January, 1904

Instruction Pamphlet No. T 5014

Axle-Driven Air Compressors

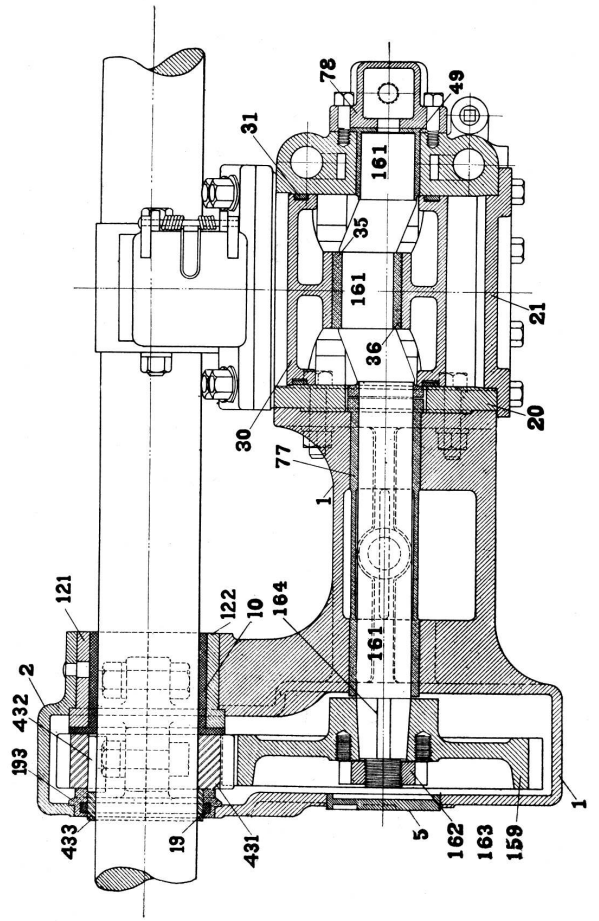
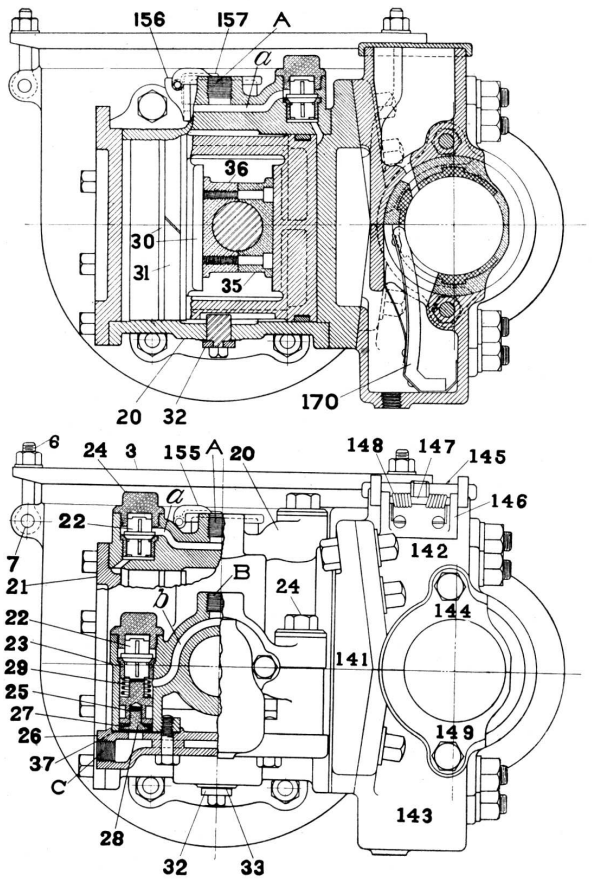


FIGURE 1. AXLE-DRIVEN COMPRESSOR.

Axle-Driven Air Compressor.

Figs. 1 and 2 show the construction of the A. C. N. form of this type of compressor. From the sectional plan, Fig. 1, it will be noted that the cylinder 20 has its axis horizontal and at right angles to the car axle. The two discharge valves are located in suitable chambers on the top at each end of the cylinder (see sectional elevation on Fig. 2) and a discharge passage *a* leads from these chambers to the discharge orifice A, midway between them. Lower down, by the side of the cylinder are the two suction valves 22 beneath which are cylindrical chambers connected to each other and to the suction orifice B by a passage *b* above the crank-shaft end-bearing. All four valves are interchangeable, as are also the removeable seats 23. It will be noted that the valves are seated by gravity and have no springs to wear, break or gum up. The cylindrical chambers beneath the suction valves are provided with pistons 25, fitted with cup leathers 27 and normally held at the bottom of their chambers by the springs 29. The casting 26 forms a cover for these chambers and connects them below the trip pistons 25. Thus when compressed air is admitted at C, the trip pistons are forced upward, thereby lifting the suction valves and cutting the pump out of action. This method of regulating the action of the pump is much superior to the old way of permitting the pump to discharge into the atmosphere, because when cut out, the four valves do not move, the discharge valves remaining on their seats, assisting the check valve in preventing a backward flow of air from the reservoir, and the suction valves being held at the upper end of their stroke by the trip pistons. The air is simply drawn back and forth in and out of the suction orifice, no other work being done.

FIGURE 2.

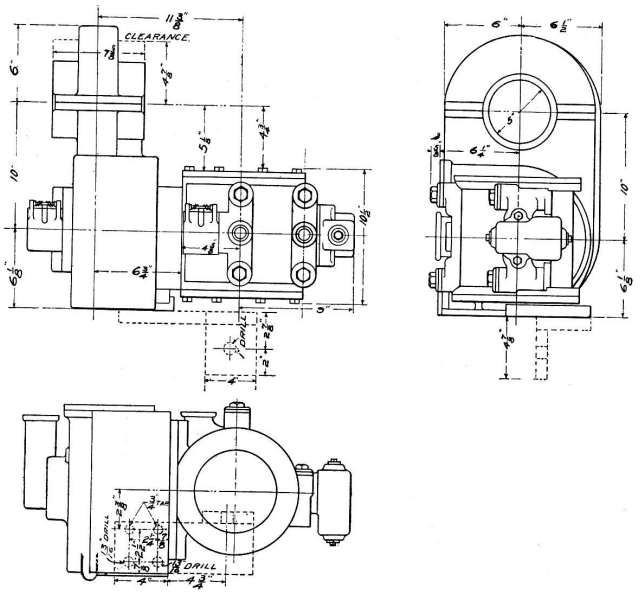


AXLE-DRIVEN COMPRESSOR.

The piston 30 is made of a single casting in the form of two discs connected at top and bottom, and left open at the sides in such a manner as to form a yoke, through the center of which the crank shaft passes. The inside rectangular surface of the discs, parallel to the ends of the piston, are machined, and the crank-pin brasses, 35 and 36 (which also serve as a crosshead), fit in between these two surfaces in such a manner that they are free to move vertically but not horizontally without also moving the piston. Thus the rotary motion of the crank-pin is transformed into the reciprocating motion of the piston. Each disc is provided with a packing-ring 31.

The center line of the crank shaft 161, is parallel to the car axle, and passes through the cylinder at its middle point. The piston is prevented from turning in the cylinder by a guide 32 which projects into a suitable groove in the under side of the piston. The side of the cylinder opposite to that of the suction valves is provided with a flange by which it is bolted to the oil-tight housing 1 that encloses the gear on the pump shaft as well as the driving gear secured to the car axle. These gears are made larger than necessary for the work that they have to perform, so that they will last a long time. When practicable, we recommend the use of a solid gear on the car axle, although we have supplied many hundreds of split axle gears that have been in successful operation for a number of years. This housing is provided with bearings 10 on the axle which support this end of the compressor and serve to keep the two gears in mesh. The position of the compressor on the car axle must depend on the kind and size of electric motor used in propelling the car. It is manifest that the compressor bearings and axle gear must be placed on the axle at a point that will not interfere

FIGURE 3.



OUTLINE OF G. C. B. COMPRESSOR.

with the motor bearings and field casting. For this reason, also, the length of the housing 1 is varied so as to bring the pump cylinder close up to the gears, or farther away, according to the space available. When there is sufficient space on the axle to admit of the compressor bearing being placed on the wheel side of the motor, and the design of the motor bearing will permit, the cylinder is placed close up to the gears, housing 1 being very short as shown in Fig. 3, opposite page. Should the construction of the motor render such a design of compressor impossible, the crank-shaft and housing are prolonged, so that the cylinder may come into the space between the motor bearings. When this is done an auxiliary bearing, 142 and 143 (Fig. 2), is fixed to the cylinder head 141. As the field casting of the motor generally comes very close to the axle at this point, the auxiliary bearing shells 144 and 149 are made quite thin on the back and are bolted to the bearing housing to hold them securely in place. To insure proper lubrication of this bearing, the grease cup with hinged lid 145, is provided, and also an oil well with a felt wick 170, which continually feeds oil to the journal. On top of the cylinder is an opening, with a lid 155, by which heavy oil may be poured into the chamber in the piston where the crank pin works, so that all parts run in a bath of oil. The front of the compressor, opposite to the axle bearings, is supported by suitable brackets which are mounted upon it, and the truck frame respectively, with a rubber cushion between them to deaden the vibrations, as shown on Fig. 5.

Standard Forms of Axle-Driven Compressors.

Owing to the widely varying conditions met with in street railway practice, due to the different types of trucks and motors, diameters of wheels and speeds, it has been necessary to establish several forms of our geared compressor. We have found, however, that one design of pump cylinder answers all purposes, the difference in the various forms of compressors being confined to the gear ratios necessary to keep the piston speed within safe limits, and the design of housing required to meet the conditions above stated. The different forms of axle-driven compressors and their gear ratio are designated as follows:

Form	G. C. B.	10″ x 10″ gears.	
"	G. C. C.	6″ x 10″ "	
"	G. C. D.	6″ x 10″ "	
"	G. C. G.	8″ x 12″ "	Not kept in stock.
"	G. C. J.	10″ x 10″ "	Extended, with auxiliary bearing.
"	A. C. N.	6½″ x 12″ "	Extended, with auxiliary bearing.

FORM G. C. B.—10″ axle gear, 10″ pump gear (see Fig. 3), may be mounted on the same axle with the motor. The space required on the axle between the motor bearing and the hub of the wheel is 7½″. The distance from the center line of the axle to the extreme end of the motor bearing on the commutator side, not to exceed 5⅛″—otherwise form G. C. J. will have to be used for this combination of conditions. The limit of speed for which this compressor is designed is 22 miles per hour when mounted on an axle with 33-inch wheels. For speed limits when other diameters of wheels are employed see chart in Fig. 9, page 17.

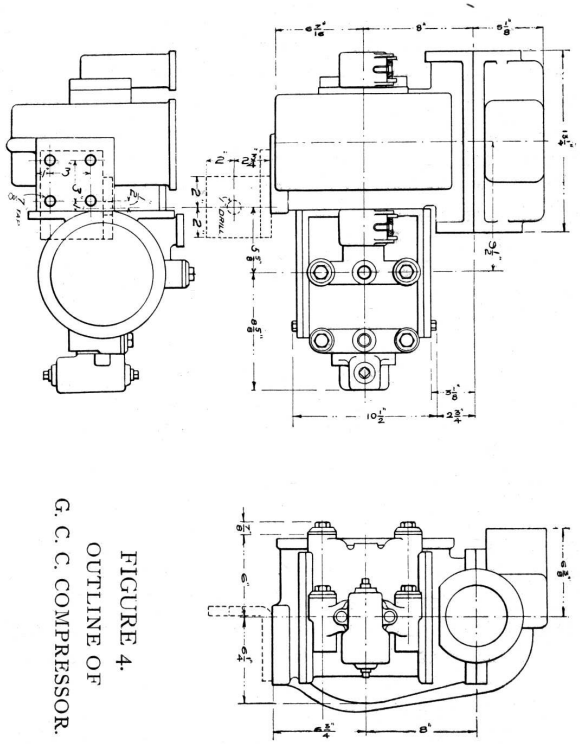


FIGURE 4.
OUTLINE OF
G. C. C. COMPRESSOR.

FORM G. C. C.—6″ axle gear, 10″ pump gear. See Fig. 4. The bearing of this compressor takes up 15 inches of axle space and cannot be mounted on the same axle with a motor. It is designed for mounting on a $3\frac{3}{8}$-inch axle with 20-inch wheels, under which conditions the maximum allowable speed of the car is 22 miles per hour. When supplied with a special steel gear and bronze bearing shells this compressor can be mounted on a free axle 4 inches in diameter (maximum); and when 33-inch wheels are used, the maximum speed will be 37 miles per hour. (See chart, Fig. 9.)

FORM G. C. D.—6″ axle gear, 10″ pump gear. See Fig. 5. A modification of the G. C. C. for use on pony axles with 18-inch wheels, in which the center line of the cylinder is two inches above the center line of the axle. With the exception of a heavy rib, one inch deep, for protection in case of derailment, no part hangs lower than five inches below the center line of the car axle. Other particulars are the same as with the G. C. C.

FORM G. C. G.—8″ axle gear, 12″ pump gear. Similar in form to the G. C. B. and may be mounted on the same axle with the motor, but requires a space of $8\frac{1}{2}$″ between the motor bearing and the hub of the wheel; the distance from the center line of the axle to the extreme end of the motor bearing on the commutator side cannot exceed $5\frac{1}{8}$″—otherwise Form A. C. N. will have to be used. The maximum axle diameter is $4\frac{1}{2}$″. The speed limit with 33″ wheels is 33 miles per hour. Note that this form of compressor is not carried in stock, and will be supplied only when special conditions warrant so doing.

FORM G. C. J.—10″ axle gear, 10″ pump gear. See

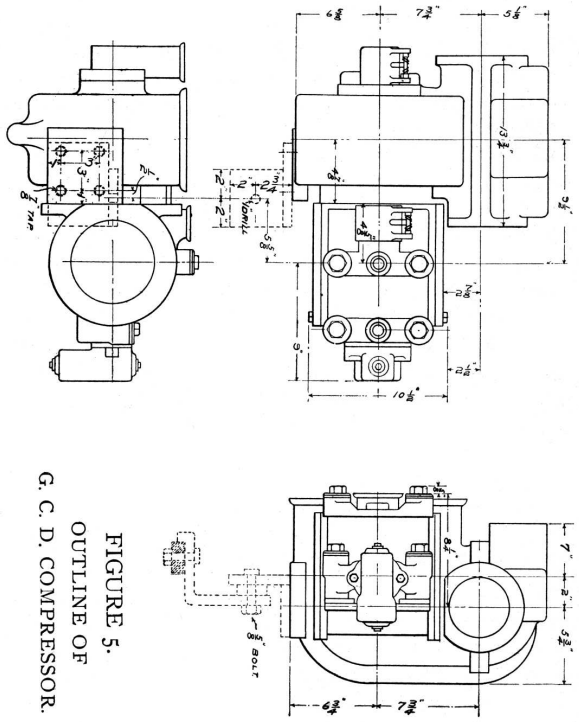


FIGURE 5.
OUTLINE OF
G. C. D. COMPRESSOR.

Fig. 6. This compressor is designed for the same service as the Form G. C. B., but is substituted for it when the motor bearing above mentioned projects so far as to prevent placing the pump cylinder close to the pump gear case, in which event the housing and crank shaft are prolonged $5\frac{1}{2}$″. This brings the cylinder into the space between the two motor bearings, and to support this end of the compressor, an auxiliary bearing is secured to the cylinder head, as described on page 103. The axle space between the motor bearing and the hub of the wheel should be 6″, but may be safely reduced to $5\frac{1}{4}$″. By using a special motor bearing shell that serves for both compressor and motor the space between the hub of the wheel and the face of the motor bearing may be reduced to $4\frac{1}{4}$″, with certain styles of motors. When less than $5\frac{1}{4}$″ space is available, the question should be referred to our Engineering Department, together with full data as to the style of motor and wheels to be used. The maximum axle diameter is $4\frac{1}{2}$″. Speed limits are the same as for the Form G. C. B.

Form A. C. N.—$6\frac{1}{2}$″ axle gear, 12″ pump gear. See Fig. 7. It is constructed to meet the requirements of fast interurban service, and is provided with the auxiliary bearing above described. The standard length of axle space is $7\frac{3}{8}$″, which may be reduced to $6\frac{1}{4}$″, if necessary. The maximum diameter of axle is $4\frac{1}{2}$ inches. The maximum speed with 33-inch wheels is 41 miles per hour. See chart, Fig. 9.

Installation of the Axle-Driven Compressor.

If the Compressor is to be mounted beside a motor, care must be exercised in locating the hole for the dowel pin of the gear, so that the compressor bearing shell prac-

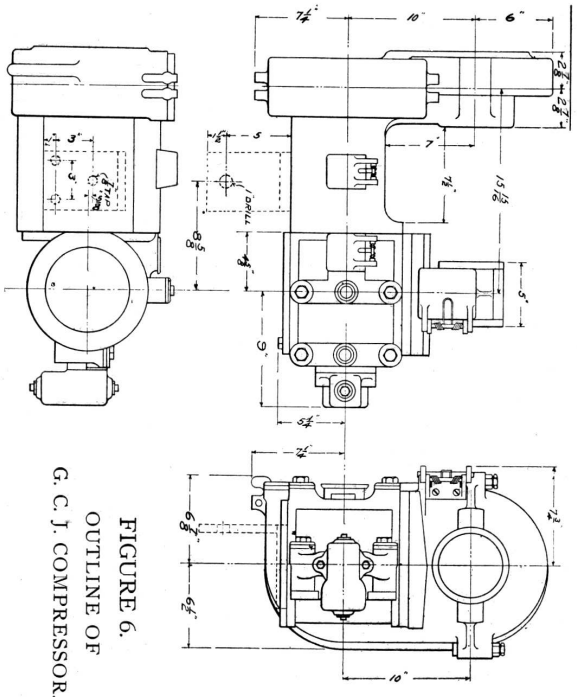


FIGURE 6.

OUTLINE OF

G. C. J. COMPRESSOR.

tically fills the space between the gear and the bearing of the motor. As these two bearings do not revolve the wear between them will be very slight, and the side play of the motor will increase very slowly. The hole in the axle should be made with a twist drill guided by a jig, made for the purpose, which insures an accurate fit of the dowel in both axle and gear. The pin should be driven firmly into the axle and the gear driven onto the pin; when the two halves of the gear have been drawn together, batter the ends of the studs to preclude any possibility of the nuts working loose. It is seldom necessary to remove an axle gear, and in such an event the nuts can be readily split with a sharp chisel. As stated on page 101, we recommend, when practicable, the use of solid gears to be pressed on the axle. A number of roads have adopted this method and consider it of great advantage, a certain percentage of their spare axles being equipped with gears, thus obviating the necessity of changing gears from one axle to another when wheels are changed. When the gear is secured in its proper place on the axle, smear the journals with oil, put on the bearing shells 10 (Fig. 1) and then the housing cap 2, seeing that the dowel pins in same enter properly in the holes prepared for them in the bearing shells. The shells are split at 45° from the parting of the housing, so that the cap holds the shells while the compressor is being put in place. See that all nuts are set up solid and locked in place by the spring washers provided for this purpose. Before tightening the bolts of the housing cap of the G. C. J. and A. C. N. forms of compressor, the auxiliary bearing should be put in its place on the cylinder head. Be sure there is 1/16″ play between the shells of the latter bearing and the motor field casting. The G. C. B. form of Compressor, having

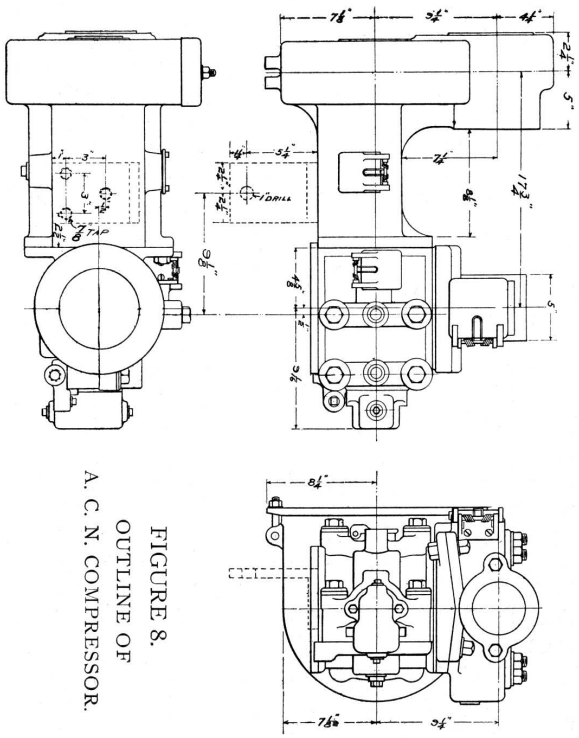
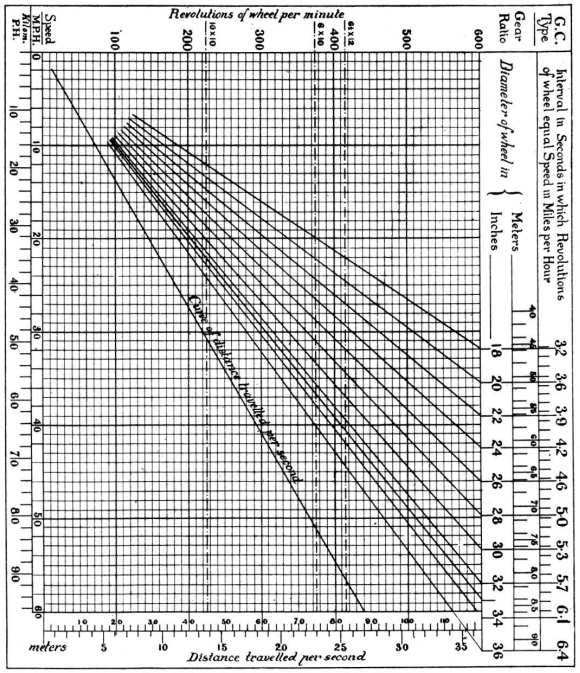


FIGURE 8.
OUTLINE OF
A. C. N. COMPRESSOR.

but one bearing on the axle, must have its suspension at some point on the line passing through the middle point of the axle bearing and the center of gravity of the machine. On the housing, is a lug provided with two $\frac{3}{4}''$ tap and two $\frac{3}{4}''$ through bolt holes, to which the wrought iron suspension bracket should be attached. This must be made to suit the construction of the car, but in many cases (see Fig. 3) can be a bar of $\frac{3}{4}''$ x 4″ iron $10\frac{3}{4}''$ long, placed vertically, covering the lug on the housing and having welded to its upper edge at one end a piece 4″ wide and $4\frac{7}{8}''$ long, protruding horizontally toward the front. A 1″ hole in the center of this protruding piece will lie on the line mentioned and therefore be a proper location for the suspension bolt. The latter may hang from the floor of the car, but it is better to support the compressor from a part of the truck when possible, as there is less oscillation in these parts. We supply a rubber cushion to be placed between the supporting piece and the bracket to deaden the vibration; a $\frac{5}{8}''$ bolt, with suitable washers, will prevent the rubber cushion from working out of its place and the compressor from lifting on reversal of movement of car. This bolt *must not* be screwed up solid, as the lost motion in journal boxes, etc., of the truck necessitate a corresponding freedom of motion at this point to prevent any uncalled for strain on the compressor.

The discharge from the compressor through the $\frac{3}{4}''$ tapped opening in the top of the cylinder must be flexibly connected with the reservoir by means of a hose. With each equipment we send a length of extra heavy hose (4 ply) provided with a special angle union fitting at one end to be screwed into the compressor, and a $\frac{3}{4}''$ nipple at the other, which should be screwed into the

FIGURE 9.



SPEED CHART.

$\frac{3}{4}$″ check valve located at the end of the pipe leading direct to the reservoir. *All* other connections to the reservoir must be made at the end opposite to that from which the air enters from the compressor, so that all air will pass through the reservoir and deposit there any moisture or oil which may be brought over.

To insure long life to the valves, pistons, etc., it is necessary to take every precaution to prevent dust being drawn into the pump. The *Suction Fitting,* therefore, should invariably be mounted in a cheese cloth covered box as described on page 48, and the connection made direct to the suction orifice of the pump by means of the proper length of $\frac{3}{4}$″ 3-ply hose. If the cross timber is not located sufficiently near the pump to obviate the necessity of it, a short length of $\frac{3}{4}$″ pipe may be placed between the hose union and the nipple. In all cases before screwing up the hose union, grease the thread of same that it may not become rusted in place, thus making it very difficult to disconnect the flexible coupling.

In this way the suction is supplied with ample screen surface which, on account of its extreme flexibility, will, when the pump is cut out and the screen is subjected alternately to suction and discharge, tend to shake off any dust that may have lodged on it while the compressor was in action.

Inspection and Care of Axle-Driven Compressors.

The lubricant in the housing should not be allowed to get below the pump shaft; the frequency with which it is necessary to replenish this supply depends so much upon the service that the car is in, and the condition of the bearings on the axle, that it is not

possible to say just how often this will be. At first the cover should be removed from the gear housing once a week and enough grease be added to bring the level well above the pump shaft. By noting the amount remaining in the housing each time, the intervals at which it will need to be replenished can readily be determined. For this lubrication a grease about the consistency of vaseline should be used; a very heavy West Virginia crude oil is the best for the cylinder, and it should be kept at the level of the crank-shaft. Pour it in through the opening on the top of the cylinder or extension of the housing. As stated above, *we decline to assume any responsibility for breakages that may occur in compressors which have not been properly lubricated.*

Other than attending to the proper supply of lubricant there is little to do besides seeing that no nuts have loosened; this latter inspection should be made once a day, if possible, and need take but a minute, as all nuts or bolts that can loosen are on the outside.

At regular intervals (every three months if the car is in hard service) the Compressor should be taken off the axle and cleaned and examined thoroughly. The bearings on the axle should then be replaced and the old ones rebabbitted for the next one to be overhauled. As this is practically the only place where oil can escape from the compressor it is necessary to keep these bearings close to the axle.

If pressure cannot be raised in the reservoir, disconnect the discharge-hose union and, while the car is running, hold the hand over the opening; if for each revolution of the axle there are two equally sharp spurts of air the pump is all right. A large leak is somewhat difficult to locate, as with an axle compressor the car must be in motion to do any pumping; for this reason roads having a large number of air brake equipments should have a stationary compressor, either belt or motor driven, which with two reservoirs makes a very convenient testing outfit. In case such an outfit is not to be had, run the car and if the air escapes from the exhaust pipe it is evident that the operating valve does not seat well: dirt may have gotten between the valve and seat. If this is all right see if a pipe has cracked or a fitting broken. In the event of the compressor failing to pump, remove the fitting under the suction valves and see if the little trip pistons are free; if the suction or regulator pipes were not properly cleaned, dirt may cause one of these pistons to stick and hold the suction valve open. It is also possible to feel from below whether the valves are seating properly or not. If one suction valve sticks, the pump will attain maximum pressure, but it will take twice as long to do it. If one discharge valve sticks open, the pump will attain about 20 pounds and cannot get much higher.

Although the pump valves are, all machined alike, each valve is ground to its own seat; therefore when cleaning them, be sure to put them back on their old seats, otherwise they are liable to leak as no ground valves are interchangeable without regrinding on the new seats. Should the pump fail to cut out, take down the trip fitting and see that the trip pistons are free; instances have occurred of a long trip piston packing leather being caught between the trip fitting and cylinder body when bolting the fitting on.

A kink in the suction hose by which it is doubled

over on itself will cause the compressor to pump slowly owing to the diminished supply passage.

IMPORTANT.

When the cover of the housing is removed to oil the compressor, *be very particular* that nothing is allowed to drop in. The lodging of a "stray" bolt or nut between the gears will destroy the whole machine.

Instructions for Ordering Spare Parts of Axle-Driven Compressors.

Note the letter that designates the form of the G. C. Type of compressor that is used, and when ordering spare parts, state the symbol of the compressor, together with the piece number and name of the part, and the *serial number* of the compressor which is stamped on the shield of the housing between the cover and the cylinder. For example, six sets of axle bearings are wanted for a 6½″ x 12″ geared compressor, whose serial number is 356; the symbol of this form is A. C. N., and marked on the casting are found the figures 10. The order should read: Six sets of A. C. N.-10 (axle bearing 3⅞″ diameter) compressor No. 356.

A part that performs the same functions in the different forms of the G. C. type of compressors will always bear the same number, in whatever form it may be found. The last of the three letters forming the symbol of the whole compressor determines the particular form to which the piece under consideration belongs, therefore always give the three letters together with the number and name of part.

Westinghouse Traction Brake Company

General Sales Office
26 Cortlandt Street, New York, U. S. A.
Cable Address
"Airbrake, New York"
Telephone, 6950 Cortlandt
Works, Wilmerding, Pennsylvania

Branch Offices

Boston, Mass.	53 State Street
Cleveland, O.	New England Building
Chicago, Ill.	711 Rookery
Cincinnati, O.	1111 Traction Building
St. Louis, Mo.	American Brake Co., 1932 N. Broadway
San Francisco, Cal.	302 Rialto Building
Pittsburg, Pa.	At Wilmerding Works

P F. No. 017