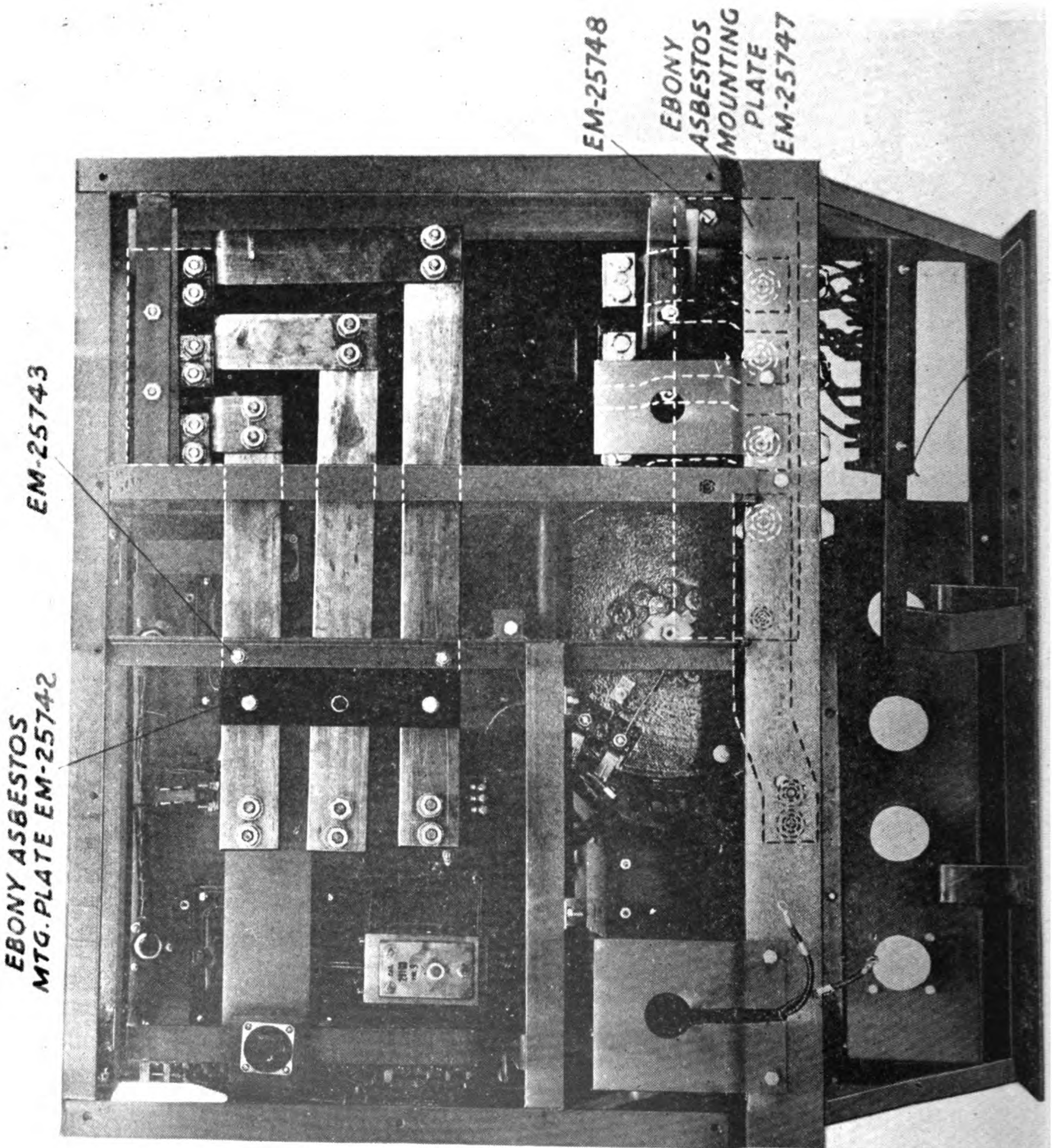


FIG. 49—Generator Circuit Breaker in Rear of Line Unit

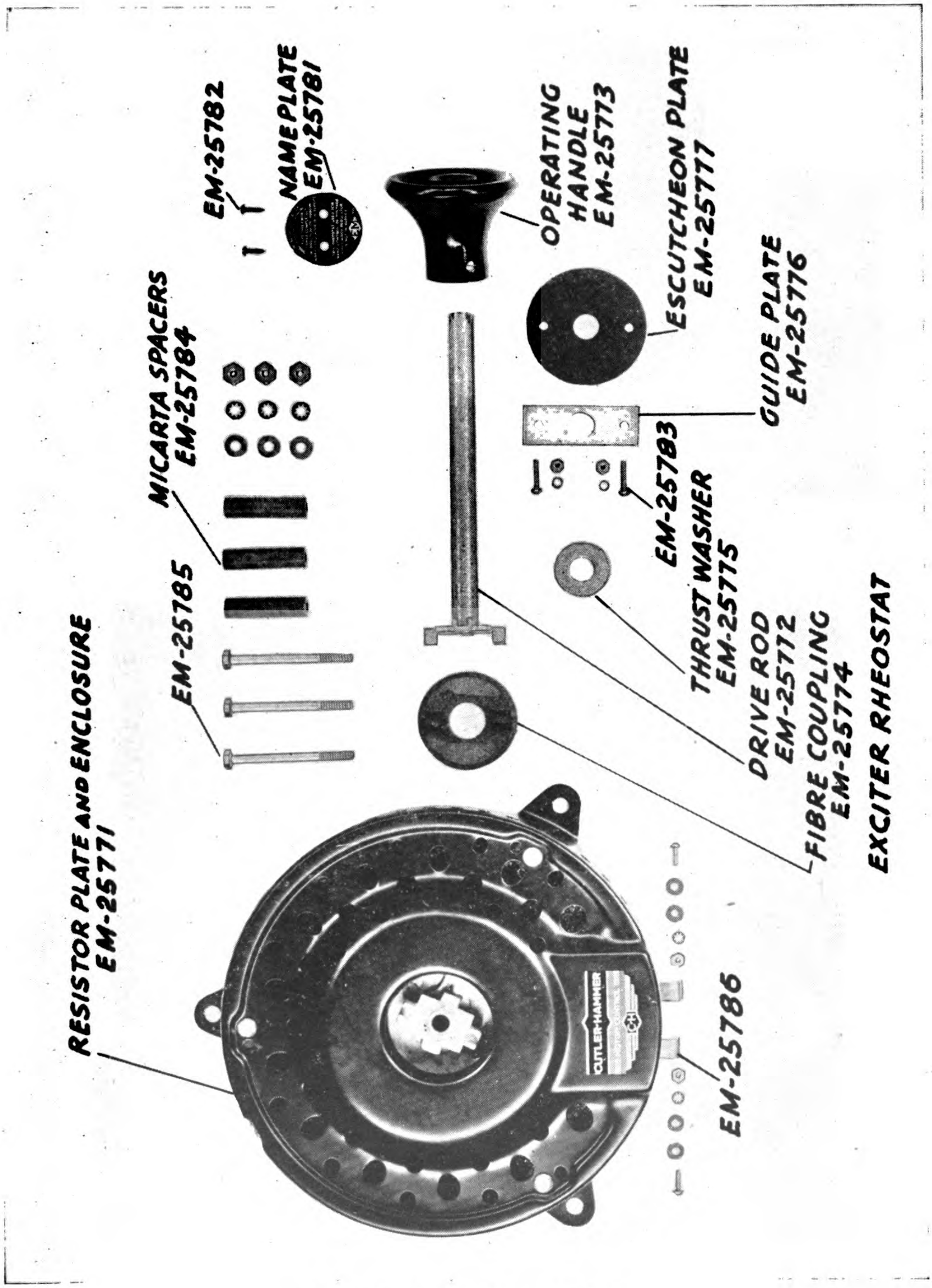


FIG. 50—Exciter Rheostat Parts

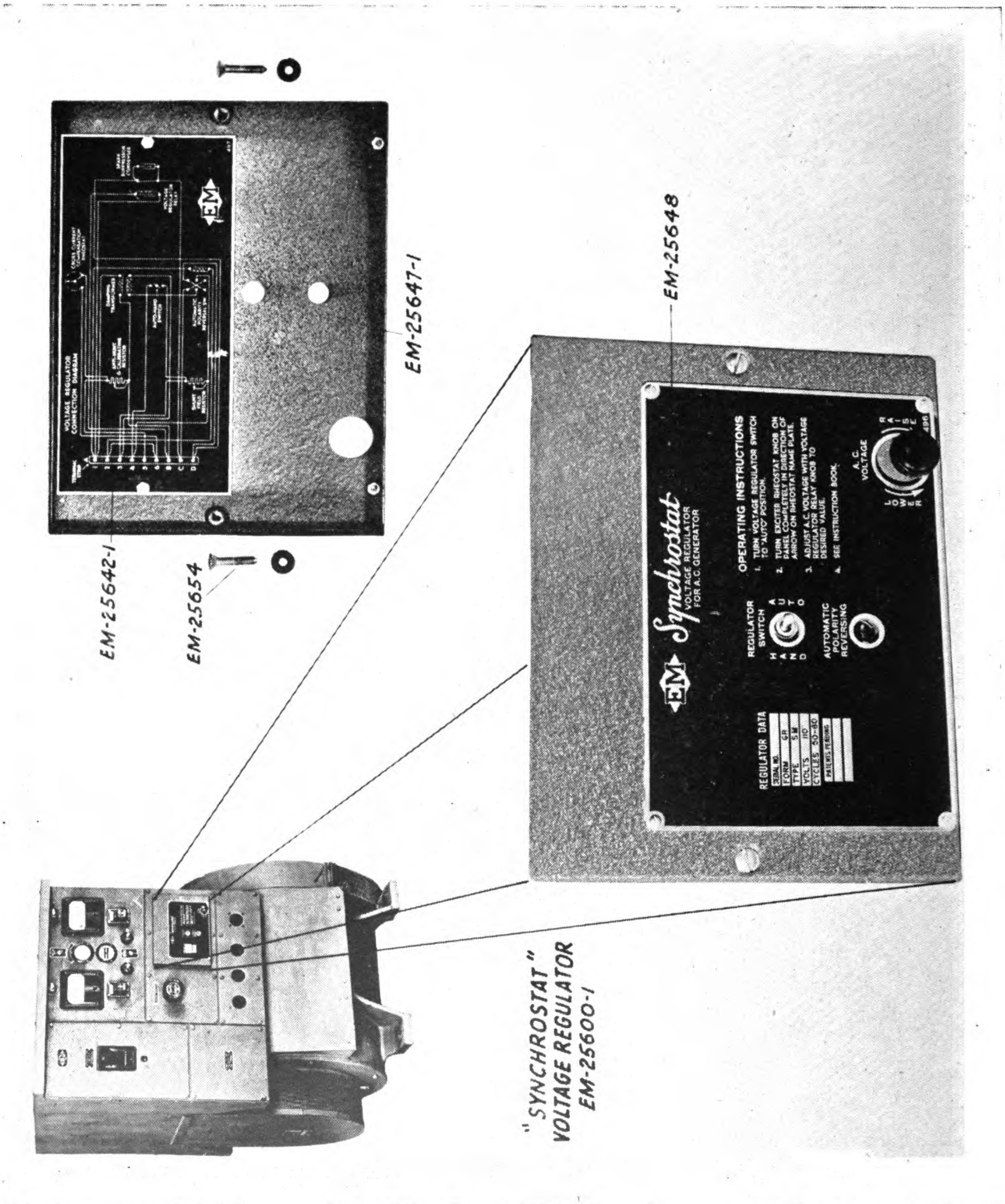


FIG. 51—Voltage Regulator

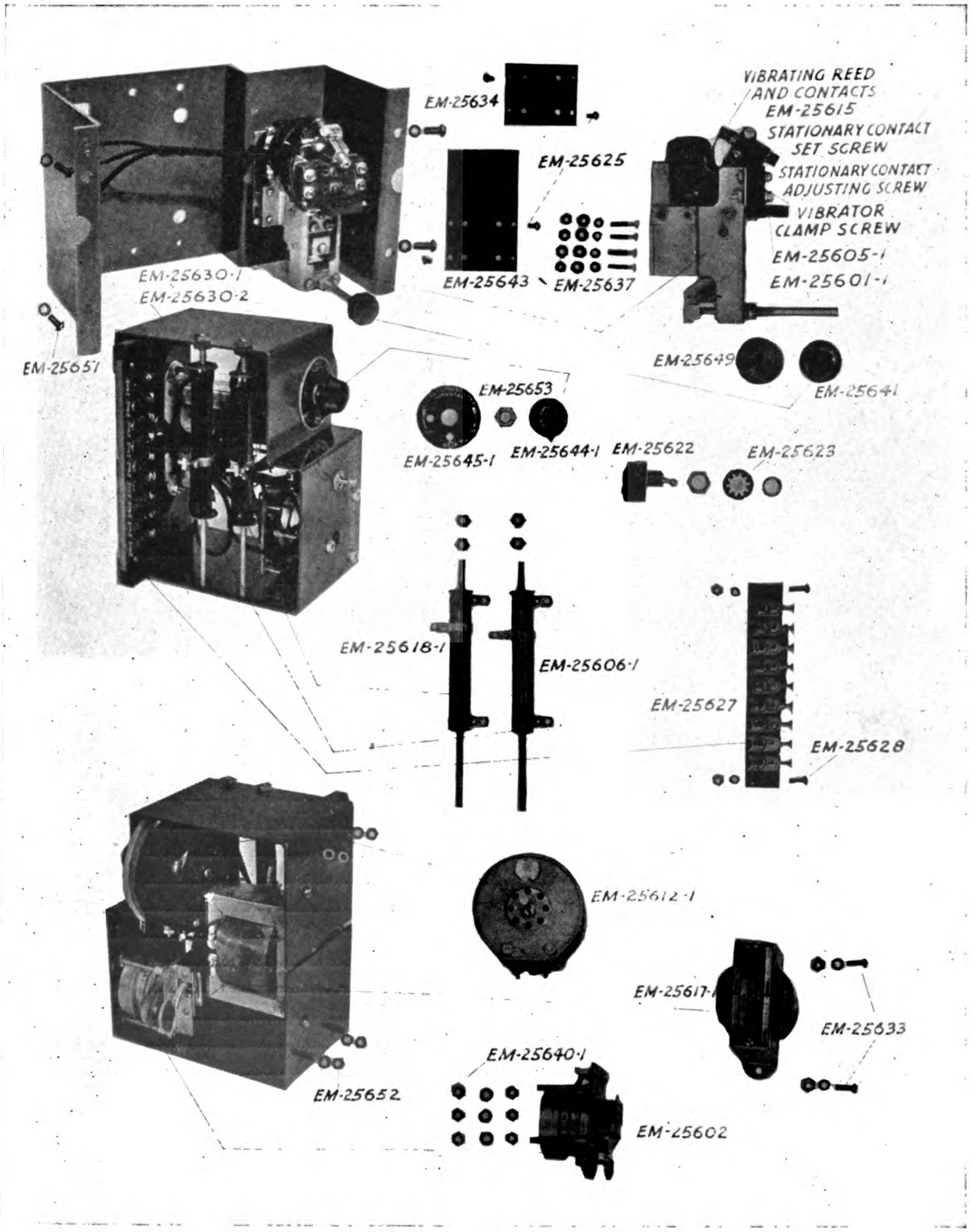


FIG. 52—Voltage Regulator Parts

GENERATOR

Item No.	Fig.	Description	Required per Generator	Price each
EM-518002	38	Armature core with coils	1	$741.25
EM-518003	37	Armature core without coils	1	308.75
EM-518004-1	40	Armature Ring	1	300.00
EM-518005-1	33	¾"-10 lifting eyebolt	3	1.88
EM-518006-1	33	Drip cover—coupling end	1	4.06
EM-518007	33	5/16"-18 hex. head cap screw ½" long	23	.02
EM-518008	33	Baffle—coupling end	1	6.60
EM-518009	38	Armature coil	72	3.88
EM-518010	34	Blower	2	9.29
EM-518011	34	½"-13 hex. head cap screw 3¼" long	12	.13
EM-518012	33	¾"x¾"x4½" coupling key	1	.61
EM-518013	36	Shaft only	1	61.88
EM-518014	33	5/16"-18 machine screw ¾" long	19	.02
EM-518015-1	33	Guard screen—coupling end	1	7.20
EM-518016	33	Exhaust screen—coupling end	2	4.38
EM-518017		Rotor spider with shaft	1	61.88
EM-518018	36	⅝"x⅝"x10¾" rotor key	1	.69
EM-518019	33	Exhaust screen center	2	3.61
EM-518020	33	Bottom screen	1	7.23
EM-518021	40	⅜"x3¼" core pin	2	.18
EM-518022	33	Rotor complete with shaft		850.00
EM-518024	33	Exhaust screen—sheave end	2	4.38
EM-518025	34	Field leads—No. 10 flex. cable	2	.80
EM-518026	33	Field lead clip AM-2	1	.15
EM-518027	33	¼"-20 RH machine screw ½" long	5	.02
EM-518028		Field lead lug—35 amp. solder type	4	.16
EM-518029	34	10-24 RH machine screw ⅝" long with hex. nut	2	.02
EM-518030	35	Carbon brushes	4	.48
EM-518031	35	Brush holder complete with spring	2	.79
EM-518033	35	10-32 RH machine screw ¾" long	2	.02
EM-518034	34	Brush holder stud with jamb nut	1	1.13
EM-518035	35	Field lead support	2	.04
EM-518036	35	10-32 RH machine screws ½" long	2	.02
EM-518038	33–39	Armature leads—4 laminations .031"x1¼"	10	1.24
EM-518039	33	Baffle—sheave end	1	6.69
EM-518040	34	Damper bars	42	.51
EM-518041	34	Cage end ring segments	12	1.65
EM-518042		Collector ring assembly complete	1	20.13
EM-518043	34	5/16"-18 socket head set screw ¾" long	2	.10
EM-518044		Collector ring sleeve	1	6.79
EM-518045	34	Collector ring	2	8.66
EM-518046	34	¼"-20 filister head machine screws ¾" long	6	.02
EM-518047-1	33	Bearing bracket	1	49.25
EM-518048	33	⅝"-11 hex. head cap screw 1½" long	6	.10
EM-518049	33	¼" pipe and plug for greasing	1	.09
EM-518050	33	¼" pipe and plug for grease drain	1	.09
EM-518052	33	⅜"-16 hex. head cap screw ¾" long	6	.03
EM-518053	34	Ball bearing	1	8.25
EM-518054	34	Bearing housing cap	1	12.38
EM-518056	34	Housing cap screws ⅜"-16 hex. head cap screw 1" long	15	.04

GENERATOR — (Cont'd)

Item No.	Fig.	Description	Required per Generator	Price each
EM-518057	34	Bearing housing	1	$ 18.56
EM-518058	33	½"-13 hex. head cap screw 1¾" long	4	.07
EM-518059	34	Sheave spacer	1	5.44
EM-518060	33	½"-13 flat head cap screw 1¼" long	1	.14
EM-518061	33	Retaining washer	1	2.23
EM-518062	33	⅜"x⅜"x1⅞" drive sheave key	1	.13
EM-518063	37	Lashing ring		.20
EM-518064	33	Drive sheave	1	20.63
EM-518065	33	5/16"-18 wing nut	1	.03
EM-518066	33	Hand hole cover	1	5.56
EM-518069	34	⅜"-16 hex. head cap screw without washer and jamb nut		.09
EM-518072	33	V-belts	3	2.33
EM-518073-1	33	Exciter mounting plate	1	5.15
EM-518074	33	⅝"-11 special stud 5½" long with jamb nuts	4	.38
EM-518075	41	3/16"x3/16"x2" exciter key	1	.11
EM-518076	33	¼" Allen head set screw—⅜" long	1	.08
EM-518077	33	Exciter sheave	1	7.84
EM-518078	38	Armature slot wedges	1 set	9.16
EM-518079	37	Armature slot insulation	1 set	6.80
EM-518081	36	Field pole complete with coil, cages, pins and shims	6	76.25
EM-518082	36	Pole shims	6 sets	.15
EM-518083	36	Pole pins	6	.66
EM-518084	34	5/16"x7.8" iron rivet with cut washer	12	.02
EM-518085	39	Armature paralleling connections		3.63
EM-518201	33	5/16"x⅜" H. H. cap screw	9	.23
EM-518202	33	5/16"x⅜" oval head screw	109	1.36
EM-518203	33	⅜"x¾" H. H. cap screw	14	.38
EM-518204	33	Guard screen	1	9.63
EM-518205	33	Lower rear cover plate	1	.86
EM-518206	33	Upper rear cover plate	1	2.75
EM-518207	33	Exciter sheave covers—next to ring	1	2.75
EM-518208	33	Exciter sheave covers—lower half	1	2.75
EM-518209	33	Exciter sheave covers—upper half	1	2.50
EM-518210	33	Angle iron brace	2	.75

EXCITER

Item No.	Fig.	Description	Required per Exciter	Price each
EM-518087-1	33	Exciter complete	1	232.50
EM-518088	41	¼"-20 hex. head cap screw 1" long	3	.02
EM-518089	41	⅛" pipe plug with slotted head	4	.07
EM-518092	41	Ball bearing No. 305 sheave end	1	4.33
EM-518093	41	Gasket sheave end	1	.51
EM-518094	41	Bearing cap sheave end	1	2.16
EM-518095	41	Drip cover and hold-down screws—sheave end	1	8.65
EM-518097	41	Bearing bracket—sheave end	1	5.78
EM-518098	41	5/16"-18 hex. head cap screw 1" long	8	.03
EM-518100	41	Fan	1	8.25
EM-518101	41	Armature complete with coils, fan and shaft	1	86.63

EXCITER — (Cont'd)

Item No.	Fig.	Description	Required per Exciter	Price each
EM-518103	41	Interpole coil with insulation	2	$ 8.65
EM-518104	41	Interpole	2	8.65
EM-518105	41	Pole bolts ⅜"-16 hex. head cap screw ½" long	8	.03
EM-518106	41	Field pole	2	11.50
EM-518107	41	Field coil with insulation	2	7.58
EM-518108	41	Field frame	1	101.25
EM-518110	41	Commutator V-ring sleeve	1	4.90
EM-518111	41	Mica V-ring	2	4.01
EM-518112	41	Commutator V-ring	1	3.05
EM-518113	41	Commutator locknut	1	1.20
EM-518114	41	Bearing cap—commutator end	1	1.81
EM-518115	41	Gasket—commutator end	1	83
EM-518116	41	Drip covers—commutator end	1 set	8.65
EM-518117	41	Screens—commutator end	1 set	8.65
EM-518118	41	Commutator bars and mica insulating segments	1 set	.05
EM-518119	41	Brush holder stud with jamb nut	2	1.74
EM-518120	41	Ball bearing No. 304—commutator end	1	3.61
EM-518123	41	Shaft	1	7.58
EM-518125	41	$\frac{5}{16}$"-18 hex. head cap screw 2" long	2	.03
EM-518126	41	Clamp scr. & nut 10-24 rd. hd. M.S. cut washer & hex. nut	1	.10
EM-518127	41	Brush yoke rocker	1	3.61
EM-518128	41	Bearing bracket—commutator end	1	6.85
EM-518129	41	Carbon brush	4	.46
EM-518130	41	Brush holder	2	4.33
EM-518131	41	¼"-20 hex. rd. cap screw—⅝" long with lock washer	2	.09
EM-518132	41	$\frac{5}{16}$" hex. head screw—¾" long		02
EM-518133	41	Brush holder spring	4	.09
EM-518134	41	Brush holder finger	4	.14
EM-518136	41	Armature leads No. 10 flexible cable		
EM-518138	41	Field leads No. 12 flexible cable		
EM-518139	33–41	Flexible conduit and attachments	1	4.38
EM-518140	....	Terminal bolt 6—32x¼ in.	2	.02

TERMINAL BOX

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25607	42–43	Current transformer (See instrument panel spares)	....	....	....
EM-25608	43	Potential transformer (See voltage regulator spares)	....	....	....
EM-25616	42–43	Current transformer (See voltage regulator spares)	....	....	....
EM-25690-1	42–43	Terminal stud, ½"-13x5". 6 hex. nuts, 6 brass washers, 1 lock washer	Std.	9	$ 0.38
EM-25691-1	42–43	Terminal studs, ¼"-20x3", 3 nuts, 1 lock nut, 7 brass washers, 3 lock washers	Std.	6	.19
EM-25692	42	Connecting links—large $\frac{3}{16}$"x1½" x5⅛"	EM	6	.18
EM-25693	42	Connecting links—small $\frac{1}{16}$"x¾" x2¾"	EM	2	.10
EM-25700-1	33	Terminal box complete		1	208.75
EM-25702	42-43	¼"-20x2 RHMS, (Neutral) 8 brass washers, 1 lock washer and 2 hex. nuts	Std.	1	.25

TERMINAL BOX — (Cont'd)

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25703	42	Terminal block, 8 point	CH No. 80-434-12	1	$ 2.63
EM-25704-1	43	Frame	EM	1	38.75
EM-25705-1	42-43	3/8"-16x2 3/4" HHCS, 1 brass washer, (3 brass washers on top left corner for ground connection) 1 shake proof washer and hex nut	Std.	2	12
EM-25705-2	42-43	3/8"-16x1 3/4" HHCS, 1 washer, 1 shake proof washer and hex. nut	Std.	2	.05
EM-25706-1	42-43	Ebony asbestos panel	EM	1	2.30
EM-25707-1	42-43	5/16"-18x1" HHCS, lock washer and hex. nut	Std.	4	.05
EM-25708-1	42-43	1/4"-20x1 1/4" RHMS, 2 washers, shake proof washer and hex. nut	Std.	2	.05
EM-25709	42-43	1/2"-13x1 3/4" HHCS, 2 brass washers, 2 lock nuts and hex. nut	Std.	4	.07
EM-25714-1	43	Top cover	EM	1	2.40
EM-25714-2	43	End plates	EM	2	4.00
EM-25714-3	43	Rear plate	EM	1	2.75
EM-25714-4	43	Link panel cover	EM	1	1.00
EM-25714-5	43	Current transformer cover	EM	1	1.15
EM-25714-6	43	Tool compartment cover	EM	1	1.00
EM-25716	43	Mounting clamp—current transformer	EM	3	.07
EM-25717-1	42-43	Bus bar (Line 2)	EM	1	2.25
EM-25718-1	42	No. 8-32x1" RHMS, 2 washers, lock washer and hex. nut	Std.	2	.05
EM-25719	42	5/8"-18x2" HHCS, 2 washers, 2 lock washers and 2 hex. nuts	Std.	4	.10
EM-25721	42	Resistor, 4000 ohms, 50 watts	Ohmite No. 0410	1	1.20
EM-25722	42	Resistor, 2500 ohms, 25 watts	Ohmite No. 0208	1	.85
EM-25723	42	Resistor mtg. clips, and No. 6-20 1/2" self tapping screws	EM & Std.	4	.05
EM-25724	42	Resistor cover plate	EM	1	.75
EM-25725	42	No. 6-32x1/2" self tapping screw	Std.	2	.02
EM-25727	42	Name plate—"Link Arrangement"	EM	1	.38
EM-25728	42	No. 10-24x1/2" RHMS, lock washer and hex. nut	Std.	2	.05
EM-25729	42	Micarta washers 7/16"x3/4"	EM	2	.05
EM-25761	43	Jumper, line 3	EM	1	.13
EM-25762	43	3/8"-16x1 1/4" HHCS, 2 washers, lock washer and hex. nut	Std.	2	.05
EM-25763	42-43	Bus bar, line 0	EM	1	.95
EM-25764	42-43	Bus bar, 1, 2 and 3	EM	3	.63
EM-25765	43	Potential transformer mtd. plate..	EM	1	1.00

GENERATOR LINE UNIT

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25600-1	51	"Synchrostat" Voltage Regulator (See Spare Parts—Voltage Regulator, Page 324)	EM	1	....
EM-25670-1	33	Generator line unit complete	EM	1	....
EM-25671-1	32	Generator circuit breaker (See Spare Parts—Breaker and Connections, Page 325)	EM	1	312.50
EM-25714-3	45	End cover plates	EM	2	2.00
EM-25770	50	Exciter rheostat (See Spare Parts—Exciter Rheostat, Page 326)	EM	1	....

GENERATOR LINE UNIT — (Cont'd)

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25800	46	Instrument panel (See Spare Parts Instrument Panel, Page 326)	EM	1	....
EM-25851	45	Back cover plate	EM	1	$ 2.75
EM-25852	45	Top cover plate	EM	1	2.40
EM-25853	45	Cover plate — Generator circuit breaker compartment	EM	1	1.15
EM-25854	45	Cover plate — Regulator and Rheostat compartments	EM	1	.90
EM-25855	45	Cover plate — Load connection compartment	EM	1	.63
EM-25856	45	Mounting plate—Engine instruments	EM	1	.75
EM-25857	45	Load cable insulating strip	EM	1	.25
EM-25858	45	¼"-20x¾" RHMS, 1 washer, lock washer and hex. nut	Std.	2	.05
EM-25861	45	Load cable entrance cover	EM	1	.63
EM-25862	45	Exciter conduit mounting plate	EM	1	.32
EM-25863	45	¼"-20x¾" HHCS, 1 washer, 1 shake-proof washer and hex. nut	Std.	4	.05
EM-25864	45	Panel light conduit mounting plt.	EM	1	.40
EM-25865	45	Terminal block, 12 points	CH No. 80-434-14	1	1.45
EM-25866	45	No. 8-32x1¼" HRMS, shake-proof washer and hex. nut	Std.	1	.05
EM-25867	45	Tubing, impregnated paper	EM	1	.15
EM-25868	45	Mounting clamps and 1" self tapping screw	EM	2	.15
EM-25870	45	Frame	EM	1	45.00

VOLTAGE REGULATOR

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Regulator	Price each
EM-25600–1	51	"Synchrostat" Voltage Regulator complete	EM	....	$205.55
EM-25601–1	52	Regulator relay including coil	EM	1	16.88
EM-25602	52	Polarity reversing switch	Hayden Mfg. Co. (Spec.)	1	9.19
EM-25605–1	52	Spark condenser, 0.01 MFD, 1000 volts	Solar Type XQ	1	.94
EM-25606–1	52	Anti-Hunt calibrating resistor 500 ohms, 50 watts	Ohmite No. 0569	1	1.05
EM-25608	43	Potential transform. 400/120/218 volts (Mtd. on term. box)	Franklin No. 17099A	1	12.50
EM-25612–1	52	Cross current compensation rheostat 13 ohms, 100 watts	Hardwick & Hindle	1	4.58
EM-25615	42	Vibrating reed and contacts (Regulator contacts)	EM	1	4.38
EM-25616	42–43	Cross current compensation current transformer, 800/5 amperes (mtd. in terminal box)	EM	1	32.00
EM-25617–1	52	Damping transformer	Franklin No. A-16142A	1	3.10
EM-25618–1	52	Shunt field dividohm, 750 ohms, 50 watts	Ohmite No. 0570	1	1.67
EM-25622	52	Regulator switch (HAND-AUTO)	Cutler Hammer No. 8381	1	.32
EM-25623	52	Lock washer	Shake Proof No. 1228	1	.03
EM-25625	52	6-32x¼" self tapping screw	Std.	4	.02
EM-25627	42	Terminal block	H. G. Jones No. 9-12	1	.94
EM-25628	52	6-32x⅜" RHMS hex. nut and lock washer	Std.	2	.04
EM-25630–1	52	Regulator frame	EM	1	5.25

VOLTAGE REGULATOR — (Cont'd)

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Regulator	Price each
EM-25630-2	52	Sub assembly frame	EM	1	$3.90
EM-25633	52	8-32x½" RHMS, hex. nut and lock washer	Std.	2	.04
EM-25634	52	Micarta insulating strip	EM	1	.03
EM-25637	52	6-32x½" RHMS, hex. nut, washer and lock washer	Std.	4	.04
EM-25640-1	52	2 No. 8-32 hex. nuts and 1 shakeproof washer	Std.	3	.05
EM-25641	52	Voltage adjusting knob	Dayton No. 119	1	.12
EM-25642-1	51	Nameplate—connection diagram..	EM	1	1.40
EM-25643	52	Micarta insulating strip	EM	1	.04
EM-25644-1	52	Knob-cross-current rheostat	Ohmite No. 120	1	.07
EM-25645-1	52	Nameplate-cross-current rheostat	EM	1	.25
EM-25647-1	51	Regulator face plate	EM	1	.85
EM-25648	51	Nameplate—voltage regulator	EM	1	1.63
EM-25649	52	Blinder disc	EM	1	.19
EM-25651	52	¼"-20x¾" RHMS	Std.	4	.04
EM-25652	52	No. 12 HH nut and shakeproof washer	Std.	4	.03
EM-25653	52	Locknut	Std.	1	.04
EM-25654	51	¼"-20x1" bevel head MS and fibre washer	Std.	2	.04

BREAKER AND CONNECTIONS

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25671-1	48	Generator circuit breaker 600 volts, 350 amperes, 3 pole	ITE No. ET-1882	1	$300.00
EM-25672-A	32	Trip unit, 175 amperes	ITE No. ET-2468	1	83.75
EM-25672-1B	32	Trip unit, 500 amperes	ITE No. ET-2590	1	83.75
EM-25674	48	Connecting lugs	Burndy No. QA-34	4	.40
EM-25695	32	Breaker cover	ITE No. 98501-A	1	20.00
EM-25696	32	⅜"-16 HH nut and cup washer..	Std.	6	.04
EM-25697	32	⅜"-16x1" FHMS	Std.	6	.04
EM-25698	32	⅜"-16x¾" FHMS	Std.	1	.04
EM-25730	48	Breaker terminals—load side	EM	3	.25
EM-25731	48	Breaker terminals—Gen. side, line 1	EM	1	.38
EM-25732	48	Breaker terminals—Gen. side, line 2	EM	1	.63
EM-25733	48	Breaker terminals—Gen. side, line 3	EM	1	.90
EM-25735	48	Bus bar, line 1	EM	1	.75
EM-25736	48	Bus bar, line 2	EM	1	.83
EM-25737	48	Bus bar, line 3	EM	1	.90
EM-25738	48	Bus bar, line 0	EM	1	.90
EM-25739	48	⅜"-16x1¼" HHCS, 2 brass washers, shake proof washer and hex. nut	Std.	14	.03
EM-25740	48	¼"-20x1½" HHCS, 2 washers, shake proof washer and hex. nut	Std.	4	.04
EM-25742	49	Ebony asbestos mtd. plate bus bar mtd.	EM	1	.44
EM-25743	48	5/16"-18x2" RHMS, 1 shakeproof washer and hex. nut	Std.	4	.04
EM-25744	48	Micarta insulating washer ⅜"x ½"	EM	4	.04
EM-25745	48	Micarta insulating strips	EM	2	.04
EM-25746	48	½"-13x3¼" studs	Std.	4	.05
EM-25747	49	Ebony asbestos mtg. plate—terminal lugs	EM	1	.75

BREAKER AND CONNECTIONS — (Cont'd)

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25748	49	3/8"-16x2" HHCS, shake proof washer and hex. nut	EM	4	$0.05
EM-25749	49	1/4"-20x1 1/4" HHCS, shake proof washer and hex. nut	EM	2	.05
EM-25751	44	Cross lead, line 1	EM	1	1.38
EM-25752	44	Cross lead, line 2	EM	1	1.57
EM-25753	44	Cross lead, line 3	EM	1	1.77
EM-25754	44	Cross lead, line 0	EM	1	1.20
EM-25755	44	Cross cable	EM	1	2.65

EXCITER RHEOSTAT

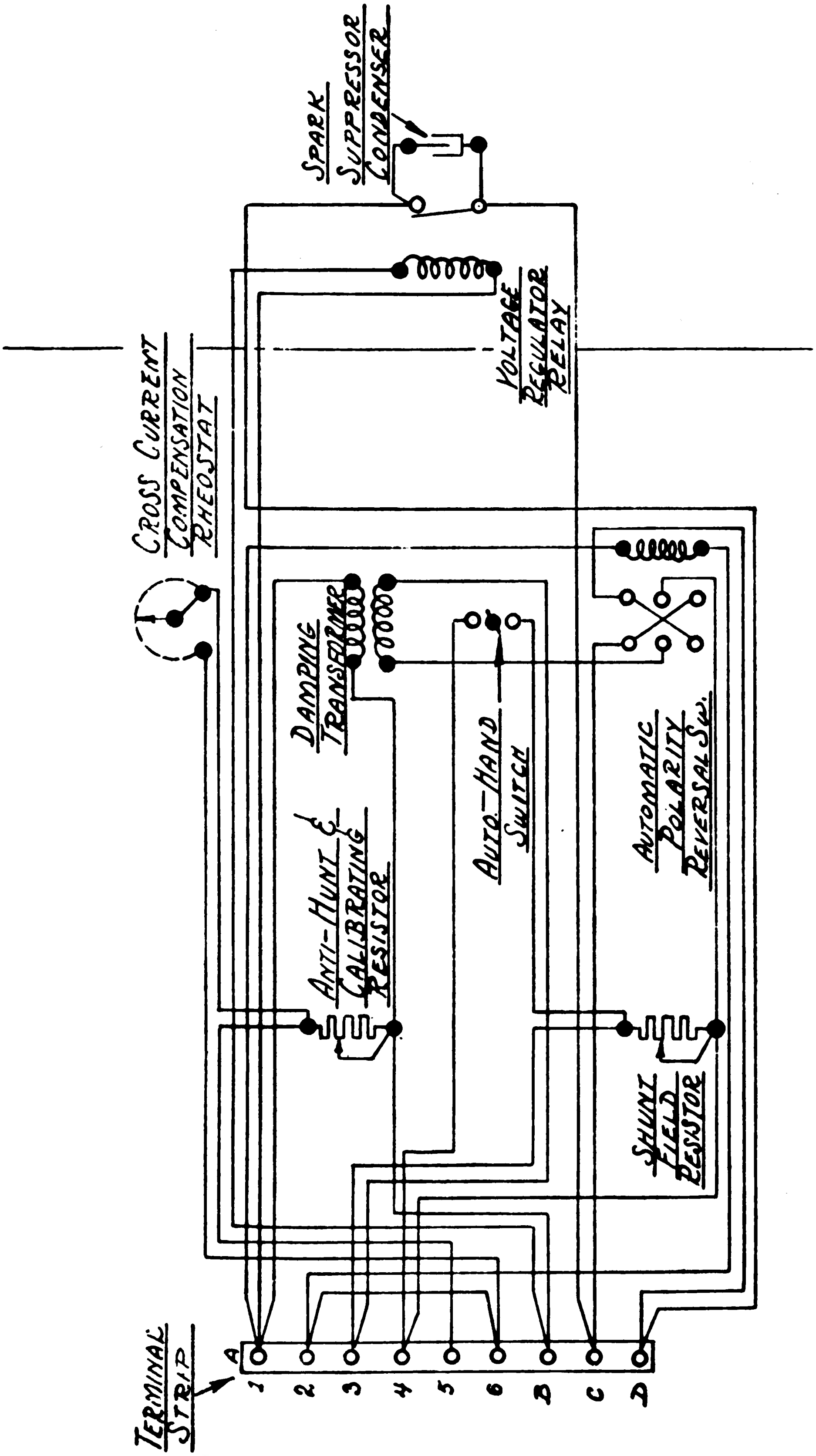
Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25770	50	Exciter rheostat complete	CH No. 11111D-7	1	$ 23.15
EM-25771	50	Rheostat resistor plate and enclosure	CH	1	17.50
EM-25772	50	Drive rod	EM	1	.88
EM-25773	50	Rheostat handle	CH No. 10410-H-101A	1	1.50
EM-25774	50	Fibre coupling	CH	1	.35
EM-25775	50	Thrust washer	CH	1	.15
EM-25776	50	Guide and mtd. plate	CH	1	.20
EM-25777	50	Escutcheon plate	CH	1	.24
EM-25781	50	Name plate	EM	1	.19
EM-25782	50	1/4" long self tapping screw	Std.	2	.02
EM-25783	50	No. 8-32x3/4" RHMS, lock washer and hex. nut	Std.	2	.03
EM-25784	50	Micarta spacers 1/4"x2"	EM	3	.08
EM-25785	50	1/4"-20x3" HHMS, washer, lock washer and hex. nut		3	.07
EM-25786	50	Connecting lugs, No. 6-22x1/2" RHCS, 2 brass washers, shake proof washer and hex. nut	Std.	2	.12

INSTRUMENT PANEL

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25603	46	Rubber mountings	Lord No. 150P-6	2	$ 0.29
EM-25607	42–43	Current transformer for ammeters 500/5 (Mounted on terminal box)	EM	3	3.13
EM-25800	46	Instrument panel complete	EM	1	393.75
EM-25801	46	AC voltmeter	WX No. HA 931786	1	43.15
EM-25802	46	Voltmeter switch	Roller-Smith No. 40373	1	24.50
EM-25803	46	AC ammeter	WX No. HA 931763	1	36.50
EM-25804	46	Ammeter switch	Roller-Smith No. 29103	1	21.50
EM-25806	46	Frequency meter, 115 volts	Frahm (Special)	1	45.25
EM-25807	46	Total hour meter	Cramer No. RT-24	1	135.00
EM-25808	46	Panel light bulb, 12 volt DC, single contact	Tung-sol	2	.23
EM-25809	46	Panel light socket	Ford No. A 13705A	2	1.00
EM-25810	46	Panel light cover	EM	2	.25
EM-25811	46	Panel light switch	H & H No. 8721N	1	.90
EM-25812	46	Synchronizing lamp	G. E. No. 1DS-14	2	.20
EM-25813	46	Synchronizing lamp switch	Cutler Hammer No. 8342	1	1.75
EM-25815	46	Potential transformer 460/115 V.	Franklin No. 18168A	1	5.30
EM-25816	46	Terminal block, 12 point	Penn Union	1	2.95
EM-25817	46	Synchronizing lamp socket	GE No. 49 x 866	2	.75
EM-25818	46	Frame	EM	1	18.25

INSTRUMENT PANEL — *(Cont'd)*

Item No.	Fig.	Description	Manufacturer and Cat. No.	Required per Unit	Price each
EM-25819	46	Rubber mountings—top & bottom	Lord No. 150P-10	4	$0.30
EM-25821	46	6-32x½" RHMS, hex. nut and shakeproof washer	Std.	24	.02
EM-25822	46	¼"-20x2" RHMS, 2 hex. nuts, 2 washers and 1 shakeproof washer	Std.	4	.05
EM-25823	47	Upper mounting bar	EM	1	.50
EM-25824	47	¼"-20x¾" HHMS, lock washer and hex. nut	Std.	6	.05
EM-25825	47	Panel support	EM	1	.33
EM-25826	47	¼"-20x¾" FHMS, lock washer and hex. nut	Std.	2	.05
EM-25827	47	Panel support	EM	1	.33



SPARK SUPPRESSOR CONDENSER
VOLTAGE REGULATOR RELAY
CROSS CURRENT COMPENSATION RHEOSTAT
DAMPING TRANSFORMER
ANTI-HUNT & CALIBRATING RESISTOR
AUTO.-HAND SWITCH
AUTOMATIC POLARITY REVERSAL SW.
SHUNT FIELD RESISTOR
TERMINAL STRIP
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MEMORANDUM

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