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CONTENTS

SNOW-REMOVAL REPORT FOR THE WINTER OF 1928-29

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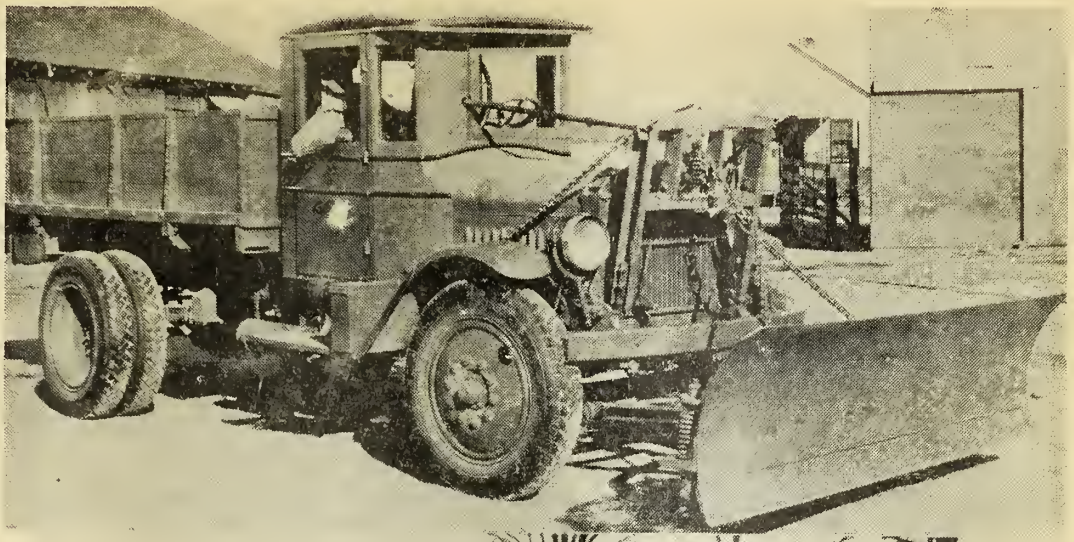
COMPILED PRINCIPALLY FROM DATA COLLECTED FROM THE 36 STATE HIGHWAY DEPARTMENTS WITHIN THE HEAVY-SNOWFALL AREA.

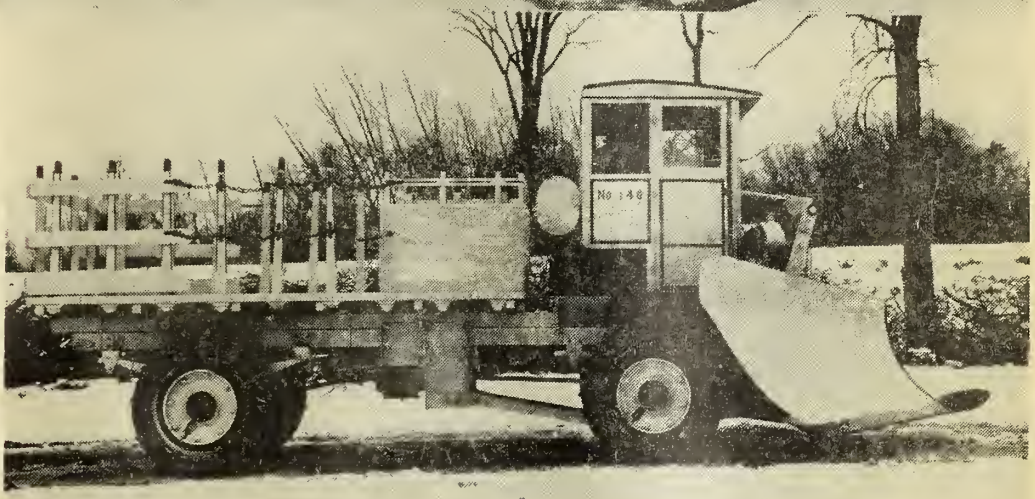
SNOW WAS REMOVED FROM 160,850 MILES OF THE MAIN HIGHWAYS, DURING THE WINTER OF 1928-29, IN THE 36 STATES LYING WITHIN THE AREA OF HEAVY SNOWFALL, ACCORDING TO REPORTS FORWARDED TO THE FEDERAL BUREAU OF PUBLIC ROADS BY THE AUTHORITIES IN CHARGE OF THE WORK. THE TOTAL COST OF THE SERVICE WAS NEARLY 6½ MILLION DOLLARS, OR AN APPROXIMATE AVERAGE OF $40 PER MILE OF ROAD CLEARED.

SNOW-REMOVAL METHODS AND EQUIPMENT HAVE PASSED THROUGH A COMPLETE CYCLE OF CHANGES

DURING THE PAST 10 YEARS THE METHODS OF SNOW-REMOVAL AND THE CHARACTER OF EQUIPMENT USED HAVE PASSED THROUGH A COMPLETE CYCLE OF CHANGES. WHEN THE SNOW-REMOVAL WORK WAS FIRST BEGUN ROAD-GRADER BLADES, MOUNTED ON OR DRAWN BY SUCH TRUCKS AS WERE AVAILABLE, WERE FREQUENTLY SEEN ON THE ROADS. FROM THESE EARLIER UNITS THERE WERE DEVELOPED STRAIGHT-BLADE PLOWS ATTACHED TO HEAVIER TRUCKS, AND A LITTLE LATER V-PLOWS OF MEDIUM WEIGHT WERE MOUNTED ON THE TRUCKS. THE NEXT ADVANCE WAS TOWARD MASSIVE AND HEAVY TYPES OF PLOWS, AND ROTARY PLOWS PROPELLED BY HIGH-POWERED TRACTORS. NOW THE PENDULUM OF THE CYCLE HAS SWUNG BACK AND IN MANY STATES, FOR INITIAL CLEARING AT LEAST, THERE ARE EMPLOYED TRUCKS OF MEDIUM TONNAGE WITH STRAIGHT-BLADE OR LIGHT V-PLOW ATTACHMENTS AS SHOWN IN FIGURE 1.

THIS CHANGE FROM LIGHT TO HEAVY EQUIPMENT, AND THE RETURN TO THE LIGHT EQUIPMENT AGAIN HAS BEEN DUE IN PART TO A VARIATION IN THE OBSTACLES TO BE OVERCOME. THE PRIMITIVE SNOW-REMOVAL EFFORTS WITH LIGHT EQUIPMENT HAD FOR THEIR PURPOSE THE SHORTENING OF THE CLOSED PERIOD OF THE ROADS BY CLEARING AWAY THE EARLY SNOWFALLS. WHEN THE DEPTH OF SNOW, EITHER FROM SNOWFALL OR DRIFTING, BECAME EXCESSIVE FOR SUCH HANDLING, THE ROADS WERE ABANDONED UNTIL THE SPRING THAWS REOPENED THEM TO TRAVEL. THE LIGHT OUTFITS WERE ADEQUATE TO MAINTAIN OPEN THOROUGHFARES THROUGHOUT THE YEAR OVER THE SECTIONS WHERE THE SNOWFALL WAS LIGHT AND DRIFTING WAS NOT EXCESSIVE, BUT IN OTHER REGIONS, WHERE THE CLIMATOLOGICAL CONDITIONS WERE MORE SEVERE, THE EQUIPMENT WAS SNOWED UNDER BEFORE THE WINTER WAS FAR ADVANCED.





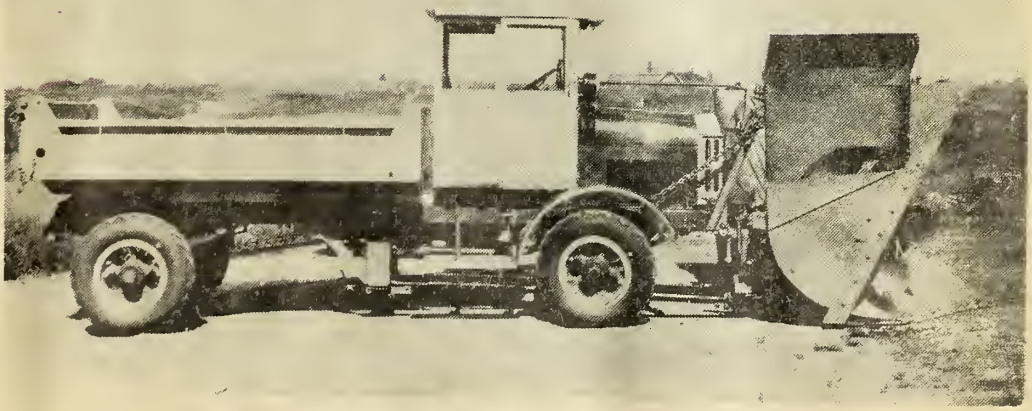


Figure 1-(above)-A straight-blade plow suited to patrol clearing.

(center)-A V-plow adapted to patrol work.

(below)-A truck-mounted rotary for initial-cut and widening work.

NEXT CAME THE DEMAND, IN HEAVY-SNOWFALL REGIONS, TO CLEAR THE MAIN ROADS IN THE SPRING INSTEAD OF WAITING FOR THE ELIMINATION OF THE SNOW BY THE SLOW PROCESS OF MELTING AND EVAPORATION. THEN IT WAS DISCOVERED THAT THE EQUIPMENT, THAT WAS ADEQUATE IN THE EARLY WINTER FOR REMOVING THE NEWLY-FALLEN SNOW, WAS WHOLLY INADEQUATE FOR CLEARING AWAY DEEP, PACKED SNOW. THIS COMPELLED THE AUTHORITIES TO PURCHASE, OR BUILD IN THEIR LOCAL SHOPS, HEAVY DISPLACEMENT AND ROTARY UNITS.

FINALLY WITH THE GROWING USE OF MOTOR VEHICLES THERE HAS COME THE NECESSITY FOR KEEPING THE ROADS OPEN TO TRAVEL THROUGHOUT THE ENTIRE WINTER. TO ACCOMPLISH THIS, THE PATROL SYSTEM HAS BEEN DEVELOPED WITH LIGHT, MOBILE EQUIPMENT FOR CLEARING THE TRAVELLED WAY, LIGHT AND HEAVY MECHANICAL UNITS FOR WIDENING PURPOSES, AND VARIOUS TYPES OF STRUCTURES FOR DRIFT PREVENTION.

PATROL SYSTEM NOW GENERALLY USED

UNDER THE PATROL SYSTEM, AS GENERALLY PRACTICED, THE SNOW IS ATTACKED WITH MOTOR-TRUCK EQUIPMENT SHORTLY AFTER THE BEGINNING OF THE STORM, AND THE REMOVAL WORK IS CARRIED ON CONTINUALLY UNTIL THE SNOWFALL HAS STOPPED AND THE TRAVELLED WAYS ARE COMPLETELY CLEAR. EXPERIENCE SHOWS THAT NEWLY-FALLEN SNOW UP TO APPROXIMATELY 12 INCHES IN DEPTH MAY BE REMOVED WITH LIGHT PLOWS MOUNTED ON TRUCKS OF MODERATELY HIGH SPEEDS, AND THE RECORDS OF THE UNITED STATES WEATHER BUREAU SHOW THAT SINGLE SNOWFALLS EXCEEDING 12 INCHES IN DEPTH ARE RARE. CONSEQUENTLY, IF THE ROADS ARE PROTECTED FROM DEEP DRIFTS, AND THE CLEARING OPERATIONS ARE BEGUN PROMPTLY, THE TRAVELLED WAY MAY BE KEPT OPEN WHILE THE SNOW IS IN PROGRESS, OR CLEARED WITHIN A SHORT TIME AFTER THE STORM HAS STOPPED, WITH ONLY THE LIGHTER, FAST-MOVING TRUCK PLOWS. THE SLOW-MOVING TRACTOR PLOWS THAT ARE MORE EXPENSIVE TO OPERATE, ARE USED LATER FOR THE NECESSARY WIDENING AND OCCASIONAL EMERGENCY WORK. IT IS NOT INTENDED TO INFER THAT THE HEAVY AND LIGHT TRACTOR, AND THE HEAVIER V OR ROTARY PLOWS ARE NOT ESSENTIAL SNOW-REMOVAL EQUIPMENT FOR IT IS WELL KNOWN THAT THE HEAVIER UNITS ARE INDISPENSABLE IN WIDENING OPERATIONS, ESPECIALLY AFTER THE SNOW HAS REACHED A CERTAIN DEPTH. THE FOREGOING DISCUSSION, HOWEVER, APPLIES CHIEFLY TO FLAT, ROLLING OR HILLY COUNTRY AND NOT TO MOUNTAINOUS REGIONS WHERE THE TRACTOR IS OFTEN FOUND TO BE MORE EFFICIENT THAN THE TRUCK.

THE TRUCKS USED IN PATROL WORK ARE GENERALLY HOUSED IN HEATED GARAGES OR SHOPS IN ORDER THAT THEY MAY BE MAINTAINED IN PROPER CONDITION AND MADE QUICKLY AVAILABLE FOR SERVICE. THE PERSONNEL TO OPERATE THE EQUIPMENT IS CAREFULLY SELECTED BEFOREHAND AND HELD SUBJECT TO CALL ON SHORT NOTICE. AT THE BEGINNING OF THE STORM, THE SUPERINTENDENT,

AFTER POSSIBLY CONSULTING THE WEATHER BUREAU AS TO THE DURATION AND INTENSITY OF THE SNOWFALL, CALLS OUT THE VARIOUS CREWS AND BEGINS THE SNOW-REMOVAL OPERATIONS. THE WORK IS CONTINUED, USING RELIEF SHIFTS WHERE NECESSARY, UNTIL THE STORM STOPS AND THE ROADS ARE CLEAR. IN THIS PATROL WORK THE MOTOR TRUCK IS GENERALLY USED FOR MOTIVE POWER TO PROPEL VARIOUS TYPES OF PLOWS. WHERE ONLY LIGHT SNOWFALLS ARE ENCOUNTERED, THE ORDINARY ROAD GRADER IS STILL USEFUL, BUT WITH HEAVIER SNOWS, THE STRAIGHT-BLADE OR V-PLOWS ARE OFTEN USED, EITHER WITH OR WITHOUT WING-WIDENING ATTACHMENTS. OF THE TWO STYLES, THE V-PLOW IS CONSIDERED THE MOST EFFECTIVE FOR OPENING THE FIRST LANE, AND THE STRAIGHT-BLADE PLOW IS PREFERRED FOR THE RETURN TRIPS IN PRELIMINARY WIDENING TO PROVIDE A CHANNEL FOR TWO-WAY TRAFFIC. USUALLY THE REGULAR MAINTENANCE TRUCKS ARE USED, AND THOSE OF MEDIUM TONNAGE, WITH A 4-WHEEL DRIVE, AND PNEUMATIC TIRES, ARE PREFERRED. THE TRUCKS ARE LOADED WITH WEIGHTS IN MOST INSTANCES SO AS TO PROVIDE BETTER TRACTION.

THE LENGTH OF SECTION PATROLLED BY ONE OUTFIT VARIES WITH THE INTENSITY AND DURATION OF THE SNOW STORMS IN THE LOCALITY, THE GENERAL DIRECTION AND STRENGTH OF THE PREVAILING WINDS, THE TEMPERATURE THROUGHOUT THE STORMS, THE TOPOGRAPHY OF THE ADJACENT TERRAIN, AND THE EFFECTIVENESS OF THE METHODS OF DRIFT PREVENTION. IN ONE OF THE NORTH CENTRAL STATES, WITH AN AVERAGE ANNUAL SNOWFALL RANGING FROM 75 TO 132 INCHES OVER DIFFERENT REGIONS OF THE STATE, TWO TRUCK PLOWS ARE CONSIDERED CAPABLE OF KEEPING 20 OR 25 MILES OF ROAD CLEARED FOR ALL KINDS OF TRAFFIC PROVIDED A TRACTOR PLOW IS AVAILABLE FOR SUPPLEMENTARY WIDENING WORK ON EACH 50 OR 60 MILES OF ROAD. AN IDEAL OUTFIT FOR A PATROL SECTION OF THE AFOREMENTIONED LENGTH, SHOULD INCLUDE ONE STRAIGHT-BLADE PLOW ABOUT 24 INCHES IN HEIGHT, ONE V-SHAPED PLOW 30 TO 36 INCHES HIGH AT THE APEX, AND ONE HEAVY DISPLACEMENT OR ROTARY PLOW FOR WIDENING PURPOSES. THE LIGHTER DISPLACEMENT PLOWS SHOULD BE MOUNTED ON $3\frac{1}{2}$-TON TRUCKS WITH 6-CYLINDER ENGINES IF THEY ARE AVAILABLE, AS SHOWN IN FIGURE 1-(BELOW). A TRACTOR SHOULD BE AVAILABLE FOR PROPELLING EITHER OF THE WIDENING UNITS.

IMPORTANCE OF WIDENING THE INITIAL CUT

WIDENING OPERATIONS ARE AN ESSENTIAL FEATURE IN THE PATROL SYSTEM OF MAINTAINING OPEN ROADS THROUGHOUT THE WINTER. THE FIRST DUTY OF THE PATROL CREWS IS TO KEEP OPEN WITH THEIR FAST-MOVING EQUIPMENT, A CUT OF SUFFICIENT WIDTH FOR TWO-WAY TRAFFIC, LEAVING TO THE HEAVIER PLOWS THE FOLLOW-UP WORK OF WIDENING THE INITIAL CUT. THE ADDITIONAL WIDTH OF CUT IS NEEDED FOR TWO REASONS: (1) TO PROVIDE SPACE FOR THE DISPOSAL OF SNOW FROM SUBSEQUENT STORMS; AND

(2) To keep the entire roadway between ditches free of an excessive amount of snow in order to improve the drainage conditions during thaws and the spring break-up. Although the removal of the snow permits greater frost penetration in the foundation and shoulders, many engineers believe that clearing snow to the outer ditch line hastens the drying of the road in the spring, and reduces the deterioration of gravel and macadam pavements during the spring thaw.

All types of snow-removal equipment are suited in some degree to widening work. At the beginning of the season, the lighter units are often capable of widening the passage to the desired width. Later, when the snow has accumulated at the edge of the road, the heavier truck plows are brought into play, and as the season advances, the larger tractor-mounted V and rotary units are pressed into service. On account of the greater speed and lower operating costs, the truck-propelled displacement or rotary plows should be used for widening work as long as they provide adequate service. When their capacity becomes inadequate, the tractor-mounted V or rotary plows may be resorted to. Trucks with widening attachments may be driven at fairly high rates of speed when being moved from one location to another but tractors cover the intervening distance between points of service at comparatively slow speeds. To eliminate the loss of time consumed in the transfer of slow-moving equipment, truck-drawn trailers have been built on which the heavy plows and tractors are loaded for rapid transportation.

Drift Prevention an Essential Operation

Drift prevention is essential in order to maintain roads open for travel continuously through the areas of heavy snowfall. Before this method of snow control had reached its present state of development, the light and rapid equipment was found entirely inadequate for keeping the roads open during storms of more than average intensity or duration. Under these conditions the heavier types of plows gave much greater satisfaction, but even with them it was possible to keep open only short sections of road during severe storms, because heavy-duty but slow-moving tractors were needed to buck the quickly-formed and deep drifts. Thus while one short section was being cleared, other portions of the road that had been previously opened, would become filled with drifts and the traffic would be blocked.

Various methods are used to control drifting. The roads are located so as to avoid the possibility of drifts or the grades are designed above the surrounding surface of the ground so that the wind may blow the travelled way clear of snow. Artificial windbreaks are used to create still-air pockets that cause the snow to fall to the

GROUND BEFORE REACHING THE RIGHT OF WAY. THE WINDBREAKS ARE CONSTRUCTED BY A LINE OF LIGHT OR HEAVY SNOW FENCE, OF ROWS OF CUT SAPLINGS INSERTED IN THE GROUND BEFORE IT FREEZES, OF BANKS OF SNOW, OF BARRIERS CONSISTING OF BLOCKS OF HARDENED SNOW OR ICE, OR OF PLOWED WINDROWS OF SNOW THAT PROTECT THE ROAD TO SOME EXTENT.

THERE ARE SOME LOCALITIES IN THE SNOW AREA WHERE DRIFTING CONDITIONS ARE NOT SERIOUS, SUCH AS THOSE PORTIONS OF A ROAD EXTENDING IN THE SAME DIRECTION AS THE PREVAILING WIND, OR WHERE THE TRAVELLED WAY IS ELEVATED ABOVE THE SURROUNDING SURFACE OF THE GROUND, OR WHERE THE HIGHWAY TRAVERSES WOODED SECTIONS.

MAINTENANCE OF OPEN ROAD CONTINUOUSLY THROUGHOUT WINTER GROWING IN FAVOR

THE MAINTENANCE OF OPEN ROADS FOR CONTINUOUS TRAVEL THROUGHOUT THE ENTIRE WINTER IS RAPIDLY GAINING IN GENERAL FAVOR. COLORADO MAY BE CITED AS ONE OF THE WESTERN STATES THAT IS AMONG THE LEADING EXPONENTS OF ALL-WINTER OPEN ROADS, EVEN THOUGH THE PHYSICAL OBSTACLES TO BE OVERCOME ARE ESPECIALLY DIFFICULT IN THAT STATE. HITHERTO, THE SNOW REMOVAL ACTIVITIES IN COLORADO WERE IN CHARGE OF COUNTY AUTHORITIES, FINANCED PARTLY FROM STATE FUNDS. BEGINNING, HOWEVER, WITH THE WINTER OF 1928-29, AND FOR THE FIRST TIME IN ITS HISTORY, THE STATE HIGHWAY DEPARTMENT INAUGURATED A PROGRAM OF WINTER MAINTENANCE, FOR THE PURPOSE OF KEEPING THE PRINCIPAL HIGHWAYS AND MOUNTAIN PASSES CONTINUOUSLY OPEN THROUGHOUT THE WINTER WHERE POSSIBLE, OR TO CLEAR THEM OF SNOW AS EARLY IN THE SPRING AS WAS PRACTICABLE. THE SNOW-REMOVAL PROGRAM OF THE STATE HIGHWAY DEPARTMENT IS CONFINED MAINLY TO THE FEDERAL-AID HIGHWAY SYSTEM WHICH AGGREGATES ABOUT ONE-THIRD OF THE TOTAL STATE HIGHWAY SYSTEM OF 9,000 MILES. THE SNOW REMOVAL ON THE SECONDARY ROADS ON THE STATE SYSTEM IS LEFT AS BEFORE TO THE COUNTY AUTHORITIES. THE DATA FOR THE PAST SEASON INDICATES THAT A LARGE MILEAGE WAS KEPT OPEN THROUGHOUT THE WINTER THROUGH THE COMBINED EFFORTS OF THE STATE AND COUNTY AUTHORITIES. THE FEDERAL BUREAU OF PUBLIC ROADS REMOVES THE SNOW FROM SOME OF THE FOREST-HIGHWAY PROJECTS IN THE NATIONAL FORESTS BUT THIS WORK IS ON A VERY LIMITED SCALE AS COMPARED WITH THAT OF THE STATE AND COUNTY AUTHORITIES.

THE SNOW-REMOVAL WORK IN COLORADO IS ESPECIALLY DIFFICULT BECAUSE OF THE MOUNTAINOUS TERRAIN. APPROXIMATELY TWO THIRDS OF THE AREA OF 103,658 SQUARE MILES OF THE STATE RANGES FROM 6,000 TO 14,000 FEET ABOVE SEA LEVEL. OF THE 59 PEAKS IN THE UNITED STATES OVER 14,000 FEET IN ALTITUDE, 46 ARE IN COLORADO, AND THE STATE HAS OVER A THOUSAND PEAKS OVER 10,000 FEET ABOVE SEA LEVEL. THE CONTINENTAL DIVIDE, OR ROCKY MOUNTAIN RANGE, EXTENDING IN A NORTH AND SOUTH DIRECTION, DIVIDES

THE STATE INTO HALVES, BUT THERE ARE NUMEROUS SUBORDINATE MOUNTAIN RANGES ON BOTH SIDES BETWEEN WHICH MANY FLAT BASINS EXIST, WHILE THE HIGHER AREAS ARE HEAVILY WOODED. THE SNOWFALL OF THE STATES IN ACCORDANCE WITH THE VARYING TOPOGRAPHICAL CONDITIONS VARIES FROM A LOW ANNUAL AVERAGE OF 2 FEET IN THE VALLEY BOTTOMS TO OVER 25 OR 30 FEET IN DEPTH IN THE MOUNTAIN PASSES.

ORGANIZATION OF SNOW-REMOVAL FORCES

THE SNOW-REMOVAL ACTIVITIES OF THE STATE HIGHWAY DEPARTMENT ARE IN CHARGE OF A SUPERINTENDENT OF MAINTENANCE WHO DIRECTS SIX DIVISION SUPERINTENDENTS. THE COST IS PAID FOR FROM GENERAL STATE FUNDS. THE COUNTY WORK IS ACCOMPLISHED, WITH COUNTY FUNDS, UNDER THE DIRECTION OF VARIOUS COUNTY ROAD SUPERINTENDENTS. THE ACTIVITIES OF THE BUREAU OF PUBLIC ROADS ARE RESTRICTED TO EARLY WINTER CLEARING BECAUSE OF THE LACK OF HEAVY EQUIPMENT, AND CONFINED TO NATIONAL-FOREST ROADS OR NATIONAL-PARK ROADS BUILT BY THE BUREAU. IT HAS NOT BEEN CONSIDERED FEASIBLE TO KEEP THESE FEDERAL-BUILT ROADS OPEN ALL WINTER SO THE WORK HAS BEEN LIMITED TO EARLY SEASONAL CLEARING SUPPLEMENTED BY OCCASIONAL STATE COOPERATION AT THE MOUNTAIN PASSES. IN THE NEAR FUTURE, DEPENDING UPON THE GROWTH IN TRAFFIC, IT MAY BECOME NECESSARY TO EXPAND THE FEDERAL CLEARING-WORK SO AS TO KEEP THE PRINCIPAL NATIONAL-FOREST AND NATIONAL-PARK ROADS OPEN FOR 12 MONTHS IN THE YEAR.

A WOODEN PLOW BUILT BY THE BUREAU OF PUBLIC ROADS AND PROPELLED BY A 5-TON TRACTOR IS SHOWN IN FIGURE 2 WHILE ENGAGED IN WIDENING OPERATIONS AT THE SUMMIT OF THE BERTHOUD PASS, ON UNITED STATES ROUTE 40 IN COLORADO, DURING DECEMBER, 1928. THE ELEVATION OF THE ROAD AT THIS LOCATION IS OVER 11,000 FEET ABOVE SEA LEVEL. THIS OUTFIT WAS EFFECTIVE FOR KEEPING THE PASS OPEN FOR AUTOMOBILE TRAVEL UNTIL EARLY IN JANUARY WHEN THE WORK WAS SUSPENDED BECAUSE THE STATE DISCONTINUED THEIR OPERATIONS ON ADJACENT SECTIONS. FIGURE 2-(CENTER) SHOWS THE SAME PLOW AT WORK IN THE PASS DURING THE LATTER PART OF DECEMBER, IN COOPERATION WITH THE STATE FORCES, AND FIGURE 2-(BELOW) ILLUSTRATES A SECTION OF ROAD ON THE SIDE OF THE CONTINENTAL DIVIDE THAT WAS MAINTAINED TO A WIDTH OF 20 FEET UNTIL THE BEGINNING OF THE NEW YEAR.

DURING THE WINTER OF 1928-29 THE STATE AND COUNTY AUTHORITIES OF COLORADO, TOGETHER WITH MINOR COOPERATION FROM THE FEDERAL BUREAU OF PUBLIC ROADS, PROSECUTED SNOW-REMOVAL OPERATIONS ON 60 PER CENT OF THE ENTIRE STATE HIGHWAY SYSTEM. ONE MOUNTAIN PASS OUT OF 11 OVER THE CONTINENTAL DIVIDE, AND FOUR PASSES OF THE SEVEN OVER SECONDARY RANGES, WERE KEPT OPEN TO TRAFFIC THROUGHOUT THE WINTER. WITH THE PRINCIPAL ROADS, INCLUDING SOME OF THE MOUNTAIN PASSES, BEING KEPT CLEARED BY THE STATE HIGHWAY DEPARTMENT, AND THE CONNECTING ROADS, WHERE TRAVEL AND BUSINESS WARRANTED THE EXPENSE, BEING CLEARED OF SNOW BY THE COUNTY AUTHORITIES, THERE WAS MADE POSSIBLE A SYSTEM OF CONTINUOUSLY-OPEN ROADS EXTENDING OVER THE GREATER PORTION OF THE STATE. THIS RESULT WAS

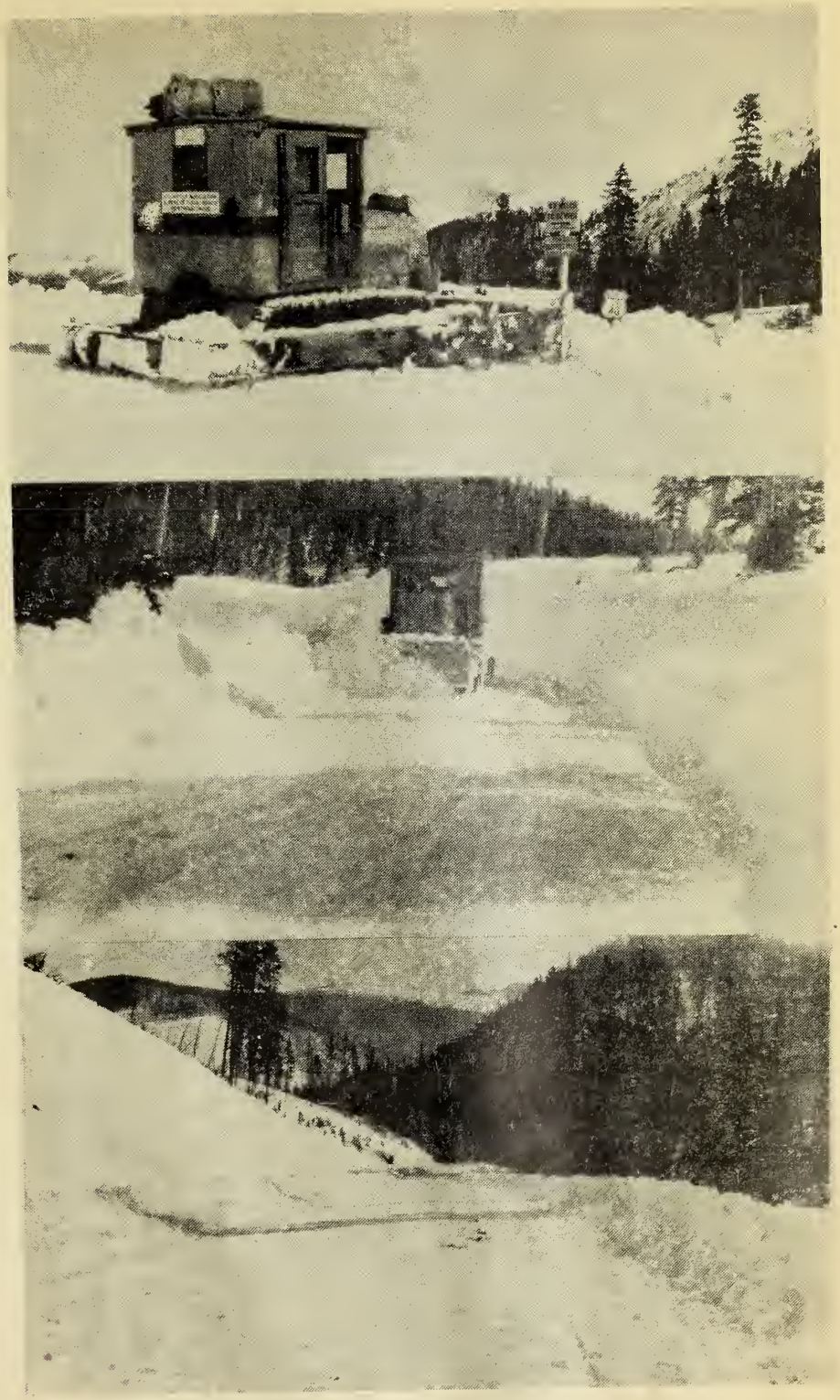


Figure 2-(above)-A 40-inch wooden push-plow of the Bureau of Public Roads at the top of the Berthoud Pass in Colorado on U. S. Route 40.

(center)-The same plow engaged in widening operations.

(below)-The Berthoud Pass road cleared for traffic.

ACCOMPLISHED AT A COMPARATIVELY MODERATE EXPENSE. THERE WERE TIMES OF COURSE, WHEN SUDDEN STORMS OR BLIZZARDS CLOSED THE SECTIONS OF THE ROADS TEMPORARILY BUT THEY WERE OPENED RAPIDLY AGAIN TO TRAFFIC. REPORTS FROM EVERY SECTION OF THE STATE, ACCORDING TO THE STATE HIGHWAY DEPARTMENT, INDICATE THAT THIS FIRST SEASON OF EXTENSIVE SNOW-REMOVAL WORK HAS PROVED PROFITABLE FOR WINTER BUSINESS OPERATIONS.

EQUIPMENT USED IN COLORADO

THE EQUIPMENT USED BY THE COLORADO STATE AND COUNTY AUTHORITIES WAS VARIED TO SUIT THE ADJACENT TERRAIN AND THE DEPTH OF SNOW. IN THE VALLEYS AND ON THE PLAINS, GRADERS HAULED BY TRUCKS WERE ADVANTAGEOUSLY EMPLOYED, WHILE TO CLEAR THE DEEPER SNOW ON THE FOOTHILLS OR MESAS, THE SAME TYPE OF EQUIPMENT, BUT OF HEAVIER CONSTRUCTION WAS EXTENSIVELY USED. IN SOME CASES, TRUCK OR TRACTOR-MOUNTED STEEL DISPLACEMENT-PLOWS WERE REQUIRED. FOR CLEARING THE PASSES, HEAVY DISPLACEMENT-PLOWS ATTACHED TO TRACTORS WERE USED IN CONNECTION WITH A STATE-BUILT ROTARY PLOW. FIGURE 3-(ABOVE) SHOWS A REPRESENTATIVE UNIT CAPABLE OF REMOVING SNOW OF MEDIUM DEPTH. THE STATE'S ROTARY PLOW IS ILLUSTRATED BY FIGURE 3-(CENTER AND BELOW). THIS OUTFIT CONSISTS OF A 6-FOOT REVERSIBLE ROTOR MOUNTED ON THE REAR OF A 5-TON TRUCK. THE ROTOR IS DRIVEN BY AN AUXILIARY 6-CYLINDER, 110 HORSEPOWER GAS ENGINE. BOTH THE FRONT AND REAR WHEELS MAY BE STEERED SO THAT THE TRUCK MAY BE DRIVEN BACKWARDS OR FORWARDS. THIS PLOW WAS ABLE TO CLEAR A PATH 7 FEET WIDE, AND 4½ FEET DEEP, THROUGH HARD-PACKED SNOW, AT THE RATE OF 400 TO 500 FEET PER HOUR. THIS PLOW HAS BEEN USED IN SNOW BANKS 24 FEET DEEP BUT UNDER SUCH CIRCUMSTANCES, IT WAS NECESSARY TO LOOSEN THE SNOW OR SHOOT DOWN THE BANKS OR DRIFTS IN EXCESS OF 8 FEET DEEP SO THAT THE SNOW MIGHT BE ACCESSIBLE TO THE ROTOR. THIS SAME PLOW, WITH OCCASIONAL IMPROVEMENTS IN THE MECHANISM, HAS BEEN USED BY THE STATE FOR SEVERAL SEASONS. THE STATE FORCES CLEAN UP BEHIND THE ROTARY PLOW USUALLY WITH A STEEL DISPLACEMENT-PLOW MOUNTED ON A TRUCK.

TENNESSEE PASS, THE ONE ROAD KEPT OPEN OVER THE CONTINENTAL DIVIDE, DURING THE WINTER OF 1928-29, IS THE BOTTLE NECK FOR THE TRAFFIC BOUND TO OR FROM THE WESTERN SLOPE, OR THE NORTHWESTERN OR SOUTHWESTERN DISTRICTS OF COLORADO. IT IS LOCATED ON UNITED STATES ROUTE 40-S AND REACHES AN ELEVATION OF 10,400 FEET AT THE SUMMIT OF THE DIVIDE. THIS PASS WAS CONSIDERED ONE OF THE MOST IMPORTANT IN THE STATE FOR THROUGH TRAFFIC, AND FOR THAT REASON THE STATE CONCENTRATED THEIR SNOW-REMOVAL ATTACK AT THIS STRATEGIC POINT. THE CONTINUOUSLY-OPEN CHANNEL OF COMMUNICATION WAS MADE POSSIBLE BY THE PATROL SYSTEM OPERATING ONE TRUCK-MOUNTED DISPLACEMENT-PLOW, WITH THE ROTARY PLOW, SHOWN IN FIGURE 3-(CENTER) HELD IN RESERVE FOR EMERGENCY AND WIDENING WORK. THIS CLEARED ROAD OVER THE PASS ACCOMMODATED A DAILY AVERAGE OF FROM 25

Figure 3-(above)-A representative snow-removal unit used by the Colorado State Highway Department.

(center)-The State-built rotary snow-plow of the Colorado State Highway Department.

(below)-The State-built rotary-plow in action.

TO 30 MOTOR VEHICLES DURING THE WINTER. THIS TRAFFIC WOULD PROBABLY HAVE BEEN MATERIALLY INCREASED HAD MORE FEEDER ROADS BEEN KEPT OPEN WEST OF THE DIVIDE.

BERTHOUD PASS, ANOTHER IMPORTANT LINK ON THE COLORADO STATE HIGHWAY SYSTEM, LOCATED ON UNITED STATES ROUTE NO. 40, 60 MILES WEST OF DENVER, WAS KEPT OPEN UNTIL EARLY IN JANUARY, 1929, WHEN WINTER OPERATIONS WERE DISCONTINUED. WHEN THE SPRING CLEARING WORK WAS BEGUN ON APRIL 1, IT WAS FOUND THAT, OVER VARIOUS SECTIONS OF THE PASS, WINTER HAD LEFT IN ITS WAKE A 14-MILE STRETCH OF DENSE SNOW, 3 TO 24 FEET DEEP, THROUGH WHICH THE STATE FORCES CUT A PATH 14 TO 16 FEET WIDE, WITH NUMEROUS TURNOUTS. THE CUT WAS MADE WITH THE STATE-BUILT ROTARY PLOW, ALREADY DESCRIBED, SUPPLEMENTED ON THE WEST-SIDE SECTIONS OF THE PASS BY A 10-TON TRACTOR WITH PUSH-PLOW ATTACHMENT. ONE TRUCK PLOW WAS EMPLOYED IN CLEAN-UP WORK ALONG THE ENTIRE STRETCH. DURING THE 45 DAYS THAT THIS OUTFIT WAS IN ACTUAL OPERATION, IT IS ESTIMATED THAT 180,000 CUBIC YARDS OF COMPACT SNOW WERE REMOVED ALTHOUGH MUCH OF THIS WAS BLASTED PRIOR TO BEING MOVED. ON THE AVERAGE 4,000 CUBIC YARDS OF SNOW WERE REMOVED A DAY AT AN AVERAGE UNIT COST OF 2 TO 3 CENTS PER CUBIC YARD. THESE FIGURES INCLUDE THE COST OF ALL LABOR AND MATERIAL AND THE DEPRECIATION OF EQUIPMENT. THE ACTUAL OPERATIONS WERE BEGUN ON MARCH 26 AND BY MAY 20 THE PASS WAS CLEARED FOR TRAVEL. THE TRAFFIC FOR THE FIRST WEEK THEREAFTER TOTALED 780 MOTOR VEHICLES.

DRIFT PREVENTION IN COLORADO

DRIFT PREVENTION IS GROWING IN FAVOR IN COLORADO. LAST SEASON 60 MILES OF SNOW FENCE WERE REPORTED AS COMPARED WITH $\frac{1}{2}$ MILE FOR THE WINTER OF 1922-23 WHEN THE WORK WAS FIRST BEGUN. A SECTION OF ROAD PROTECTED WITH SNOW FENCE ON TOP OF THE BERTHOUD PASS IS ILLUSTRATED IN FIGURE 4. THE PICTURES, ALTHOUGH TAKEN AT THE SAME LOCATION, WERE SNAPPED IN OPPOSITE DIRECTIONS. THE PICTURE BELOW SHOWS A SECOND SNOW FENCE INSTALLED IN THE SAME LOCATION AFTER THE FIRST ONE HAD BEEN BURIED.

SNOW-REMOVAL OPERATIONS WELL ORGANIZED IN MINNESOTA

FOR SOME YEARS MINNESOTA HAS BEEN ONE OF THE MOST PROGRESSIVE STATES IN SNOW-REMOVAL ACTIVITIES IN THE MIDDLE WEST. THE HIGHWAY DEPARTMENT ORGANIZATION IS DIVIDED INTO 8 ENGINEERING DIVISIONS, EACH OF WHICH CONTAINS TWO MAINTENANCE DISTRICTS WITH A SUPERINTENDENT IN CHARGE IN EACH DISTRICT. THESE SUPERINTENDENTS DIRECT THE SNOW-REMOVAL WORK. THE STATE USUALLY RESTRICTS ITS SNOW-CLEARING OPERATIONS TO THE

Figure 4-(above)-Snow fence at top of Berthoud Pass in Colorado.

(below)-New fence installed above the old fence that has been covered by snow. Picture taken from same position but in opposite direction from that shown above.

TRUNK HIGHWAYS BUT NUMEROUS COUNTIES CLEAR THEIR LOCAL ROADS AND PLACE THE WORK UNDER THE RESPONSIBLE CHARGE OF THE COUNTY HIGHWAY ENGINEER. DATA ON STATE OPERATIONS ONLY, HOWEVER, IS INCLUDED IN THIS REPORT. WHILE THE STATE WORK IS USUALLY IN CHARGE OF MAINTENANCE SUPERINTENDENTS, THE WORK OF CLEARING PORTIONS OF THE ROADS IS SOMETIMES AWARDED BY CONTRACT. WHETHER THE WORK IS PROSECUTED UNDER THE DAY-WORK OR CONTRACT SYSTEM, THE POLICY IS TO OPEN ALL THE MAIN HIGHWAYS TO TRAVEL WITHIN 24 HOURS AFTER THE CESSATION OF EACH STORM.

TABLE I SHOWS THE SNOW-REMOVAL DATA FOR MINNESOTA. THE FIGURES ARE SEGREGATED INTO THE 16 MAINTENANCE DISTRICTS, AND SHOW COMPARATIVE COSTS BASED UPON THE UNIT OF THE INCH MILE. THE KIND OF EQUIPMENT USED IS ALSO NOTED. AS MIGHT BE EXPECTED, THE UNIT COSTS FOR THE VARIOUS DISTRICTS VARY OVER A WIDE RANGE DEPENDING UPON TOPOGRAPHICAL, AND CLIMATOLOGICAL CONDITIONS AND OTHER FACTORS. THE FIGURES ARE RELATIVE ONLY AND SUFFICIENT DATA IS NOT AVAILABLE FOR COMPARATIVE PURPOSES.

THE TOTAL COSTS OF SNOW REMOVAL FOR THE VARIOUS DISTRICTS IS GIVEN EXCLUSIVE OF THE AMOUNT CLASSIFIED AS OVERHEAD. THE OVERHEAD EXPENSE IS ESTIMATED BY THE STATE AS 7½ PER CENT IN EACH INSTANCE. THE AMOUNT EXPENDED FOR SNOW FENCE WAS ALSO EXCLUDED FROM THE TABULATION, AND NO MENTION IS MADE OF NEW EQUIPMENT SINCE THIS ITEM IS CARRIED BY THE STATE ON A RENTAL BASIS.

THE TOTAL COST OF THE WORK FOR THE DIFFERENT DISTRICTS MAY BE SEGREGATED UNDER THREE MAIN HEADINGS: (1) INSTALLATION AND REMOVAL OF SNOW FENCE; (2) LABOR EMPLOYED IN SNOW REMOVAL; AND (3) THE COST OF EQUIPMENT. OBVIOUSLY THESE PERCENTAGES WOULD BE EXPECTED TO VARY CONSIDERABLY BECAUSE OF THE DIFFERENT CONDITIONS TO BE OVERCOME IN SUCH A LARGE STATE AS MINNESOTA, AND BECAUSE OF THE VARYING CAPACITY OF THE 16 PERSONNEL UNITS. THE AVERAGE PERCENTAGES FOR THE THREE MAIN SUBDIVISIONS OF THE WORK OVER THE ENTIRE STATE ARE AS FOLLOWS:

1.-INSTALLATION AND REMOVAL OF SNOW FENCE - 12 PER CENT.
2.-COST OF LABOR EMPLOYED IN SNOW REMOVAL - 32 PER CENT.
3.-COST OF EQUIPMENT, INCLUDING ESTIMATED RENTAL, ETC.- 56 PER CENT.

FOR THOSE DISTRICTS THAT INCLUDE CONTRACT WORK IN THEIR TOTAL COST, THE PERCENTAGES OF LABOR AND EQUIPMENT RENTAL HAVE BEEN ESTIMATED.

FIGURE 5-(ABOVE) ILLUSTRATES THE REPRESENTATIVE UNIT USED BY MINNESOTA IN THEIR SNOW-REMOVAL WORK. IT INCLUDES TWO 3-TON TRUCKS WITH A STATE-BUILT V-PLOW MOUNTED ON THE FORWARD TRUCK. FIGURE 5-(BELOW) SHOWS ANOTHER TYPE OF OUTFIT USED ON THE WORK.

TABLE I.- DETAILED SNOW-REMOVAL COSTS OF THE MINNESOTA STATE HIGHWAY DEPARTMENT FOR THE SEASON OF 1928-29

Maintenance District No.	Average Snowfall 1928-1929	Av. Mean Temperature for Snow Season	Length of Road Cleared	Width Cleared	Cost of New Snow Fence for Season	Cost of Snow Removal and Control: Total Cost Excl. of Overhead	Cost of Snow Removal and Control: Cost per Inch Mile	Number of Units Available: Truck-Displacement Plows	Number of Units Available: Truck Rotary Plows	Number of Units Available: Tractor Displacement Plows	Number of Units Available: Tractor Rotary Plows	Number of Units Available: Trucks	Number of Units Available: Tractors	Length of Snow Fence
	Inches	Degrees	Miles	Feet										Miles
1	35.2	10.9	431.60	30	$1,800	$ 15,392	$1.01	11	-	2	-	22	2	21.93
2	51.2	13.7	454.82	30	1,200	21,252	.91	9	-	-	1	18	1	18.37
3	30.3	10.8	543.20	30	1,800	16,661	1.01	10	-	5	-	10	5	20.45
4	47.7	12.7	458.30	30	1,800	30,019	1.37	9	-	2	3	18	4	25.11
5	23.4	9.1	473.60	30	1,800	17,735	1.60	11	-	1	-	11	1	39.02
6	38.4	11.1	468.54	30	2,400	28,690	1.59	14	1	8	-	14	5	40.53
7	56.0	14.5	372.80	30	2,400	37,321	1.79	16	-	7	2	16	7	40.53
8	35.9	14.4	444.70	30	2,400	27,294	1.71	10	-	5	2	10	4	39.77
9	54.9	16.7	347.70	30	1,800	28,942	1.52	18	-	6	-	18	4	37.88
10	30.5	16.6	411.70	30	2,400	39,000	3.11	8	-	2	1	12	2	42.20
11	50.1	18.6	337.97	30	1,464	52,431	3.10	7	-	3	-	11	2	38.41
12	60.6	18.6	483.83	30	2,400	62,784	2.14	9	-	4	1	12	4	46.02
13	69.1	17.6	418.78	30	2,400	55,958	1.93	14	-	5	1	14	3	42.48
14	40.0	17.6	433.65	30	3,000	41,710	2.40	9	-	4	-	9	2	42.77
15	43.3	17.9	479.60	30	2,400	48,859	2.35	11	-	4	2	11	2	41.82
16	71.3	17.3	471.10	30	2,400	58,674	1.75	9	1	6	-	11	3	41.67
Totals			7,031.89		$33,864	$582,722		175	2	64	13	217	51	578.96

NOTE: THE FIGURES FOR AVERAGE SNOWFALL, MEAN TEMPERATURE, AND COST PER INCH-MILE, ARE APPROXIMATE.

Figure 5-(above)-Twin motor trucks with V-plow used by the State of Minnesota.

(below)-A single-truck snow-removal unit in Minnesota.

THE FOLLOWING MAJOR TABULATION SHOWS THE SNOW-REMOVAL DATA FOR THE WINTER OF 1928-29 IN THE 36 STATES LYING WITHIN THE HEAVY-SNOWFALL AREA. THE INFORMATION WAS FURNISHED BY THE STATE HIGHWAY DEPARTMENTS EXCEPT IN ONE OR TWO INSTANCES WHERE THE COUNTIES SUPPLIED THE DATA. IT SHOULD BE BORNE IN MIND THAT THE FIGURES INDICATE THE WORK DONE ON THE RURAL ROADS OF THE STATES, OUTSIDE OF MUNICIPALITIES, AND ASIDE FROM THE FEW COUNTIES ALREADY MENTIONED, THE DATA DO NOT INCLUDE THE WORK DONE BY THE VARIOUS COUNTIES AND TOWNSHIPS ON THEIR LOCAL ROADS, OR SNOW-REMOVAL OPERATIONS CARRIED ON BY MUNICIPALITIES, TRANSPORTATION COMPANIES, PUBLIC INSTITUTIONS, OR DIVERS BUSINESS AGENCIES.

THE ATTACHED MAP SHOWS THE LOCATION OF THE MOST IMPORTANT ROADS KEPT OPEN FOR TRAFFIC DURING THE WINTER OF 1928-29.

UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS - DIVISION OF CONSTRUCTION

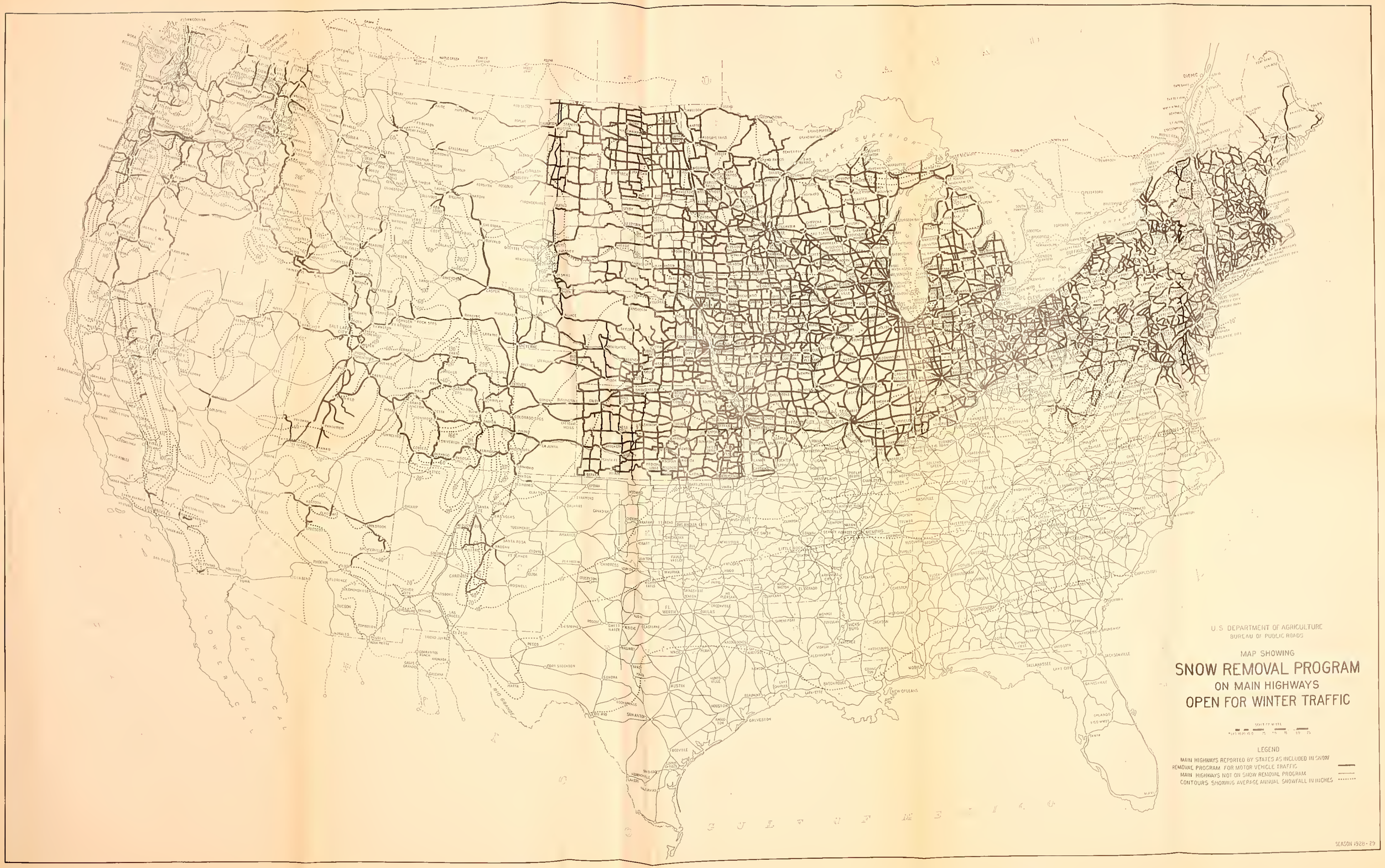
SNOW REMOVAL DATA - WINTER 1928-29

	STATE	Total mileage State roads (including Fed.-aid roads) surfaced with gravel or higher types of pavement as of Jan. 1, 1929	Min. and max. average annual snowfall recorded over a period of yrs. in different sections of State	Control of snow removal 1928-29	Snow Removal Equipment - Winter 1928-29: Truck plows: Displacement type	Truck plows: Rotary type	Tractor plows: Displacement type	Tractor plows: Rotary type	Miscellaneous equipment: Trucks and tractors	Miscellaneous equipment: Graders	Snow fence 1928-29	Snow Removal Winter 1928-29: Mileage of roads with snow removed	Average seasonal snowfall from records in different sections of State	Total cost snow removal	STATE	REMARKS
			Inches								Miles		Inches			
NORTH ATLANTIC STATES	Maine	1,681	74.4 to 131.9	State and townships	65	-	176	2	66 Trucks ** 178 Tractors	-	65	4,291	87.3	$ 114,896	Maine	Work financed jointly by State and towns
	New Hampshire	2,164	65.1 to 94.0	State and townships	35	-	146	4	35 Trucks ** 160 Tractors	4	50 **	1,741	80.3	85,085	New Hampshire	Data includes both State and township work
	Vermont	3,384	63.6 to 110.6	State and townships	34	-	81	-	34 Trucks 81 Tractors	14	22	2,145	92.8	42,000	Vermont	Work financed jointly by State and towns
	Massachusetts	1,579	45.4 to 61.5	State	300	-	23	-	300 Trucks 23 Tractors	-	30	1,427	47.2	157,262	Massachusetts	Total cost includes new equipment
	Rhode Island	612	24.1 to 47.0	State and townships	95	-	10	9	95 Trucks 19 Tractors	-	4	704	24.2	42,000	Rhode Island	
	Connecticut	1,906	40.3 to 75.8	State and townships	25	1	-	-	208 Trucks 8 Tractors	-	15	2,050	27.2	83,130	Connecticut	Total cost includes fiscal year expenditure; State work only
	New York	10,561	28.8 to 141.4	Counties & townships	812	18	518	44	886 Trucks 508 Tractors	116	1,660	25,028	61.2	876,537	New York	Data includes 54 out of 57 rural counties; covers county & town roads
	New Jersey	1,681	14.4 to 54.4	State and counties	180	-	6	4	180 Trucks 10 Tractors	29	21	962	18.7	113,473	New Jersey	Data includes State work only
	Pennsylvania	9,166	24.7 to 92.2	State	621	8	84	19	629 Trucks 103 Tractors	37	413	7,967	31.5	914,809	Pennsylvania	
SATLANTIC STATES	Delaware	703	16.7 to 22.9	State and counties	31	-	4	-	31 Trucks 4 Tractors	-	5	790	18.4	6,532	Delaware	
	Maryland	2,656	13.9 to 69.4	State	126	7	-	3	133 Trucks 3 Tractors	5	37	2,800	25.3	26,000	Maryland	
	Virginia	4,722	7.3 to 33.4	State and counties	55	-	25	-	90 Trucks 60 Tractors	90	4	6,000	10.1	7,000	Virginia	Mileage includes all roads on program
	West Virginia	2,392	8.8 to 101.0	State and counties	43	2	4	1	92 Trucks 7 Tractors	37	4	1,188	38.1	15,262	West Virginia	
NORTH CENTRAL STATES	Ohio	10,497	16.8 to 34.8	State and local	287	3	-	3	559 Trucks 197 Tractors	347	38	6,138	22.4	93,802	Ohio	Data includes State work only
	Indiana	4,592	13.6 to 61.3	State and local	83	-	3	-	838 Trucks 132 Tractors	265	-	3,715	24.0	14,426	Indiana	Data includes State work only. Numerous wooden plows also used.
	Illinois	6,252	11.6 to 39.4	State and counties	100	4	9	-	306 Trucks 52 Tractors	35	4	6,661	18.2	156,682	Illinois	Data includes State work only
	Michigan	5,770	33.5 to 121.4	State and counties	564	3	77	63	673 Trucks 153 Tractors	-	400	7,273	66.6	720,442	Michigan	Data includes State and county work
	Wisconsin	8,642	24.9 to 78.3	Counties & townships	238	1	122	10	239 Trucks 144 Tractors	28	1,114	19,800	60.2	568,393	Wisconsin	Mileage includes county & town roads. Funds incl. new equip., budget 1-1-29.
	Minnesota	6,613	24.0 to 54.4	State and local	175	2	64	13	217 Trucks 51 Tractors	-	679	7,032	42.4	613,585	Minnesota	Total cost exclusive of 7.5% (est.) for overhead. Data on State work only
	Iowa	5,171	21.2 to 38.1	State and local	175	10	19	3	256 Trucks 116 Tractors	200	660	6,761	44.3	700,000	Iowa	Total cost is approx. amount reported by State and includes city extension work
	Missouri	4,268	6.7 to 34.2	State and counties	50	-	10		414 Trucks 162 Tractors	709	51	7,540	19.5	68,840	Missouri	Entire maintenance organization and equipment available for snow removal
	North Dakota	2,245	25.0 to 45.2	State and counties	7	6	6	3	13 Trucks 9 Tractors	-	189	1,200	27.7	129,668	North Dakota	Total cost includes $100,000 for new equipment, and covers calendar year 1928
	South Dakota	3,413	18.7 to 97.7	State and local	45	-	32	10	60 Trucks 55 Tractors	480	102	3,800	60.5	112,222	South Dakota	Total cost is exclusive of county, city or township expenditures
	Nebraska	3,877	4.0 to 72.4	State	14	-	15	-	67 Trucks 138 Tractors	341	283	3,428	37.3	70,776	Nebraska	Total cost includes funds used for drift prevention
	Kansas	2,729	8.8 to 29.2	State and counties	37	*	8	*	37 Trucks 8 Tractors	*	*	8,690	15.1	*	Kansas	Work by counties with State maintenance money but amount not available
WESTERN STATES	Montana	1,354	15.5 to 270.9	State and counties	14	1	-	-	20 Trucks	30	35	*	65.0	12,000	Montana	Mileage of roads cleared unavailable
	Wyoming	1,306	9.2 to 219.7	State	10	-	7	-	20 Trucks 7 Tractors	10	12	1,223	89.8	77,720	Wyoming	
	Colorado	4,155	12.8 to 276.5	State and counties	10	1	10	-	106 Trucks 50 Tractors	98	61	5,274	112.8	71,961	Colorado	Data on county equipment not available
	New Mexico	2,010	5.3 to 138.4	State	4	-	1	-	15 Trucks 17 Tractors	22	-	746	33.0	10,444	New Mexico	
	Arizona	1,586	0.4 to 83.0	State	4	-	4	-	11 Trucks 5 Tractors	14	-	282	16.9	5,000	Arizona	
	Utah	1,643	5.0 to 155.1	State	35	-	24	2	40 Trucks 26 Tractors	40	30	2,540	71.8	75,512	Utah	Total cost includes $15,000 spent for new equipment during year
	Nevada	1,431	0.6 to 87.0	State	3	-	3	3	20 Trucks 10 Tractors	7	1	820	37.4	15,116	Nevada	
	Idaho	2,372	1.0 to 207.0	State and counties	15	9	12	3	60 Trucks 31 Tractors	60	6	5,160	69.2	151,460	Idaho	Data on county equipment not available
	Washington	2,734	3.8 to 252.3	State	12	5	3	3	42 Trucks 6 Tractors	19	6	2,108	69.0	125,868	Washington	
	Oregon	3,490	1.4 to 338.6	State and local	61	7	16	4	68 Trucks 20 Tractors	8	14	2,630	66.9	163,190	Oregon	
	California	3,927	1.0 to 783.0	State	10	-	17	3	16 Trucks 14 Tractors	16	1	836	106.5	37,924	California	
	TOTAL	134,187			4,475	86	1,539	209	6,865 Trucks 2,657 Tractors	3,061	5,916	150,850		$6,481,920		

* Asterisk indicates information not available. ** Double asterisk indicates data estimated.

Notes: The above data is compiled from reports by the States in answer to questionnaires submitted by the U. S. Bureau of Public Roads. Snowfall figures compiled from U. S. Weather Bureau records.

The number of displacement plows, rotaries, and other equipment listed, include those reported as under the control of various States and counties, but does not include those owned by numerous other counties of which we have no information, and also by townships, municipalities, transportation companies and divers business agencies.


U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS
MAP SHOWING
SNOW REMOVAL PROGRAM
ON MAIN HIGHWAYS
OPEN FOR WINTER TRAFFIC
LEGEND
MAIN HIGHWAYS REPORTED BY STATES AS INCLUDED IN SNOW REMOVAL PROGRAM FOR MOTOR VEHICLE TRAFFIC
MAIN HIGHWAYS NOT ON SNOW REMOVAL PROGRAM
CONTOURS SHOWING AVERAGE ANNUAL SNOWFALL IN INCHES
SEASON 1928-29
LAKE SUPERIOR
GULF OF MEXICO

HANDY METHOD FOR UNLOADING A DRAGLINE OR STEAM SHOVEL

CONTRIBUTED BY DARNALL BURKS
OF THE DIVISION OF MANAGEMENT.

THE METHOD HEREIN DESCRIBED FOR UNLOADING A DRAGLINE FROM A RAILROAD FLAT CAR SHOULD BE OF WIDESPREAD INTEREST. THE PICTURES AND NOTES WERE OBTAINED RECENTLY ON A TEXAS BRIDGE JOB WHEN A NEW DRAGLINE WAS UNLOADED.

THE CUSTOMARY METHOD OF UNLOADING A HEAVY PIECE OF EQUIPMENT OF THIS KIND CALLS FOR A RUNWAY OF HEAVY TIMBER-CRIBBING. THE TIME AND EXPENSE INVOLVED IN OBTAINING, HAULING, PLACING, AND RETURNING THESE TIMBERS IS FREQUENTLY A CONSIDERABLE ITEM. BY THE METHOD USED IN THIS CASE ONLY TWO OR THREE ORDINARY RAILROAD CROSSTIES ARE NEEDED TO BRIDGE THE SLIGHT DROP FROM THE CAR FLOOR TO THE GROUND.

THE DRAGLINE, WHICH WAS EQUIPPED WITH A 50-FOOT BOOM, ARRIVED AT THE SIDING ON TWO FLAT CARS. THE FIRST STEP IN THE UNLOADING WAS TO MOUNT THE BOOM, PROVIDE THE NECESSARY SUPPLIES FOR THE ENGINE, AND GET IT INTO SHAPE FOR OPERATION. WITH THE SHOVEL RESTING NEAR THE MIDDLE OF ONE CAR A CHAIN WAS PASSED UNDER THE FRONT END OF THE OTHER CAR JUST AHEAD OF THE FRONT TRUCKS AND ATTACHED TO THE BUCKET TACKLE. FIGURE 1-(ABOVE) SHOWS THE DRAGLINE WITH BOOM MOUNTED AND READY TO LIFT THE FRONT END OF THE CAR CLEAR OF THE FRONT TRUCKS SO THAT THEY MAY BE REMOVED.

THE PROCESS OF DISCONNECTING THE TRUCKS WAS VERY SIMPLE. ONLY ONE CONNECTION HAD TO BE BROKEN. THIS CONSISTED OF REMOVING THE PIN WHICH CONNECTED THE BRAKE LEVER ON THE TRUCK TO THE PISTON ROD OF THE MAIN BRAKE ATTACHED TO THE CAR FRAME. THE CAR FRAME RESTED ON THE TRUCKS BY MEANS OF A COUNTERSUNK SEAT AND THERE WERE NO OTHER CONNECTIONS BETWEEN THEM. AS SOON AS THE BRAKE PIN HAD BEEN REMOVED THE CAR FRAME WAS LIFTED CLEAR OF THE TRUCK AND THE TRUCK ROLLED AWAY - MEANWHILE SLACKING AWAY ON THE TACKLE AND LOWERING THE CAR FRAME TO THE RAILS. THREE HANDY CROSSTIES WERE PLACED ON THE RAILS AT THE LOWERED END OF THE CAR FLOOR IN ORDER TO MAKE THE JUMP TO THE GROUND LESS ABRUPT. AN IDEAL RUNWAY WAS THUS COMPLETED.

THE DRAGLINE, ENTIRELY UNDER ITS OWN POWER, THEN PROCEEDED DOWN THIS RUNWAY, OFF THE TRACK AND ONTO THE ROAD ALONG THE SIDING. HERE IT WAS SWUNG AROUND AND AGAIN PICKED UP THE END OF THE CAR AND HELD IT UNTIL THE TRUCKS WERE ROLLED BACK INTO PLACE AND THE BRAKE PIN REPLACED. THE CAR FRAME WAS THEN LOWERED AND THE JOB FINISHED.

FIGURE 1-(CENTER) SHOWS THE SLOPE OF THE RUNWAY AND THE DRAGLINE READY TO PICK UP THE LOWERED END OF THE CAR. FIGURE 1-(BELOW) SHOWS THE CAR FRAME RAISED AND THE TRUCKS BEING RUN BACK. AFTER THE TRUCKS HAD BEEN PLACED IN POSITION, THE TACKLE WAS SLACKED OFF UNTIL THE FRAME WAS SEATED AND THE JOB COMPLETED. THE TRUCK SHOWN IN THE PICTURE WAS USED TO CARRY THE BUCKET AND MISCELLANEOUS EQUIPMENT DURING THE MOVE TO THE BRIDGE SITE.

THE TOTAL TIME REQUIRED FOR THE UNLOADING, ASIDE FROM MOUNTING THE BOOM, WAS 30 MINUTES AND THE PERSONNEL ACTUALLY EMPLOYED CONSISTED OF THE DRAGLINE OPERATOR AND HIS ASSISTANT.

THE REVERSE PROCESS OF LOADING SHOULD BE EQUALLY SIMPLE. WHERE ONLY ONE FLAT CAR IS AVAILABLE THE SAME METHOD OF UNLOADING IS STILL POSSIBLE BY CAREFULLY BALANCING THE SHOVEL, CRANE, OR DRAGLINE, WHICH IS TO BE UNLOADED, OVER THE REAR TRUCK WHILE THE FRONT TRUCK IS REMOVED. AS A MATTER OF PRECAUTION, HOWEVER, SUFFICIENT BLOCKING SHOULD FIRST BE PROVIDED BEHIND THE REAR TRUCK TO MAKE OVERBALANCING IMPOSSIBLE. FOR LOADING OR UNLOADING HEAVY EQUIPMENT, SUCH AS ROAD ROLLERS, TRACTORS, CONCRETE PAVERS, ETC., WHICH ARE NOT PROVIDED WITH LIFTING POWER OF THEIR OWN, THE SAME GENERAL METHOD SHOULD BE ADEQUATE PROVIDING A COUPLE OF SUBSTANTIAL JACKS ARE AVAILABLE FOR LOWERING AND AGAIN RAISING THE END OF THE CAR.

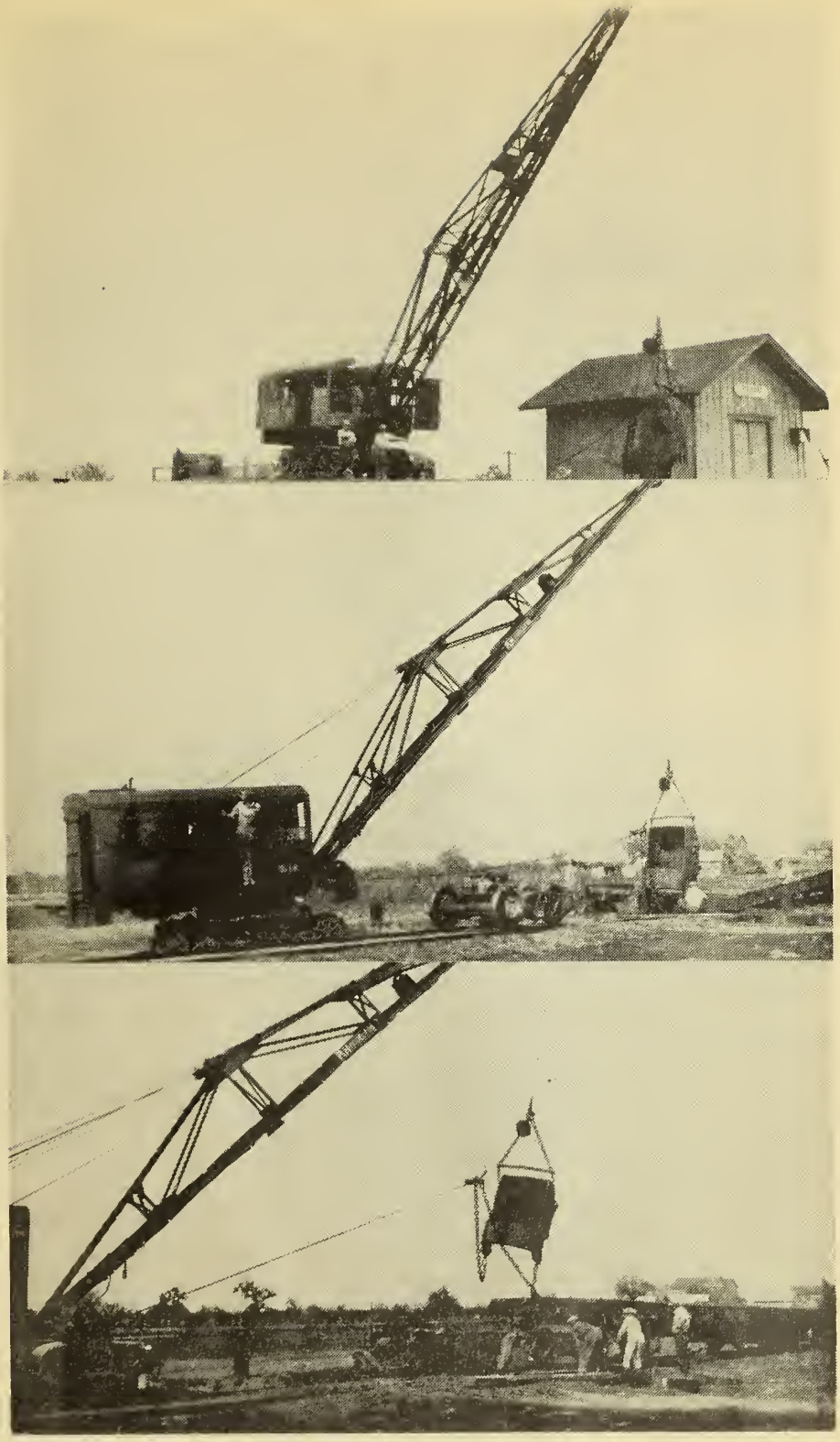


Figure 1-(above)-Lifting the further end of the flat car ahead so as to remove the wheels from beneath.

(center)-The slope of the runway just before the dragline raises the car preparatory to replacing the wheels.

(below)-Replacing the wheels under the raised car.

METHOD OF OBTAINING UNIFORM DISTRIBUTION OF ROAD OIL

CONTRIBUTED BY NEIL M. BURDICK
OF THE DIVISION OF MANAGEMENT.

A METHOD USED IN OREGON FOR OBTAINING A UNIFORM DISTRIBUTION OF ROAD OIL SEEMS TO PROVIDE A SOLUTION FOR THIS VEXING PROBLEM. THE PRACTICAL DIFFICULTY IN SPRAYING A HEAVY OIL UNIFORMLY OVER THE ROAD SURFACE ARISES FROM THE FACT THAT EVEN ON OUR MODERN DISTRIBUTORS THE HEIGHT OF THE SPRAYING NOZZLES ABOVE THE ROAD SURFACE IS NOT CONSTANT BUT VARIES MORE OR LESS AS THE TRUCK WHEELS PASS OVER VARIOUS ROUGH PORTIONS OF THE SURFACE, OR CHANGES OF GRADE. WHEN THE NOZZLES RISE TOO HIGH ABOVE THE ROAD SURFACE, THE SPRAY CONES WILL OVERLAP FORMING STREAKS WITH AN EXCESS OF OIL, WHILE WHEN THE NOZZLES ARE TOO LOW SIMILAR STREAKS LACKING SUFFICIENT OIL WILL BE FORMED. THIS TENDENCY TO STREAK IS ESPECIALLY NOTABLE ON COOL DAYS WHEN THE HEAVY OIL CONGEALS WITHOUT FLOWING OVER THE SURFACE. LATER, UNDER TRAFFIC, THESE LEAN STREAKS SHOW A TENDENCY TO RAVEL, WHILE THE RICH STREAKS TEND TO BLEED, RUT, OR SHOVE.

THE WRITER RECENTLY HAD THE OPPORTUNITY TO OBSERVE THE OPERATION OF A METHOD BEING DEVELOPED IN OREGON TO SOLVE THESE DIFFICULTIES. THE PROCESS CONSISTS ESSENTIALLY OF ADMITTING TO THE SPRAYING OIL ABOUT 8 PER CENT WATER TO WHICH HAS BEEN ADDED ABOUT 1 PER CENT OF LIQUID SOAP. THE HOT OIL IMMEDIATELY VAPORIZES THE WATER THAT FORMS FOR A FEW SECONDS, A STEAMING OIL-FROTH ON THE ROAD SURFACE AN INCH OR MORE IN DEPTH AND OF SUFFICIENT FLUIDITY TO INSURE A UNIFORM DISTRIBUTION.

THE JOB OBSERVED WAS ON THE BAKER-PLEASANT VALLEY ROAD IN BAKER COUNTY, OREGON. THE DISTRIBUTOR WAS MOUNTED ON A 1,000-GALLON TANK-TRUCK. A POWER PUMP CIRCULATED THE OIL--95 PER CENT ASPHALT HEATED TO 350° F.--THROUGH THE SPRAYHEAD AND THENCE THROUGH A RELIEF VALVE BACK INTO THE TANK. FOR SUPPLYING THE WATER-AND-SOAP MIXTURE AN AUXILIARY NOZZLE WAS MOUNTED AHEAD OF EACH OIL JET. THE SOAPY WATER WAS FED TO THE NOZZLES BY GRAVITY FROM A TANK. APPROXIMATELY 80 GALLONS OF WATER MIXED WITH 3 QUARTS OF LIQUID SOAP WERE PLACED IN THE WATER TANK FOR EACH 1,000 GALLONS OF OIL.

IN OPERATION THE SOAP-AND-WATER MIXTURE WAS ALLOWED TO SPRAY AGAINST THE OIL NOZZLES AND THEN DRIP INTO THE OIL JETS. THE HOT OIL IMMEDIATELY VAPORIZED THE WATER, FORMING A STEAMING OIL WHICH FLOWED SUFFICIENTLY TO INSURE A UNIFORM DISTRIBUTION OF THE OIL. THE DEPTH OF THE APPLICATION FOR ABOUT 40 FEET, OR 4 SECONDS, BEHIND THE DISTRIBUTOR, WAS APPROXIMATELY THREE-FOURTHS OF AN INCH, BUT THIS WAS LESS THAN ONE-HALF THE DEPTH NOTED IMMEDIATELY BEHIND THE JETS. WHEN AN APPLICATION WAS TRIED WITHOUT USING ANY SOAP THE DEPTH OF THE RESULTING FROTH WAS ONLY ABOUT ONE-THIRD OF THAT OBTAINED WHEN THE LIQUID SOAP WAS ADDED TO THE WATER.

TO ALL APPEARANCES THE OIL COATING OBTAINED BY THIS METHOD WAS VERY UNIFORM. KNIFE SCRATCHES REVEALED NO GREAT VARIATION IN THE THICKNESS OF THE FINAL COATING. OCCASIONALLY SMALL WATER BUBBLES WERE NOTICED IN THE OIL FILM, BUT IT DOES NOT SEEM THAT ANY POSITIVE HARM CAN REASONABLY BE EXPECTED FROM THAT SOURCE. ALL FACTS CONSIDERED, THE RESULTS APPEARED TO BE VERY SATISFACTORY AND WELL WORTH THE SLIGHT ADDITIONAL COST.