General Electric Company

RAILWAY DEPARTMENT

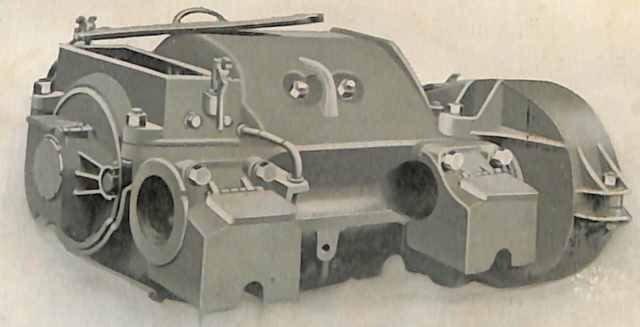
October, 1903 Bulletin No. 4347

THE GE-74 MOTOR

The GE-74 is essentially a new type of railway motor, embodying in its construction the best features of both the box and split frame type of General Electric motors. The motor may properly be called a GE split box frame motor.

In the construction of this motor are embodied the results of years of the widest experience in the manufacture of railway motors. It is confidently believed that the GE-74 motor represents the highest development yet attained in the design of the smaller and intermediate sizes of motors, and that it will unquestionably receive appreciative recognition from all users of this class of apparatus.

In the following pages will be found a description of the motor with a statement of its advantages.



GE-74 RAILWAY MOTOR

MAGNET FRAME

The magnet frame is octagonal in shape and is divided, in a horizontal plane considerably above the center, into a smaller upper frame and a larger lower frame which are bolted together. The lower frame has two large openings at the ends; these openings have bored seats into which frame heads carrying the armature shaft bearings are bolted.

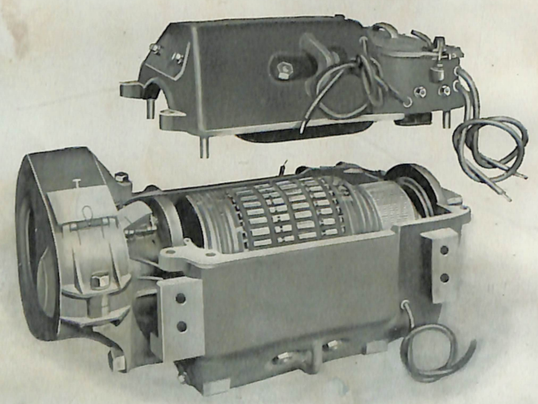
The axle bearing caps are bolted to vertically planed surfaces on the lower frame. The laminated pole pieces are inclined at an angle of 45 degrees to the horizontal and are bolted to the interior pole cores by through bolts with nuts on the outside of the frame. The through bolts are readily renewed in case they break or the threads become injured, and the outside nuts may be easily reached with a wrench.

Forged bails are cast into the frame to facilitate handling the motor and planed bosses on the four bottom corners permit the motor to be set up in exact position when desired.

Provisions for ventilation and inspection of the interior of the motor are very complete.

The opening over the commutator is closed by a malleable iron cover with a felt gasket and the cover is held in place by a quickly adjustable cam locking device. There is an opening below the commutator and two openings in the sloping sides of the frame at the pinion end. These openings are closed by malleable iron covers which may be removed to permit greater ventilation whenever the service conditions are favorable.

The armature and field leads are brought through rubber bushed holes at the commutator end of the motor on the side next to the truck bolster. This arrangement reduces to a minimum the movement of the leads when the truck swivels in rounding curves.



GE-74 RAILWAY MOTOR WITH TOP OF FRAME LIFTED OFF

BEARINGS

The frame heads are made of malleable iron cast in one piece. In order to secure large and long bearings without sacrificing other desirable features of construction, the heads are made conical in shape, and extend under the commutator shell and pinion-end armature core head. This construction forms a support for the bearing linings which is very strong and rigid.

The frame head castings have large oil wells into which oily wool waste is packed and comes in contact with a large surface of the armature shaft through an opening in the low pressure side of the bearing linings.

The linings are unsplit bronze sleeves, finished all over, with a thin layer of babbitt metal soldered to the interior bearing surface. The babbitt furnishes an ideal bearing surface and is so thin that it will not allow the armature to rub on the poles in case it is melted out by overheating.

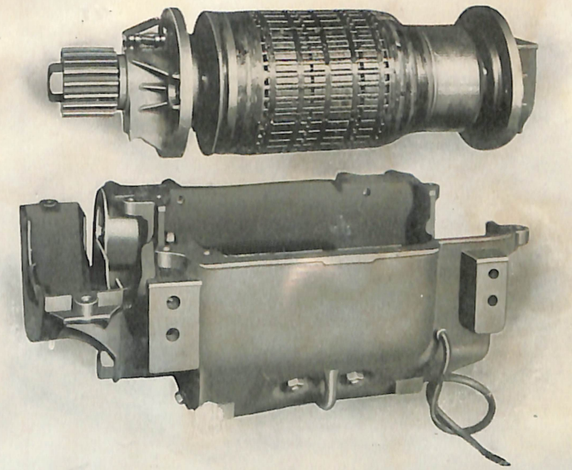
Oil is prevented from entering the interior of the motor by oil deflectors which throw it into large grooves cast in the heads, from which it is then conducted away.

This form of bearing is fully equal in simplicity and reliability to the standard M.C.B. journal bearing. The method of lubrication and treatment is practically the same and the boxes are reached through large hand holes protected by swing covers, held in place by a spring. Records show that in elevated railway service, armature shaft bearings of this type have run 137,000 miles without renewal of the linings. The amount of oil required for the bearings is exceedingly

small. Wide experience indicates that no other type of bearing equal to this has ever been placed on a railway motor.

The axle linings are held in place by cast steel caps which are tongued and bolted to planed and grooved vertical surfaces on the lower frame. Large oil wells are cast in the caps and are packed with oily wool waste which comes into contact with a large surface of the axle through openings in the bearing linings. As with the armature shaft bearings, the method of lubrication is similar to that used for standard M.C.B. journals.

The GE-74 motor is constructed with very liberal wearing surfaces. The armature shaft bearing at the commutator end is 3⅛″ in diameter and 6¾″ long, and at the pinion end is 3⅝″ in diameter and 8¾″ long. The axle bearing linings are 10¾″ long and a maximum axle of 5½″ in diameter may be used.



GE-74 RAILWAY MOTOR WITH ARMATURE LIFTED OUT OF FRAME

FIELD COILS

Special attention has been given to the design of the fields with the object of reducing to a minimum the tendency of the motors to flash when the current is intermittently interrupted at high armature speeds and voltages.

The mummified type of field coil is used. The coil is made in two sections and is wound on suitable forms with copper ribbon, insulated between turns with asbestos ribbon. The sections are separated and insulated by mica board. The formed coil is then wound with special insulating fabrics, thoroughly taped and treated in a vacuum process which thoroughly fills the spool with an insulating and hardening compound.

The construction of the spool makes it solid and compact and well adapted to radiate heat. The insulating material used makes it practically waterproof. In case of injury, repairs are easily made.

For support of the coils and protection against chafing in service, strong spool flanges of pressed sheet steel bear against the laminated pole pieces and securely clamp the coils in place when the pole pieces are bolted in.

ARMATURE

The armature has three coils per slot. The coils are wound on accurately shaped forms and in steam molds pressed in units of three coils each with insulation between adjacent coils. These triple coils are insulated with specially prepared fabric, which has been developed by the General Electric Company after exhaustive experiments. As a final protection, principally from mechanical injury, the coils are taped and then filled with a special compound.

The windings are especially well protected from carbon dust, oil or mechanical injury. The pinion-end core head extends out under the end windings, with a flange extending up past the ends of the coils. The windings at both ends are covered with a strong canvas dressing securely bound in place.

Following a long established practice of the General Electric Company, no bands are allowed to project above the armature core. Some years ago a special device was developed for securing the ends of the band wires, independent of solder. Armature bands and windings on General Electric railway motors never come off because of insecure or insufficient binding.

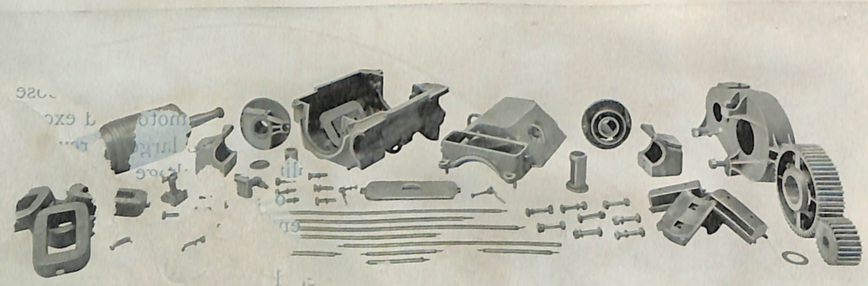
COMMUTATOR

Conforming to the standard practice of the General Electric Company, the commutator segments are made of hard drawn copper, insulated throughout with the very best grade of mica. The cone micas are built up and pressed hard and compact in steam molds. The segment mica is made of a somewhat softer quality, with the view of making it wear down evenly with the copper.

Much care is taken in the construction of the commutator. The coned surfaces are machined with extreme care and cleaned to prevent possible short circuits, while the creepage distances are made long to prevent grounding.

The excellent commutating qualities of the motor, together with the good construction of the commutator and deep segments, insure a long life for the commutator.

The commutator shell and cap are made of cast steel and these parts are extremely strong. The segments are clamped very tight and the cap is pressed down securely in an hydraulic press before tightening the commutator nut.



PARTS OF GE-74 RAILWAY MOTOR

BRUSH-HOLDERS

The brush-holders, two in number, are made of cast bronze and have two carbon brushes per holder. The brushes slide in finished ways and are pressed against the commutator by independent fingers which give a practically uniform pressure throughout the working range of the brushes. The arrangement of the springs actuating the fingers is such that there is but slight pressure on the pins on which the fingers pivot. This prevents any tendency of the fingers to stick on the pins and reduces the wear to a minimum.

There is a "pig tail" or shunt between the fingers and the brush-holder body to prevent current passing through the springs or pivoting pins.

The brush-holders are adjustable to allow for wear of the commutator. They are clamped on mica insulated studs, sliding in finished supports which are bolted to the frame. This method of insulating brush-holders was developed by the General Electric Company some years ago and has been applied to a number of types of GE motors with marked success. There is a great advantage in using the highest quality of insulating material which is not injuriously affected by heat or moisture.

VENTILATION

In the construction of the GE-74 motor, special attention has been given to the matter of ventilation. As previously mentioned, there are a number of openings in the magnet frame, and in service which will permit of it, the covers may be left off, thus securing a free circulation of air between the exterior and interior of the motor.

The armature is so constructed that when turning, it draws a large volume of air into the interior of the core and expels it along the exterior. So well ventilated is the armature that it becomes a powerful blower at full speed, and the large volume of air passing through it in addition to small electrical and mechanical losses, keeps it unusually cool. A strong point in the construction is that ventilation is effected without sacrificing necessary protection to the armature windings.

GEAR, PINION AND GEAR CASE

The gear is made of a superior grade of cast steel and the pinion of forged steel, extra hammered, to improve the quality of the metal. The gears have a 5½" face and a No. 3 pitch. The teeth are accurately cut by tools specially designed for doing this work.

The gear case is made of malleable iron and is of an improved design. Radiating from the points where it is attached to the motor frame are strengthening ribs to prevent the case from cracking. Both the top and bottom halves of the case are bolted to the lower magnet frame. With this construction the gear case is not affected by loose bolts in other parts of the motor and excessive vibration of the case is entirely prevented so that the liability of breakage is reduced to a minimum. Successful has been the method of suspension and operation of General Electric motors that this feature is considered a salient point in the construction of the GE-74.

SUSPENSION

The motor is supported on the truck by means of a suspension bar which is bolted to lugs cast on the lower frame. By the removal of the small upper frame, the armature is completely exposed. If then, the frame head bolts and the upper half of the gear case are removed, the armature together with the frame heads may be lifted out, leaving other parts of the motor still intact as assembled on the truck. To protect the field coils from injury, pins set in the four corners of the upper frame act as guides when assembling and form legs upon which the frame is set when removed. Motors may be mounted on or removed from a truck from a pit, but are preferably handled from above when the truck

is out from under the car, no pit being required.

WEIGHTS AND DIMENSIONS

General dimensions and weights of the GE-74 motor will be found on the motor suspension diagram, page 7, and weights of equipments on page 14.

ADVANTAGES

The GE-74 motor as a type possesses a number of advantages, some of which may be briefly summarized as follows:

The bearings of the GE-74 motor are practically identical in design with the bearings of General Electric box frame motors, and in common with them show great superiority in method of lubrication as affecting the life of bearings, cost of maintenance and cost of lubrication.

The construction of the GE-74 motor permits of the use of a superior design of gear case. The case has three points of suspension. Both the top and bottom half of the case are bolted to the lower magnet frame, this being possible in the [illegible] split considerably above the center. With this form of suspension, the loosening of bolts, other than the gear case bolts, does not in any way affect the gear case suspension. Excessive vibration of the case is prevented and a strong and rigid construction secured.

The design of the motor makes it very convenient to handle and especially so when trucks are taken from under the car and the work done on the floor, without the use of a pit.

The motor as a type is economical in space and consequently permits the use of large factors of safety. The large bearing sufaces, size of bearings, width of gear case, good ventilation, etc., should be noted. Attention is called to the good commutation, high efficiency, low core loss, low I^2R loss, high free running efficiency, good ventilation, superior brush-holder construction, large commutator, deep segments, superior insulation, protection from mechanical injury, etc. All of which will commend the motor to practical users of this class of apparatus.

RATING

On account of the electrical efficiency and good ventilation of the GE-74 motor, its capacity for continuous service is high. The motor is rated at 65 H.P. based on a temperature rise by thermometer of not more than 75 degrees C. above the surrounding air after one hour's run at 500 volts, the temperature of the surrounding air not exceeding 25 degrees C.

This method of rating has been in use for a number of years, and while it does not necessarily give an exact measure of the capacity of a motor to perform all classes of service, it is a convenient and now well understood rating which conveys an approximate idea of the relative sizes of motors sufficiently close for general use. In addition, a motor run at this rating will receive a thorough test of commutation, bearings, brush-holders, heating, etc.

The predetermination of the capacity of a motor to perform a given service is a problem, the solution of which necessitates a complete knowledge of the mechanical, electrical and thermal characteristics of the motor. Knowing these characteristics, it is possible to calculate the losses in a motor while performing any specified service. There is but one way of determining how hot a motor will run with these losses, and that is by reference to actual tests of the motor under the same or similar service conditions.

Manifestly, the heating of a given motor in service depends absolutely on the character of the service and consequently no reliable estimate can be made of the necessary capacity, or characteristics of the motor for successful operation, without a complete knowledge of the operating conditions. The weight of car or train, schedule speed, location and number of stops, duration of stops, profile and plan of road and voltage are necessary for a

complete and careful analysis of the problem.

The General Electric Company carefully tests each type of motor for efficiency, I^2R losses, core losses, friction losses, speed, commutating capacity, etc., at various voltages and amperes.

Exhaustive tests are made to determine the capacity of the motor to dissipate heat under operating conditions. For this purpose motors are put into actual service on the company's experimental track (more than two miles in length) and run day after day over a wide range of known service conditions, careful temperature measurements being taken, until sufficient data is obtained to show what temperature different parts of the motor will reach, not only with various total losses, but with various distributions of these losses.

Possessing such complete information covering all the characteristics of a given type of motor, the Company's engineers are in a position to determine with much assurance the adaptability of the motor to handle any specified service. The problem then becomes not a matter of guesswork, but of calculation.

As the power required to operate an equipment affects not only the heating of the motors, but also the total amount and cost of power for operating the road, careful calculations are made to determine the most suitable characteristics of a motor for a given service and the most economical gear ratio to use. The possibilities for saving power by careful design and proper selection of gear ratio are much greater than ordinarily appreciated.

As the reputation of its motors and the interests of its customers are involved in the selection of motors, the General Electric Company desires to aid and co-operate with customers in selecting motors adapted for their service. To this end, customers are furnished with blank service data sheets to fill out, showing the character of the service which it is desired to operate. The General Electric Company's great experience in this class of work enables it to render valuable assistance, and long experience has indicated that co-operation is mutually beneficial.

The blank form shown on page 8 will be gladly furnished to prospective customers.

Speed, torque and efficiency curves of the GE-74 motor with various gear ratios, corresponding to gear ratios given in the table, will be found on pages 9 to 13. These curves are convenient for general reference.

The diagram of the motor showing external dimensions and axle preparation on page 14, will enable truck builders and car manufacturers to adapt trucks and cars for the proper reception of the motor.

APPROXIMATE WEIGHT IN POUNDS

Motor complete with gear and gear case	3,534
Double motor equipment, complete, with two K-28 controllers	8,318
Double motor equipment, complete, with Type control and two C [illegible] ster controllers	9,00
Four motor equipment, complete, [illegible] two [illegible]	[illegible]
Four-mot equipm [illegible] omp [illegible], th Type M control and [illegible] o C-6 ter ontrollers	

GEAR RATIOS

CHARACTERISTIC CURVES, ETC.

Gear ratios with characteristic letters and numerals corresponding with two turn armatures and 70.5 turn fields, are as follows:

Pinion	Gear	Gear Ratio	Classification	Characteristic No.
16	73	4.56	GE-74-A- 6	84
19	70	3.68	GE-74-A- 7	85
22	67	3.04	GE-74-A- 8	86
25	64	2.56	GE-74-A- 9	87
28	61	2.13	GE-74-A-10	88

DATA FOR GENERAL ELECTRIC COMPANY FOR RAILWAY EQUIPMENTS

on the.....Railway

MOTOR CARS: (OPEN OR CLOSED).....

Weight of empty cars and trucks *not* including electrical equipment.....tons (2000 lbs.)
Length of car over all,..... Length of car body,..... Seating capacity,.....
Capacity with standing load,..... If open car give number of benches,.....

TRAIL CARS: (OPEN OR CLOSED).....

Weight of empty cars and trucks.....tons (2000 lbs.) Length of car over all,.....
Length of car body,..... Seating capacity,..... Capacity with standing load.....
No. of trail cars handled by motor car,..... Hours during which trail cars are operated,.....

At max. voltage the approx. max. speed desired on level is.....miles.
Max. line voltage is..... Min. line voltage is..... Average line voltage is.....
Time (excluding layovers) required to make round trip.....minutes. Length round trip.....miles.
Dista ce **round trip** in city service.....miles. Suburban.....miles. Interurban .....miles.
Average number of stops on **round trip** in city service is..... Suburban is..... Interurban is.....
(It is assumed that the average duration of stops will be 10 seconds each.)
Have motor cars single or double trucks?..... Diam. of car wheels is.....inches.
Number and duration of layovers, if any,.....
.....
.....

GRADES: Underscore grades which cars both ascend and decend in round trip.

Length in ft.	%	Length in ft.	%	Length in ft.	%	Length in ft.	%	Length in ft.	%

REMARKS (Particularly in reference to character of service not covered by previous questions.)

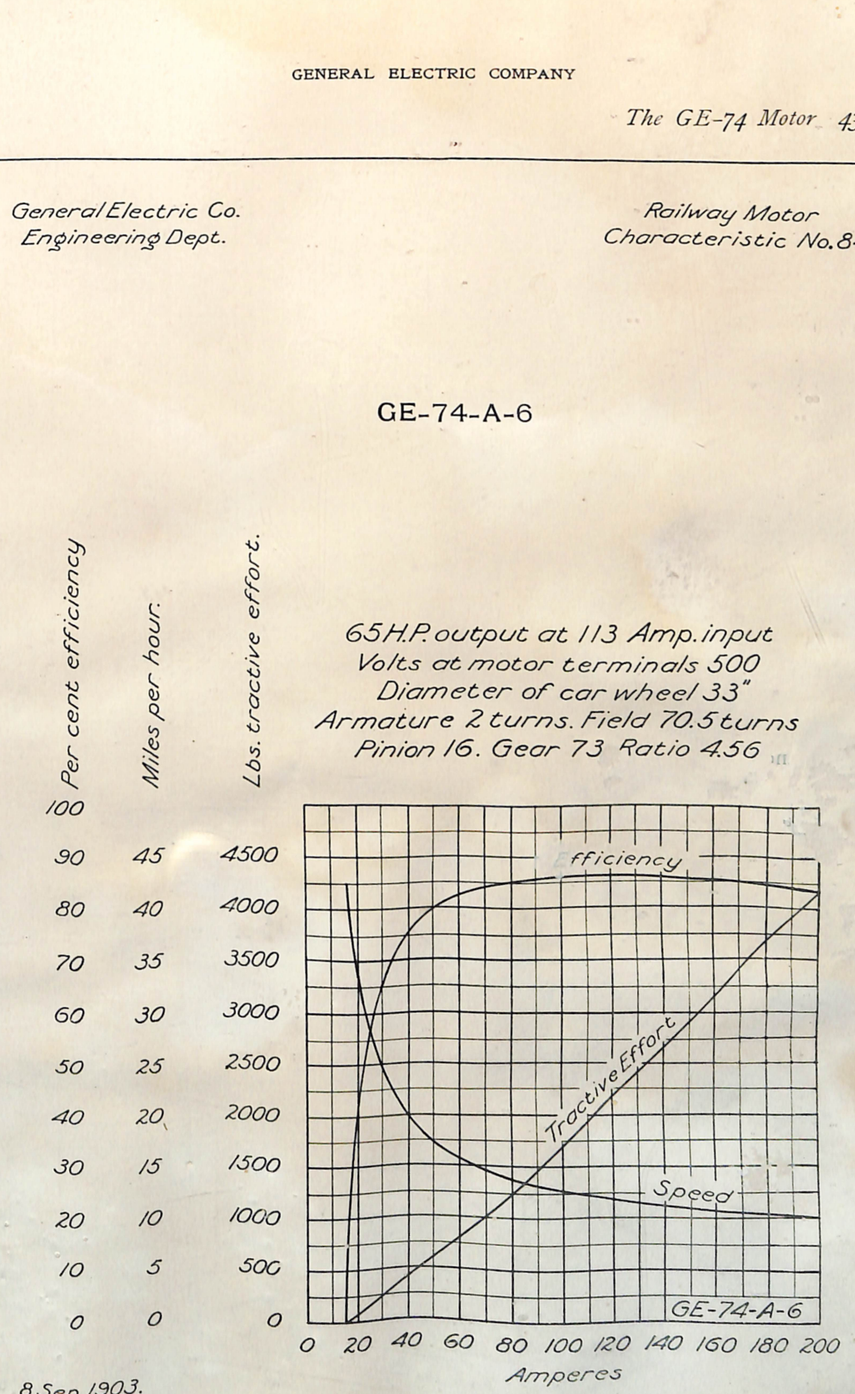
Dated,..... Signed.....
By.....

General Electric Co.
Engineering Dept.

Railway Motor
Characteristic No. 84

GE-74-A-6

65 H.P. output at 113 Amp. input
Volts at motor terminals 500
Diameter of car wheel 33"
Armature 2 turns. Field 70.5 turns
Pinion 16. Gear 73 Ratio 4.56



8 Sep. 1903.

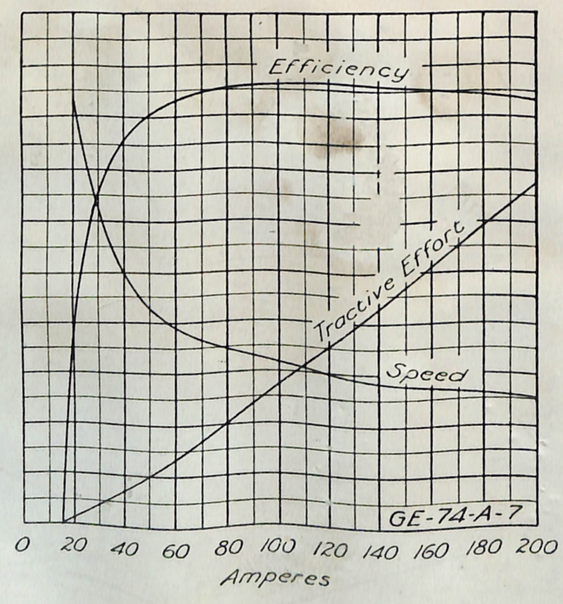
General Electric Co.
Engineering Dept.

Railway Motor
Characteristic No. 85

GE-74-A-7

65 H.P. output at 113 Amp. input
Volts at motor terminals 500
Diameter of car wheel 33"
Armature 2 turns. Field 70.5 turns
Pinion 19. Gear 70. Ratio 3.68

Per cent efficiency.	Miles per hour.	Lbs. tractive effort.
100		
90		
80	40	
70	35	3500
60	30	3000
50	25	2500
40	20	2000
30	15	1500
20	10	1000
10	5	500
0	0	0



8 Sep. 1903.

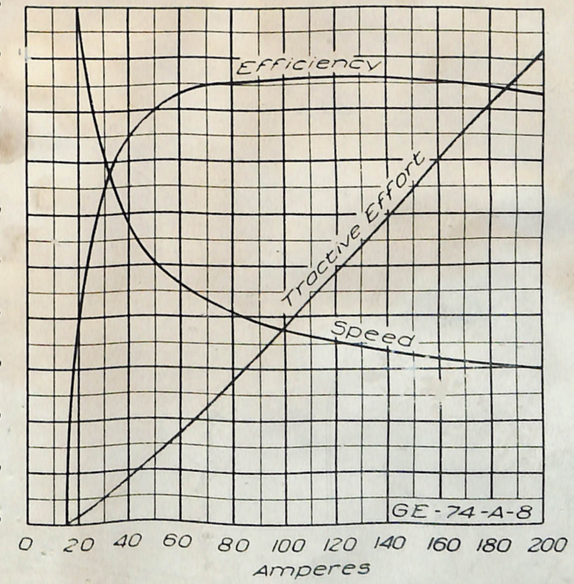
General Electric Co
Engineering Dept

Railway Motor
Characteristic No. 86

GE-74-A-8

65 H.P. output at 113 Amp. input
Volts at motor terminals, 500
Diameter of car wheel, 33"
Armature 2 turns. Field 70.5 turns
Pinion 22. Gear 67. Ratio 3.04

Percent efficiency	Miles per hour	Lbs tractive effort
100	50	3000
90	45	2700
80	40	2400
70	35	2100
60	30	1800
50	25	1500
40	20	1200
30	15	900
20	10	600
10	5	300
0	0	0



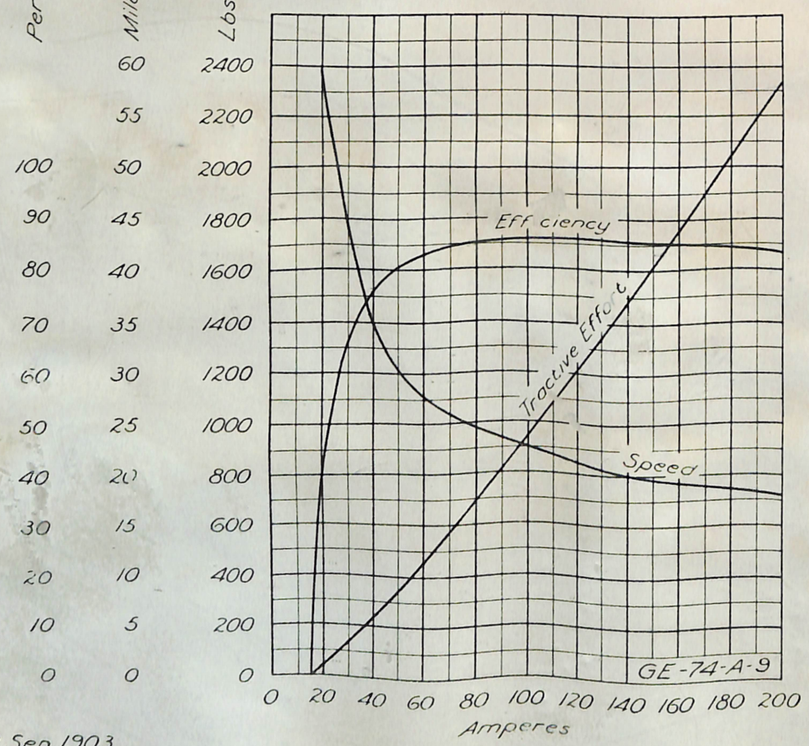
8 Sep. 1903

General Electric Co.
Engineering Dept.

Railway Motor
Characteristic No. 87

GE-74-A-9

65 H.P. output at 113 Amp. input
Volts at motor terminals 500
Diameter of car wheel 33"
Armature 2 turns. Field 70.5 turns
Pinion 25. Gear 64. Ratio 2.56



8 Sep. 1903.

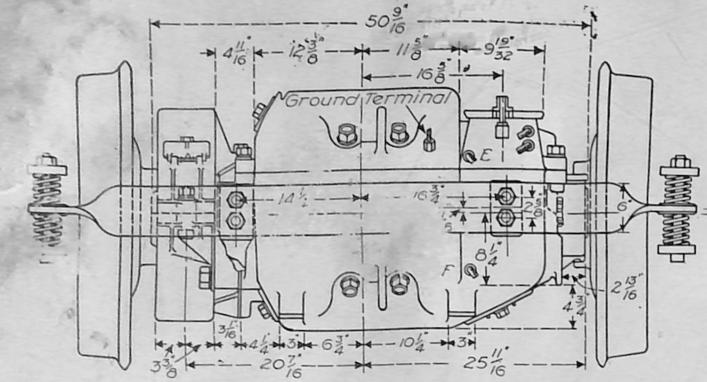
General Electric Co.
Engineering Dept.

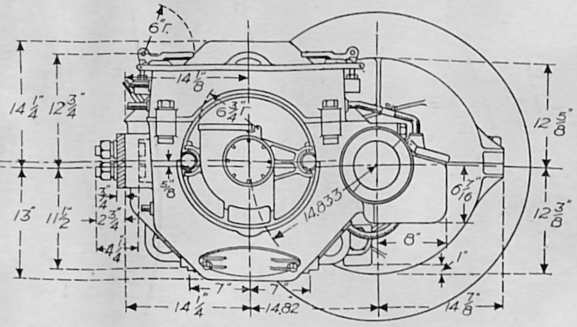
Railway Motor
Characteristic No. 88

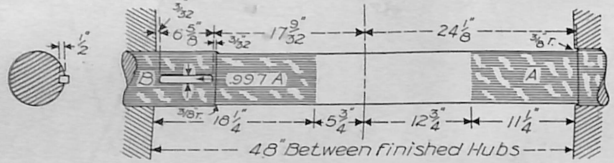
GE-74-A-10

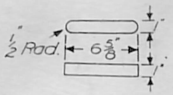
65 H.P. output at 113 Amp. input
Volts at motor terminals 500
Diameter of car wheel 33"
Armature 2 turns. Field 70.5 turns
Pinion 28. Gear 61. Ratio 2.18

8 Sep. 1903.









Diam of Axle

A	B
5½"	6"

Dimensions of unfinished parts are subject to a small variation

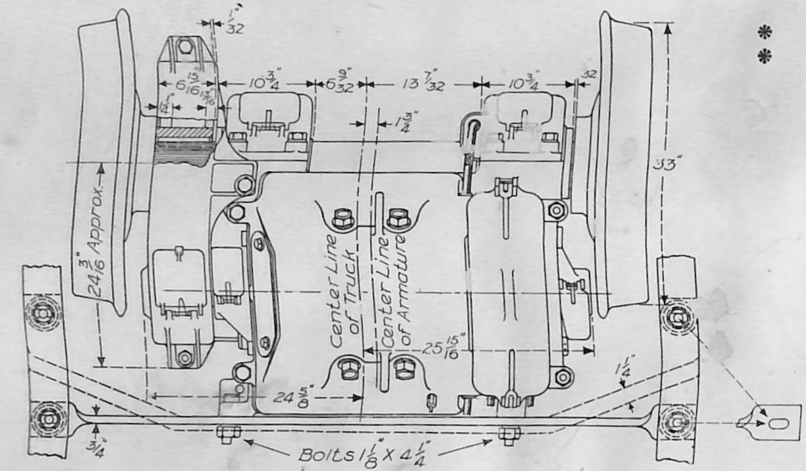
* Weight of Pinion and Gear change with ratio of Gearing

Weight of Motor complete without axle gear and case ----- 3119 Lbs.

* ,, ,, Armature and Pinion (20 teeth) ---------- 845 "

* ,, ,, Axle Gear (69 teeth) ---------- 240 "

,, ,, Gear Case ---------- 175 "



DIMENSIONS OF GE-74 RAILWAY MOTOR

GENERAL ELECTRIC COMPANY

PRINCIPAL OFFICES, SCHENECTADY, N. Y.

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BALTIMORE, MD., Continental Trust Building.
PITTSBURG, PA., Park Building.
ATLANTA, GA., Empire Building.
NEW ORLEANS, LA., 917 Hennen Building.
CINCINNATI, OHIO, Perin Bldg., Fifth and Race Sts.
CLEVELAND, OHIO, Citizens Building.
COLUMBUS, OHIO, Hayden Building.
NASHVILLE, TENN., Room 22, Cole Building.
CHICAGO, ILL., Monadnock Building.
DETROIT, MICH., 1434-35 Majestic Building.
ST. LOUIS, MO., Wainwright Building.
OKLAHOMA CITY, OKLA., 408 Culbertson Building.
DALLAS, TEXAS, Scollard Building.
HELENA, MONTANA, Power Block.
MINNEAPOLIS, MINN., Phoenix Building.
DENVER, COLO., Kittredge Building.
SALT LAKE CITY, UTAH, 25 East First South Street.
SAN FRANCISCO, CAL., Crossley Building.
LOS ANGELES, CAL., Douglas Building.
PORTLAND, ORE., Worcester Building.

FOREIGN:

FOREIGN DEPARTMENT,
Schenectady, N. Y., and 44 Broad St., New York, N. Y.
LONDON OFFICE,
83 Cannon Street, London, E. C., England.

For all CANADIAN Business,
Canadian General Electric Company, Ltd.,
Toronto, Ontario.

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