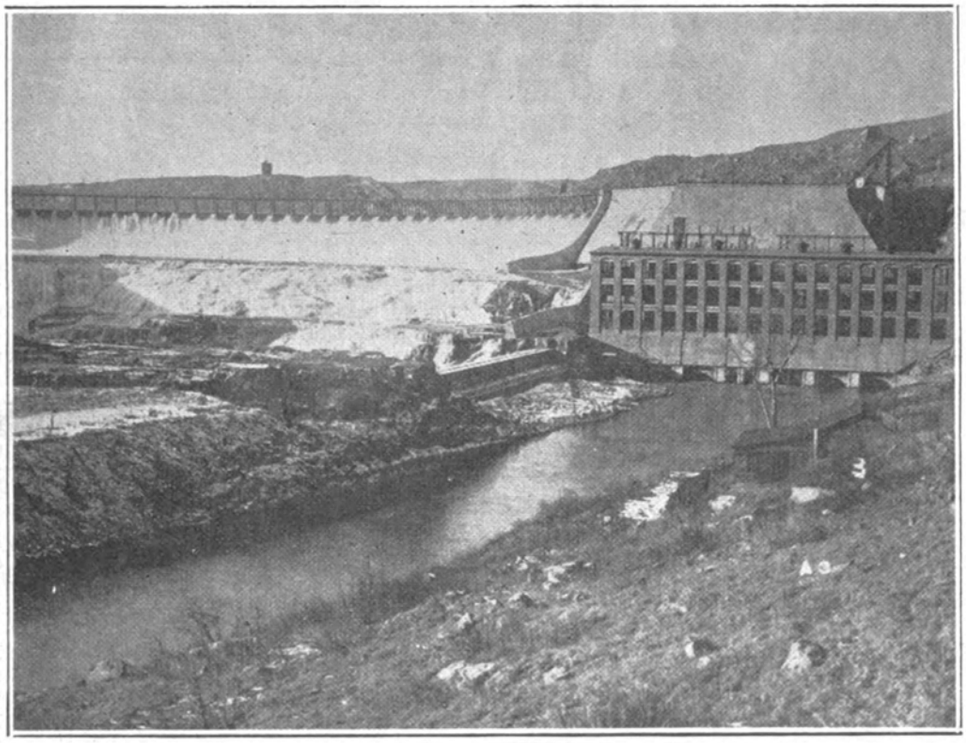
Operating a Railway System with Electricity

PROGRESS has no age. Onward is ever the slogan of railway construction, operation and efficiency. In this forward movement, electricity challenges the supremacy of steam, and on the Scroll of Time the year 1916 marks the dawn of the electrical era in railroading—and the accomplishment of a definite step to conserve the world's resources. The Chicago, Milwaukee and St. Paul Railway has been able to carry through to definite accomplishment the dreams and aspirations of scientists and electricians by the extended electrification of a portion of its main Pacific North Coast line.

For 440 miles, from Harlowton, Montana, to Avery, Idaho, over the Great Continental Divide, the main line of the Chicago, Milwaukee & St. Paul Railway has been electrified; the first unit of 115 miles from Three Forks to Deer Lodge is now in actual operation and other units will be operated as rapidly as work is completed. In affording a smokeless, dustless and gasless main line route for 440 miles through the Belt, Rocky and Bitter Root Mountains, this railway has identified with its equipment the latest word in all those factors that conduce to the safety, comfort and pleasure of the traveling public.



HYDRO-ELECTRIC POWER PLANT AND DAM AT GREAT FALLS, MONTANA.

The entire work cost approximately twelve million dollars and required three years' time to complete. The electrical energy is obtained from the mountain waterfalls along the route.

Of all the achievements in railroad transportation, electrification stands as the one supreme towering fact of a hundred years. The magnificent upbuilding of railroad value and worth has rested for over a century on the one foundation of steam locomotion. Electric locomotion means the change to a newer, better foundation, on which builders shall realize undreamed-of efficiency and comfort.

The traveler is destined to reap great benefits from this stupendous achievement, for with electrification has come a greater dispatch in train operation, a better maintenance of time schedules, the practical elimination of vexatious delays due to snow blockades and cold weather, smoother riding caused by the greater evenness of speed, enhanced comforts due to greater cleanliness, and a pronounced improvement of the view from car window and observation platform, owing to the absence of smoke, dirt and other undesirable incidents to steam travel.

There is only one other event in railroad history that compares with the electrical achievement of the Chicago, Milwaukee & St. Paul Railway, and that was the first trip of the first steam locomotive. That trip ushered in the era of steam railroading. When the first train ran over the electrified trackage of the main line of the Chicago, Milwaukee & St. Paul Railway, drawn by an electrical locomotive, the electrical era in railroading was ushered in.

Harlowton, Montana, and Avery, Idaho, are the terminals of this main line electrification across the Great Continental Divide. Harlowton, on the Musselshell, a tributary of the Missouri River, is directly south of Montana's geographical center. Avery is on the St. Joe Swiftwater, Idaho's beautiful historic stream, famous for its timbered slopes, magnificent fishing and hunting and gorgeous scenery, whose waters find their way to the Columbia River. The full "from-east-to-west" sweep of the Rocky Mountains is traversed and the electrical line runs across the three principal mountain ranges with their bewildering panorama of picturesque valleys, rivers and forests, contrasting with the bleak, barren and forbidding stony uplifts which form a continuation of the vast wastes of the Great American deserts of fifty years ago.

The Belt Mountains are crossed at an altitude of 5,788 feet at Summit, the main Rockies or the Continental Divide at an altitude of 6,322 feet at Donald, and the Bitter Root Mountains at an altitude of 4,163 feet at East Portal. Pipestone Tunnel, the half-mile bore through the backbone of the continent at Donald, is the highest elevation of the railway.

To give an idea of the difficulties that had to be overcome in this enormous undertaking, a two per cent grade had to be surmounted for a distance of 20.9 miles on the east approach to the Continental Divide; immediately west of the Divide, for a distance of 10.4 miles, is a 1.66 per cent grade, and on the western slope of the Big Belt Mountains, for a distance of forty miles, is a one per cent grade, where the line climbs 52.8 feet to the mile. These grades make steam locomotive operation difficult for long, heavily loaded trains and especially so in winter time. Today electric locomotives not only haul heavier trains more smoothly over these grades, but travel at much greater speed in all kinds of weather than when steam power was used.

The particular and impressive feature of the electrification is that this is the first undertaking to install and operate electric locomotives on tracks extending over several engine divisions and under the most difficult traffic conditions. The various terminal and tunnel electric installations made by railways in the past were necessary by reason of local conditions and are limited to short distances. Purely economic reasons, together with anticipated superior operating results and greater comfort for the traveling public, was the inspiration for the extended electrification of the Chicago, Milwaukee & St. Paul Railway. Already results have been obtained that foreshadow large developments in steam road electrification throughout the world.

The electrical power employed to operate the entire 440 miles of electrified main line road and the 160 miles of electrified spurs and yards of the railway is obtained from the hydro-electric power plants of the Montana Power Company, whose main plant is located at Great Falls, Mont. The power is delivered to the railroad at fourteen sub-stations scattered along the route.

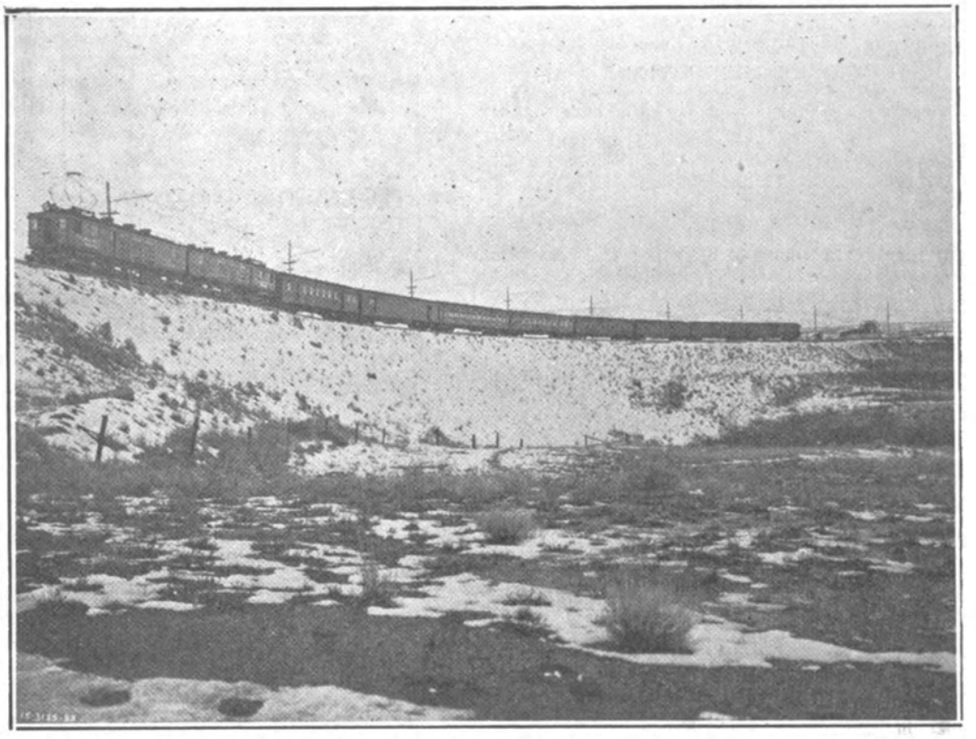
Since the sub-stations receive the electricity in 100,000-volt alternating current, and since they must deliver it to locomotives in 3,000-volt direct current, each sub-station has two functions to perform—to reduce the voltage and to change the current from alternating to direct.

The reduction of the voltage is accomplished as follows: The 100,000-volt alternating current is received through oil switches, is conveyed to the high-tension current distributor made up of three lines of copper tubing, and there forms the source of power for the sub-station. From the current distributor the current is conducted through other oil switches to the transformers, entering at 100,000 volts and merging at 2,300 volts.

The voltage being reduced, the next step is to change from alternating to direct current. The current is conducted from the transformers through switches to the motor-generator sets and is the power employed to operate them. Motor generators, of which there are either two or three in each sub-station, consist of one alternating current motor driving two direct current generators. The motor is of the 60-cycle synchronous type, which means that the current changes sixty times each second. Each set generates a 1,500 or 2,000-volt direct current, and the two generators, being permanently connected in series, deliver a combined direct current of 3,000 volts, which is the highest voltage direct current adopted for railroad work in the world. By way of comparison, the direct current voltage for ordinary street railway work is only 550 volts.

After passing through the control switches,

this 3,000-volt direct current is conducted to the feeder and trolley lines, thence through the pantagraph for the operation of the locomotive. Each locomotive is equipped with two pantagraphs, one located at each end. The pantagraph performs the same function as the trolley pole on the ordinary electric car.



THE WORLD'S MIGHTIEST ELECTRIC LOCOMOTIVE CLIMBING THE CONTINENTAL DIVIDE.

To eliminate any likelihood of the trolley wire breaking and falling to the earth, a strong steel cable, called a "catenary," runs just above the trolley wire and parallel to it all the way, and from this catenary the trolley wire is suspended by hangers at short intervals. In ordinary trolley construction, crosswires strung between twin poles are the only support for the trolley wire. But in the "catenary" type, single poles, each bearing a bracket, support the catenary, and the catenary supports the trolley wire.

Under normal conditions, forty-two immense electrical locomotives are required to haul freight and passenger trains over the electrified mountain districts. These locomotives each cost approximately $112,000; they weigh 284 tons each and will haul 3,200-ton loads trailing up a one-per-cent grade at an average speed of sixteen miles an hour. Similar electric locomotives geared for greater speed will haul 800-ton passenger trains over the same stretch of road at a speed of about twenty-five miles an hour, and on a level stretch at a speed of sixty miles per hour. To appreciate the immense tractive power of these electrical "Goliaths" one should know that the wood-burning locomotive of fifty years ago weighed twenty tons and had a tractive power of only 5,000 pounds. The present day Mallet steam locomotive has a tractive power of 76,200 pounds and the electrical locomotives weighing 284 tons have a tractive power of 85,000 pounds. These electrical locomotives are 112 feet, 8 inches long, and are driven by separate motors, twin-geared to each of eight pairs of driving wheels. The cab extends nearly the whole length of the locomotive.

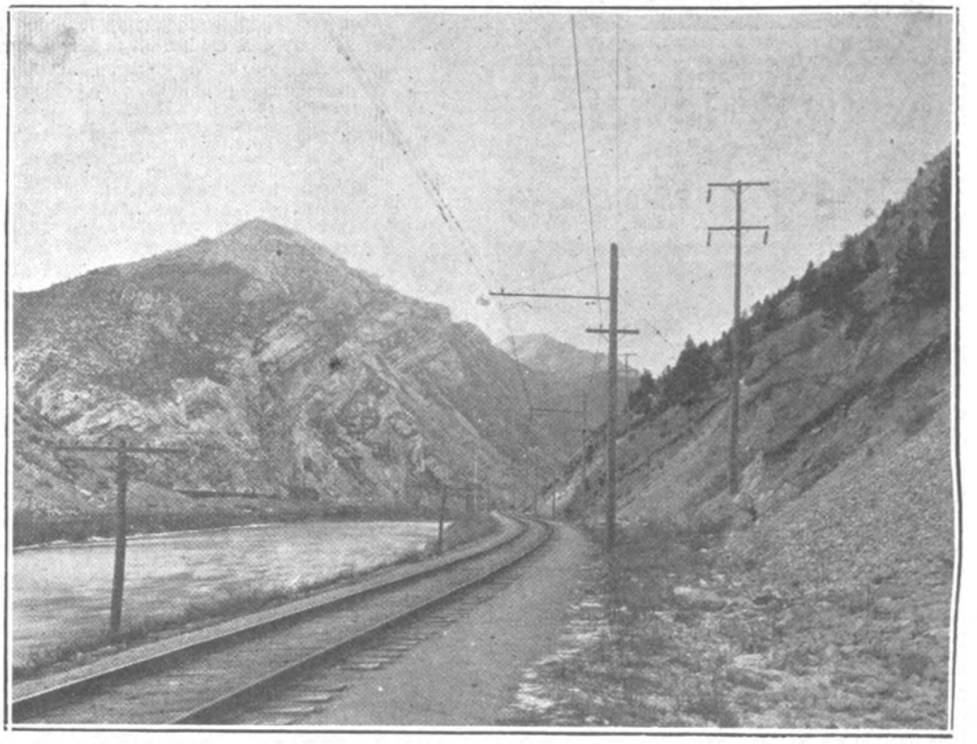
Regenerative braking applies to a method used on down grades, by which the train, instead of consuming electricity, actually produces it while traveling onward, and by which, at the same time, the speed of the train is kept under perfect control. This is the first use ever made of direct current regenerative braking, and the following from an authority on the subject explains its functions:

"Electric motors are reversible in their functions, namely: while they absorb electrical energy and give out mechanical energy going up grades, they can reverse this operation and absorb the mechanical energy given the train down grade by gravity, and transfer it into electrical energy. Thus the electric locomotive provides a perfect braking system, which is independent and separate from the air brakes, which are used only in emergency and for stopping trains. Electric energy so generated can be turned into the trolley wire to assist other trains and reduce the amount of purchased electric current."

In actual operation, at the crest of the grade, the helper locomotive is brought to the front of the train and coupled with the forward locomotive, both being operated as one. The train is then controlled on the down grade by regenerative braking. This system of braking eliminates wheel, brake-shoe and track wear and overheating, insures uniform speed on down grades, and returns electrical energy to substations to be utilized by other trains, from 25 to 52 per cent of the power being recovered.

The electric locomotive can be operated for a thousand miles or more with only casual inspection, whereas the steam locomotive on mountain work requires considerable attention at every division point. This has made it possible to operate the electric locomotive over several old steam divisions, and practically eliminate roundhouses and yards at intermediate points.

By contrasting its workings with the steam locomotive in cold weather, the superiority of the electric locomotive is notably demonstrated. In cold weather a steam locomotive, losing much of its power through heat radiation, draws lighter loads, makes less speed, and has greater difficulty in climbing grades and penetrating snow-drifts, while the electric locomotive, aided by the cold in keeping its motors cool, is able to draw maximum loads, maintain its regular speed, and, by its immense power, to drive through snowdrifts with comparative ease.



A TYPICAL VIEW OF THE MOUNTAIN SCENERY ON THE ELECTRIFIED LINE.

There are fourteen sub-stations on the road between Harlowton and Avery, each of which, with its equipment, costs about $160,000. Each sub-station is about thirty-three miles from its neighbor. Stations are located at Two Dot,

twelve miles west from Harlowton and continuing west, at Summit, Josephine, Eustis, Piedmont, Janney, Morel, Gold Creek, Ravenna, Primrose, Tarkio, Drexel, East Portal and Stetson.

Summarizing, the advantages of the electric locomotive are that it:

Does away with fuel trains.

Runs at an even speed.

Has no tender, as it uses neither coal or water.

Operates over several steam railway divisions.

Is always ready to start simply by turning a hand-switch.

Has no ashes to dump, no flues to clean, and no boilers to inspect.

Has power to send it through the heaviest snowdrifts.

Handles twice the load of the steam locomotive at greatly reduced cost.

Is smokeless, noiseless, dirtless, and "jerkless."

Operates best in cold temperatures when steam locomotives have their greatest troubles.

Is thoroughly dependable in all temperatures.

Is easy on track and roadbed at all speeds.

Becomes a generator, when reversed on down grades, which return from 25 per cent to 52 per cent of the power used in climbing.

The electrification over the Great Continental Divide is a long stride forward in railroading, in electricity and in conservation of resources. To produce enormous power from mountain waterfalls instead of from coal, to transmit this power in the form of electricity over great distances with but small loss in transmission, and to apply it so as to promote more efficient and economical operation, is an achievement which has created a new epoch in railroad transportation and has erected another milestone in the world's progress.

Railway Tariffs and Freight Rate Changes

As Corrected Weekly by the State Railroad Commission for Michigan Shippers

MARCH 29—REDUCTIONS.

C. & N. W., 268. Pig iron, Escanaba Mills and Phelps to Larch and Flat Rock, 5-5.

N. & N. W., 249. Pig iron, Marquette to Larch and Flat Rock, 5-5.

D. T. & I., 78. Car demurrage at Michigan stations, 4-15.*

D. & T. S. L., 323. Car demurrage at Michigan stations, 4-15.*

M. C., 1067. Switching to Delray, connecting Wyandotte Southern, Wyandotte Terminal and Delray Terminal Railroads, 5-1.

P. M., 1929. Switching at Detroit and Akron, 5-1.*

M. C., 1264. Coal, Bay City, etc., to Vassar, Atwood, Reed City, etc., 4-17.

MARCH 30—REDUCTIONS.

C. M. & St. P., 279. Pig iron, Wells to Iron Rover, 5-5.

M. C., 1231. Sand and gravel, Niles to Buchanan, 4-10.

G. T., 411. Sand, Oxford, Washington, etc., to Wayne, 4-10.

MARCH 30—ADVANCES.

G. T., 411. Sand and gravel, Clarkston, Pontiac, etc., to Detroit, Royal Oak, etc., 4-10.

P. O. & N., 238. Sand and gravel, Randall Beach to Detroit, Royal Oak, etc., 4-10.

MARCH 31—ADVANCES.

M. C., 1149. Wheat (ex-lake), Detroit to Grand Rapids, Owosso, Charlotte and Bennington, 4-15.

N. Y. C. (L. S. 90). Car demurrage at Michigan stations, 4-15.

APRIL 1—REDUCTIONS.

G. R. & I., 1045. Pig iron, Antrim, Cadillac to Traverse City, 4-11.

W. T. Line, 50. Exceptions to Western classifications, 5-10

APRIL 1—ADVANCE.

C. C. C. & St. L., 545. Drain tile, Addison Junction and Prattville to various Michigan points, 5-2.

APRIL 3—REDUCTIONS.

E. Morris, 129. Paper stock board, strawboard, board chip, board ceiling, board tag, roofing, etc., 5-15.*

C. C. C. & St. L., 489. Cement, Cement City to Lansing, Eaton Rapids, 5-15.

E. J. & S., 62. Car demurrage rules, 4-15.*

M. C., 1121. Logs, Denton and Wayne to Eloise, Dearborn, 4-15.

M. S. T. & S. S. M., 748. Iron ore, Manistique to Newberry, 5-9.

N. Y. C. (L. S. 89). Absorption of switching of Wyandotte Southern Railway, 5-1.

N. Y. C. (L. S. 88). Absorption of switching of Wyandotte Terminal Railway, 5-1.

N. Y. C. (L. S. 87). Absorption of switching of Delray Terminal Railroad, 5-1.

N. Y. C. (L. S. 86). Absorption of switching of Delray Connecting Railroad, 5-1.

APRIL 4—REDUCTION.

E. Morris, 49. Classes A. A. R. R. and M. C. R. R. station to Northern Pennsylvania points, 5-15.*

M. C., 1052. Car demurrage rules, 4-15.*

APRIL 4—ADVANCE.

M. C., 1269. Paper, Cheboygan to various Michigan points, 5-15.

P. M., 1885. Grain (ex-lake), Port Huron to various Michigan points, 4-15.

APRIL 5—ADVANCE.

E. & L. S., A-52. Cordwood, E. & L. S. stations to Wells, 4-15.

APRIL 5—REDUCTIONS.

E Morris, 149. Paper, etc., Michigan points to Northern Michigan points, 5-15.*

G. R. & I., 1046. Ice, Lake City, Hiram, Sand Lake to Grand Rapids, 4-16.*

P. M., 1929. Logs, Port Huron to Cadillac, 4-15.

Note: *Also contains advances.

APRIL 6—REDUCTIONS.

C. C. C. & St. L. 489, cement, Cement City to Gull Lake 5-20.

G. T. 285, paper, Grand Trunk stations to various Michigan points, 5-15.*

APRIL 7—REDUCTIONS.

D. S. S. & A. 984, eggs, Houghton to Marquette, 4-17.

P. M. 1899, paper, etc., Pere Marquette stations to various Michigan points, 5-15.*

APRIL 7—ADVANCE.

D. S. S. & A. 520, lumber, D. S. S. & A. stations to Adrian, Detroit, Lansing, etc., 4-17.

D. T. & I. 80, live stock, D. T. & I. stations to various Michigan points, 5-14.

APRIL 10—REDUCTION.

D. S. S. & A. 931, edging, etc., Chassell, Dollarville, Hancock, etc., to Marquette, 4-20.

M. C. 1270, handling grain at elevators at Detroit, 4-25.*

P. M. 1930, sand, Scottdale to Benton Harbor, 4-20.

APRIL 11—REDUCTION.

D. T. & I. 77, drain tile, Scofield to Alma, Bay City, Midland, etc., 4-22.

*Also contains advances.

FOR THE WEEK ENDING APRIL 7.

St. Clair Paper Company, Inc. (F), Borough of Manhattan, N. Y., and Capac.	$205,000
Star Wheel Corporation, Detroit	50,000
West Royal Oak Land Co., Detroit	40,000
New Century Realty Company, Detroit	25,000
William Pike Company, Detroit	5,000
Cadillac Tool Company, Detroit	15,000
Cosmopolitan Realties, Inc., Detroit	10,000
Hamford Corporation, Detroit	50,000
Metropolitan Detective Agency, Detroit	5,000
Little & Beever Company, Detroit	6,000
Muskegon Logging Company, Muskegon	5,000
Detroit Plating Company, Detroit	5,000
Macomb County Printing Company, Mt. Clemens	8,000
Gill Herman Company (F), Cincinnati, O., and Detroit	50,000
August Goss & Company, Saginaw	12,000
Robert E. Bell Company, Detroit	40,000
Guardian Frigerator Company, Detroit	25,000
Benton Harbor Utilities Company, Benton Harbor	10,000
U. S. Auto Supply Stores Company, Detroit	50,000
Steel Treating Equipment Company, Detroit	10,000
Mass Creamery Company, Mass	10,000
Mechanics Realty Co., Detroit	1,000
Mapleview Land Company, Detroit	40,000
Cheyenne Avenue Land Company, Detroit	10,000
Berwin Realty Company, Detroit	100,000
Detroit Architectural Iron Works Company (name changed to Detroit Architectural Iron Works), Detroit	10,000
Overland-Stores Company (F), Toledo, Ohio, and Lansing	100,000
Jewel Tea Co., Inc. (F), Chicago, Ill., and Detroit	50,000
Town and Country Land Company, Detroit	50,000
Droford Starter Company, Detroit	5,000
Repeater Ice Cream Cone Company, Detroit	2,000
Griggs Land Company, Detroit	50,000
Kaltz & Schnell Company, Detroit	3,000
Direct Furniture Company, Detroit	5,000
Wolverine Rubber Sundries Company, Detroit	5,000
Webster, Oliver, Streeter Company, Detroit	10,000
South End Sanitary Dairy, Grand Rapids	1,000
Owosso Michigan Knights of Columbus Building Association, Owosso	10,000
Montamower Company, Traverse City	250,000
Franklin Heights Company, Lansing	37,500
Reid Realty Company, Detroit	10,000
Detroit Bearing & Casting Company, Detroit	110,000
Anti-Friction Lubricant Company of St. Joseph, Michigan, St. Joseph	20,000
Longridge Land Co., Detroit	15,000
East Detroit Development Company, Detroit	250,000
Cargill Peninsular Company (name changed to Evans, Winter, Hebb., Incorporated), Detroit	175,000
Blackmore & Harwood Telephone Company, Leslie	500

INCREASES.

Globe Knitting Works, Grand Rapids, from $600,000 to	800,000
Weber Bros. Company, Detroit, from $5,000 to	35,000
Most-Houghten Company, Detroit, from $10,000 to	25,000
Troyoak Land Company, Detroit, from $150,000 to	250,000
Dancer-Brogan Company, Lansing, from $50,000 to	100,000
Prudential Mortgage Company, Detroit, from $10,000 to	50,000
Commercial Electric Supply Co., Detroit, from $40,000 to	100,000
"Merkury" Realty Co., Detroit, from $30,000 to	50,000
Germania Realty Company, Detroit, from $20,000 to	80,000
Detroit Accessories Corporation, Detroit, from $5,000 to	25,000

DECREASES.

Walcott & Wood Machine Tool Co. (name changed to Walcott Lathe Company), Jackson, from $150,000 to	100,000
Allmade Bakeries Company, Detroit, from $300,000 to	100,000

DISSOLUTIONS.

Menominee Water Company, Menominee	100,000
Jacob Zerga Plumbing & Heating Co., Detroit	10,000
McKinley Drug Co., Detroit	10,000
United States Auto Supply Co., Detroit	5,000
Jewel Tea Company (F), Chicago, Ill., and Jackson	100,000
Michigan Qualityre Company (F), Portland, Me., and Detroit	100,000