U. S. DEPARTMENT OF AGRICULTURE

BUREAU OF PUBLIC ROADS

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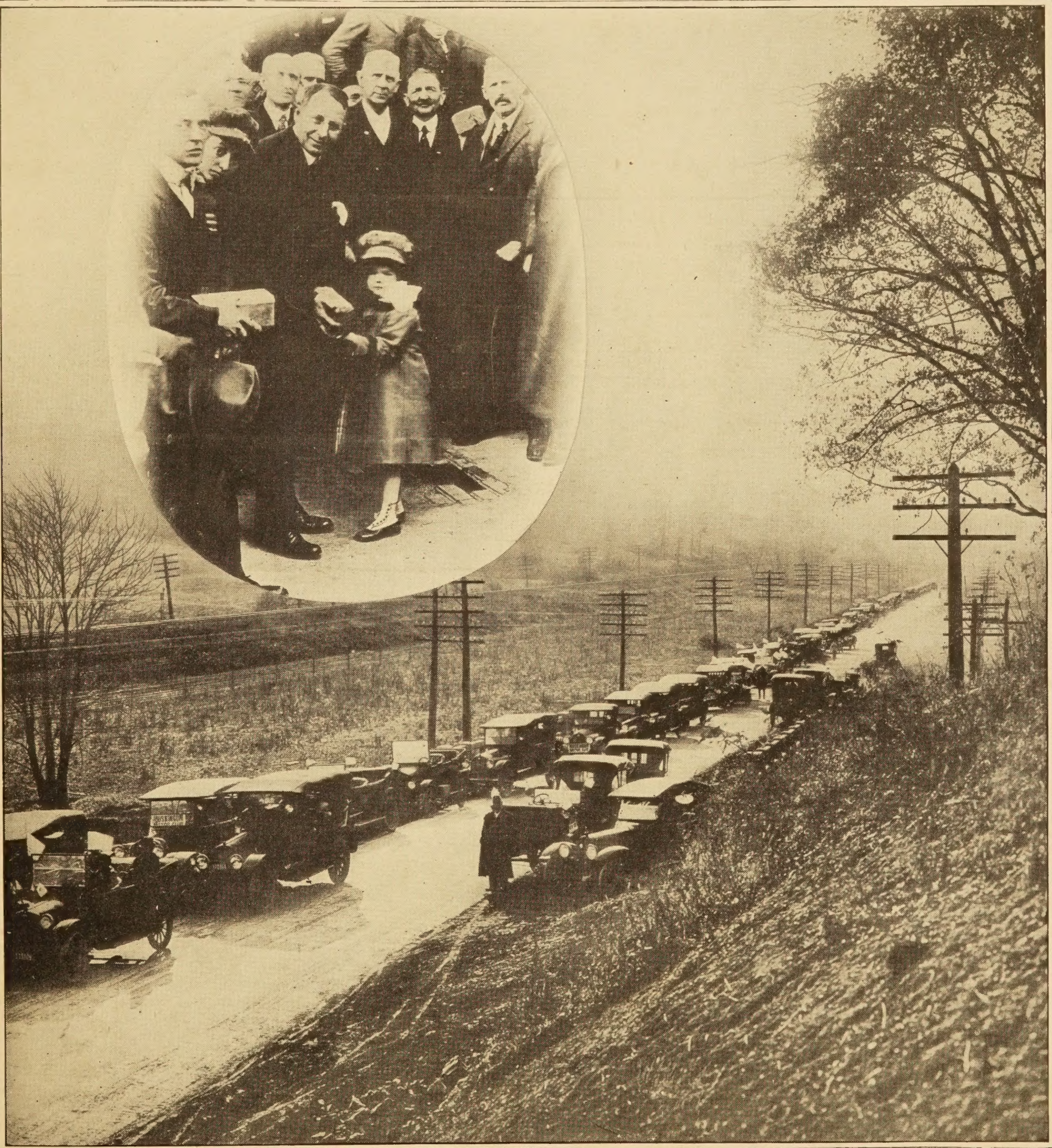

OPENING OHIO FEDERAL AID PROJECT No. 1—GOVERNOR LAYING LAST BRICK. Page 28

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U. S. DEPARTMENT OF AGRICULTURE

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PUBLIC ROADS

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1919

NEW ROADS OFFICIAL NAMED

Thomas H. MacDonald, of Iowa, to be in charge of Highway Work for Department of Agriculture

Thomas H. MacDonald, chief engineer of the Iowa State Highway Commission, has been appointed by the Secretary of Agriculture as engineer in immediate charge of the work under the Federal aid road act, which provides for cooperation between the States and the Federal Government in the construction and improvement of roads.

Mr. MacDonald will assume his new duties as soon as he can close up his work in Iowa. In the meantime he will continue to keep in close touch with the Federal aid road work of the department, as he has done during the past two or three months.

Steps already have been taken to expedite the resumption and extension of highway construction under the terms of the Federal law, as amended by the post office appropriation act, and nothing will be omitted to facilitate the vigorous prosecution of the work. The regulations have been carefully revised in the light of past experience and of suggestions offered by the State highway departments, the standards for plans, specifications, and estimates have been modified to meet special conditions existing in some of the States, and other changes in practices and procedure have been made, all with the definite object of speeding up the work.

Mr. MacDonald will immediately supervise and direct all the activities of the Bureau of Public Roads under the Federal aid road act, including the expenditure of the additional appropriation of $209,000,000 provided by the post office appropriation act for the extension and development of highway construction during the present and the next two fiscal years. For the time being, in the midst of the pressure incident to the resumption and extension of road work, Mr. MacDonald will devote his energies to problems arising under the Federal aid road act. It is planned that in the near future, he will formally assume the position of Director of the Bureau of Public Roads, made vacant by the death of Logan Waller Page.

Mr. MacDonald was graduated from the Iowa State College in the civil engineering course and was employed by the Chicago Great Western Railroad for a time on track work. In 1904 he became assistant professor of civil engineering at the Iowa State College and was placed in charge of road investigation work. In 1906 he was appointed highway engineer with the first highway commission in Iowa and held this position until 1913, when he was made chief engineer of the present State highway commission. He is also supervisor of State roads, having charge of all highways and streets adjoining or upon State farms, State institutions, and the State capitol at Des Moines. He is a member of the executive committee of the American Association of State Highway Officials.

Mr. MacDonald's broad knowledge of and wide experience in highway construction matters peculiarly qualify him for the very important task of directing the activities of the Federal Government under the road act, in cooperation with the State highway commissions of the various States, and of supervising the expenditure of the large sums that are now available for this purpose.

THE ENGINEER IN ROAD WORK

By RODMAN WILEY, Commissioner of Public Roads of Kentucky

WHEN one speaks of an engineer he does not necessarily mean a college graduate. Of course, it is very desirable to be a graduate from a recognized school of engineering, as that forms the basis upon which to build with experience. Neither do we mean that a man is an engineer simply because he is qualified to run a transit or level or has had a few years' experience with some engineering corps. Such an idea either in the mind of the man himself, or the people in general, is an injustice to the engineering profession.

It makes no difference what branch of engineering a man may decide to follow, he will find that it takes a great deal of study, years of training and experience, and plenty of common sense before he the A B C of engineering. In addition he must know how to meet and deal with the public and how to handle men. He must possess more ready information than most any class of professional men.

One of the best definitions of engineering according to my judgment is "science applied with common sense."

One of the most prominent engineers in this country has said that a man to be a successful engineer must have 75 per cent common sense, 15 per cent chance to display it, and 10 per cent education. After all, a man to be successful in most any line of work must have a good stock of common sense.

FORERUNNER OF CIVILIZATION.

Were we to analyze intelligently any work that has been done or is being done, we would discover that the engineer's part is not the most insignificant. He has made possible practically everything that is of use to man. As a matter of fact, the engineer is the forerunner of civilization, it might be said, the indispensable sentinel of progress.

On October 18, 1917, there appeared the following masterful editorial in the Canadian Engineer:

> Every industry depends directly upon the engineer. There are few points of life where his work has not effected big alterations. Tolerant he must be to human weakness; efficient he must be, for in few other fields of effort is the elimination of the unfit more rigorously practiced. His training is applied science and his practice demands large common sense.
>
> The engineer is one of the pivots of modern civilization; therefore he should be more in evidence as a public man. He is well fitted to carry forward the lessons of practical experience in the realm of national affairs.

In the financial end, engineers are oftentimes called upon to make an examination of the road needs of a community, the possible resources, and to report to the constituted authorities the amount of money needed and the best method of securing it; at other times they advise with the proper authorities to see if their program is sound from a financial standpoint, just the same as engineers are called upon to report to bankers and brokers on the soundness of investments in other lines of work. To-day very few investments of any size are made unless the proposition has the approval of some well-known engineer in whom the investors have implicit confidence.

MISTAKES IN LOCATION.

Every one has seen on numerous occasions the mistakes that have been made by viewers in locating roads. It must be remembered that wherever a road is built schoolhouses, residences, churches, and business houses will follow the development. In case the location is bad, it is most difficult and oftentimes impossible to provide any remedy, because if the location is changed all the improvements are lost, consequently the taxpayers are compelled from year to year to pay a heavy cost for maintaining an improperly located road. On the other hand, very few of you have ever seen a road located by good engineers that ever needed to be changed. France, Belgium, England, and Italy realized centuries ago that whenever any road improvement was started it should be in charge of the most competent engineers in the nation, consequently the roads in those countries have been located with such foresight, such knowledge of the development of the country, that it is almost impossible even at this time, with all our advanced ideas and new methods of travel to make any desirable changes.

The great trouble has been principally the fault of the taxpayers. They have not called for a business-like administration of the road affairs of their counties, and consequently they have not received it. A road is simply one of the systems of transportation, and its location requires as much if not more skill on the part of an engineer as the location of a railroad, because a railroad company usually has ruling grades, ruling degrees of curvature, and no departure is allowed from those standards, whereas when locating a road an engineer must have a vision. In his mind's eye he must see the country as it will grow, and as it will be years after the road is built. Consideration must be given to the finances of the county, which is usually not the case in railroad work.

CALLS FOR RARE JUDGMENT.

A railroad company might expend thousands of dollars to reduce a grade one-half per cent, to reduce the degree of a curve one or two points, but in road work an engineer adopts such grades as will insure the economical construction of the highway, provided, of course, that traffic will not be impeded. Highway location calls for rare judgment on the part of an engineer.

The grading of a road requires the same amount of skill and experience on the part of the man doing the work as does the grading of any railroad or interurban line. The same kind of machinery, the same instruments, are used for both classes of work. A railroad company never considers for one moment starting any construction work without having experienced engineers on the ground at all times to see that it is properly done; a contractor doing the work knows from bitter experience that he can not hope to make money unless he has an experienced man in charge, and I can not understand how men entrusted to build roads can figure that they can depart from the usual custom or that they can break all precedents and do something that railroad companies and contractors have found to be impossible from an economical standpoint and impracticable from all other angles.

When it comes to surfacing any road, the man in charge should have a thorough knowledge of the behavior of all local materials under different kinds of traffic and different climatic conditions, as well as to understand the method of doing the work. Experience has shown that attention to minute details is necessary if any type of road is properly built. One man can take a certain amount of stone and build a good road and another man will take the same class of stone and the same amount of stone and build an inferior road. That shows for itself that there is something in a man knowing how. However, the most important thing about the surfacing of any road is knowing the type to select. A great many men have had sufficient experience to know how to build a gravel road, a macadam road, or most any type of road that might be selected but the real engineering comes when we are trying to decide the proper type to build in certain localities. To intelligently make a decision, consideration must be given to the finances of the district, availability of materials, local materials, the kind and volume of traffic passing over the road, possible increase in traffic due to the improvement and the approximate cost of maintaining any type that is decided upon.

HUNDREDS OF MILLIONS WASTED.

Hundreds of millions of dollars have been wasted in this country by building the wrong type of road. In the central section of Kentucky we find almost invariably macadam roads; in western Kentucky gravel roads, and in most instances those types have been built without any consideration whatever being given to the traffic that has or will pass over the road during its life. To my mind, the selection of the proper type of road requires the highest type of engineering ability and before building any road it would be economical and certainly good common sense to get the advice of the foremost engineers in the country as to the most economical type.

On many of the roads in Kentucky, even at this advanced age, we find that it is impossible to transport the ordinary road machinery because the drainage structures will not carry the loads. Sometimes there are fairly good roads on which there has been installed drainage structures totally unsuited to the traffic. Again, structures of the wrong size have been built. It is not uncommon to see a 100-foot span trestle where perhaps a 4 by 4 culvert would suffice. Oftentimes there is installed a culvert pipe which is totally incapable of carrying the water. Even the determination of the proper size of any drainage structure is a high-class engineering problem.

NOTHING SHOWS BUT BIG EXPENSE.

The design of culverts and bridges is a branch of engineering that requires years of training and experience. No railroad company would consider for a moment letting one of their section foremen build a bridge or culvert according to his own ideas. On the contrary, every structure is carefully designed, carefully checked several times before it is ever allowed to be installed. The great trouble with highway work has been that almost everyone thinks they understand how to design and build drainage structures and we find to-day our highways adorned with structures which have little to commend them except the enormous prices paid by an unknowing public.

After a road is built it must be maintained, and everyone who has had any experience in road maintenance knows it should not be attempted by any but experienced men because it is one of the easiest ways known to waste money. Just what to do to a road in certain stages of deterioration is one of the most difficult things for even the most experienced engineers to determine. I have seen some men use 500 cubic yards of stone to the mile and make less showing and do less good than an experienced man would with a hundred yards of the same material.

It has always occurred to me as being peculiar that separate accounts have not been kept showing the expenditures which have been made on a road. To-day it would be impossible to go to any county in Kentucky and find the cost of a single mile of road unless that mile had been built under State supervision where cost records are accurately kept. It is part of the training of an engineer to analyze costs, to segregate costs so that they know not only the original cost of any improvement but also what it has cost from year to year; only by keeping and knowing such things can we ever be certain that we are doing economical work.

TAXPAYERS PAY FOR ALL MISTAKES.

I have endeavored to show that every phase of road building is an engineering problem and the sooner that fact is realized the sooner will the taxpayers be properly protected. But the thing I am contending for will not come over night. Men without any knowledge of the subject will be elected to office on some fake issue and will continue to build roads according to their own pet theories, many of which will be at variance with good engineering, but the taxpayers should remember that they are paying for all mistakes made.

Never before in the history of the world has mankind been so dependent upon the engineer. The late war was essentially a war of engineers; for it is they who designed the guns, the ships, the gas bombs, the depth bombs, the aeroplanes, the ammunition, built the roads, cantonments, the trenches, railroads and bridges for our armies, and the public is now beginning to recognize the truth of the saying that "when something of importance has to be done, it is necessary to call in the engineer."

Noted men have made the statement that of the $300,000,000 expended in this country on roads last year that at least one-third was wasted, and it is now time for the people to take this matter in hand and see that not a single piece of road work is attempted unless done by skilled engineers; then every cent expended on location will be a permanent investment, every fill and every cut that is made will be properly done, every bridge and every culvert built so that it will carry the loads that pass over the road. The type of surfacing used will be the most economical one, and the roads when once built will be maintained instead of being allowed to deteriorate from day to day. Every cent expended will be properly accounted for, and then and only then will the taxpayers realize a dollar's worth of work for every dollar of their money invested in roads. When such time shall come the people will be willing to pay taxes for roads, because they will see that their interests are properly safeguarded, and we will have more and better roads at a cheaper price.

TYPICAL SPECIFICATIONS

In order to meet the frequent requests for information as to what specifications will be approved by the Bureau of Public Roads for use on Federal-aid highways, typical specifications have been prepared and furnished to the district engineer for use in reviewing specifications for Federal-aid road work.

In preparing these specifications the aim has been to obtain good work by the use of well-recognized methods of general adaptability. This has quite naturally, and very properly, prevented the inclusion of specifications based on new theories or recent developments which have not as yet so proved their worth during long periods of actual use as to have caused their general acceptance. In short, these specifications are conservative. On the other hand, they represent good practice and, if followed, will insure good work.

The general clauses are written with full knowledge that local conditions and local laws will require numerous minor modifications. It is patently impossible to cover all local conditions within any reasonable space, and so no effort has been made to cover such conditions at all, it being assumed that the engineers who are responsible for the actual preparation of the specifications are familiar with the local conditions which will necessitate these minor modifications.

It should also be understood that these specifications are not, in any sense, to be taken as indicating the bureau's opinion as to the best practice under all possible conditions in the construction of the several classes of highways. It, therefore, follows that wherever those who are writing specifications desire to adopt more rigid technical requirements than those established in the typical specifications, the more rigid requirements will be accepted. It is well recognized that there are special conditions of drainage, soil, volume of traffic, etc., which may make material modifications desirable and, where such conditions prevail, the requirements of the typical specifications are not to be accepted as necessarily adequate to meet these conditions.

In brief, these specifications are submitted as typical of conservative practice and as a guide to those who desire to know what the Bureau of Public Roads will accept as satisfactory requirements in constructing Federal-aid highways under normal conditions.

BRITISH GRANT FOR ROAD WORK

The British Government has decided that, owing to high prices, lack of materials, shortage of labor, transport difficulties, and the need for much repair and reconstruction work, as well as the desirability of stimulating useful work, to make a grant of $50,000,000 to promote work on roads and bridges throughout the country. Of this grant $8,500,000 will be furnished by the road board and the balance by the national exchequer. The work most urgently needed is the strengthening and resurfacing with improved materials of important roads and bridges, with preference given to highways on which there is or likely to be a large motor traffic, especially on those which suffered deterioration during the war.

NEW REGULATIONS FOR VOUCHERS FOR ALL FEDERAL AID PROJECTS

New regulations as to the submission of vouchers for work done on Federal aid projects have recently been promulgated, the purpose being to simplify the vouchering, and at the same time keep within the accounting regulations established by the Comptroller of the Treasury, and to insure uniformity of procedure.

The question which, under the former regulations, gave the most trouble was the question of underruns and overruns, including incidentals and extras not specifically noted in the project agreement. Under the new instructions these are to be omitted from all vouchers except the final voucher. This has been done to save constant repetition of items of minor importance and to avoid the confusion which has too often resulted from an effort to make apparent underruns balance apparent overruns before the project has progressed far enough to warrant the assumption that the underruns will persist. To illustrate, it has often happened that where a project has carried both excavation and borrow, changes in the methods of construction, the alignment, or the grade, etc., have often resulted in changing the ratio existing between the excavation and the borrow. It is, of course, proper that the underruns, in a case of this kind, should be used to balance the overruns, but it has been found that, in practice, underruns which appear in one mile may be entirely wiped out in the next, so that when an adjustment was applied for on the original underrun, it often became necessary to readjust later on, because of the elimination of the underrun. To avoid cases of this kind it has been decided that overruns, underruns, and incidentals will all be adjusted on the final voucher. This procedure has the further advantage that besides avoiding constant adjustments and readjustments it makes it possible to allow the State to utilize all of the underruns to assist in paying for overruns and contingencies. This should prove to be of considerable assistance to the State, for contingencies are apt to run a good deal higher than was expected.

In the past it has been the practice of the Bureau of Public Roads to make the same retent against a State that the State makes against its contractors but, for many reasons, this has proved to be unsatisfactory. In order to assist the States as much as possible in handling their work, a uniform retent of only 5 per cent has been decided on and will be applied on future vouchers. The retent would have been eliminated entirely had it not been necessary to retain it in order to cover the differences which are constantly arising from slight variations in the theoretical pro rata. As it is, it has been reduced to the absolute minimum in an effort to carry the policy of assisting the States as much as possible to its logical limit.

The next provision of the new regulations is also promulgated with a view toward assisting the States, particularly on long projects composed of numerous sections. Under this provision underruns on one section become available in carrying overruns and contingencies on to other sections. It is thought that this provision will be of considerable value to those States which have adopted the policy of submitting long projects divided into a number of sections, and it is hoped that full use will be made of it.

The new regulations also permit of the use of an approximate pro rata on all but the final voucher. This is in the interest of simplicity. The former system of using a pro rata carried out to four or five decimal points was out of line with the known accuracy of the vouchers themselves. In the future, the pro rata will, in fact, be found by the simple process of computing the actual pro rata as a whole number and a decimal fraction and then striking off the decimal and using the whole number.

As appears in all of what has been here set down, the object of the new regulations on vouchering has been to assist the States by simplifying and liberalizing the method of securing payments of Federal aid just as much as is possible within the established rules of the Comptroller of the Treasury. These rules are, of course, binding wherever Federal funds are involved, but it is thought that the new regulations permit of a freedom of action that will prove quite satisfactory to all of those who are handling Federal Aid.

HIGHWAYS IN INDIANA.

Indiana is now ready to carry out an important program of road improvement under the recently enacted State highway commission and county unit road laws. Under the county unit law bonds for road purposes may be issued up to 2 per cent of the assessed valuation. The new State highway commission law provides for a levy of 10 cents on the $100 for the commission fund. State funds available for highway construction this year amount to about $2,000,000 and the Federal aid funds apportioned to the State to $2,163,392. If the State matches the Federal aid apportionment $15,000,000 will be spent during the next three years.

The new highway commission is to lay out a plan of State highways connecting every county seat and every town of more than 5,000 population. This will give about 32 miles to each county.

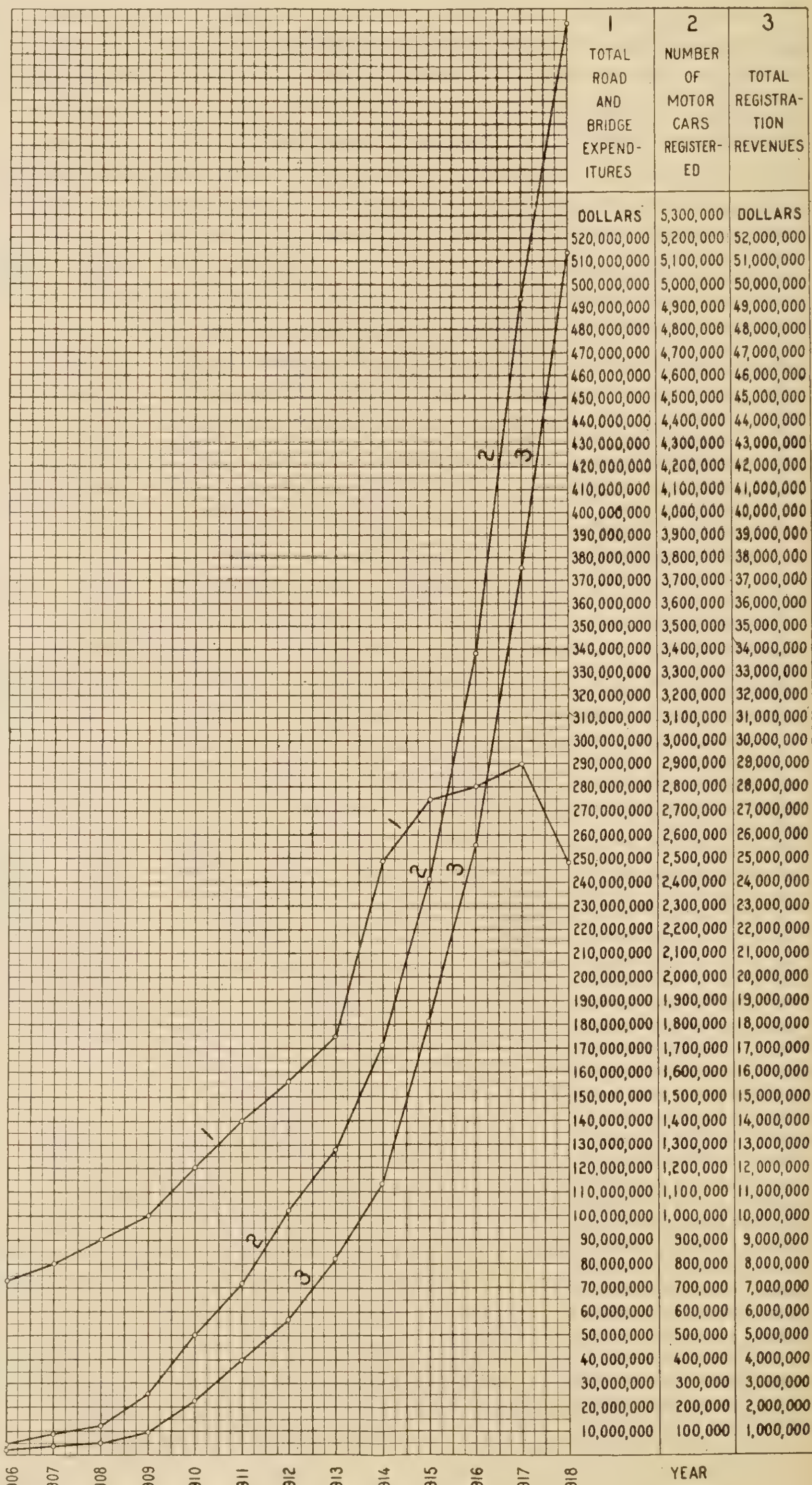
6,146,617 MOTOR VEHICLES IN U. S.

Registrations, Licenses, and Revenues in the United States During the Calendar Year 1918.

By ANDREW P. ANDERSON, Highway Engineer, Bureau of Public Roads.

A TOTAL of 6,146,617 motor cars and commercial vehicles and 240,564 motorcycles were registered in 1918 in the 48 States and the District of Columbia. The registration and license fees, including chauffeurs, operators, and dealers, amounted to a total of $51,477,416.61. These figures do not include about 107,000 automobiles and motor trucks manufactured for the Federal Government during the year 1918, which, as a rule, were not registered and paid no registration fees.

As compared with 1917, the data for 1918 represent an increase of 1,163,277, or 19 per cent, in the number of cars, and $13,976,180, or 27 per cent, in revenues. While these figures represent a striking increase in both the number of cars registered and the revenues collected, they show a considerable decline in the percentage or rate increase which existed throughout the five-year period previous to 1918. During this period the annual average increase in the number of cars over each succeeding year was 44 per cent and the increase in the amount of revenues was 45 per cent, as compared with the 19 and 27 per cent increases for the year 1918. This decrease in the rate is no doubt largely, if not entirely, due to the effect of the war.



87 PER CENT IN UNITED STATES.

There is very little definite information available as to the number of motor cars in countries other than the United States and Canada. According to the best available data and estimates, the total number of motor cars in the world amounts to about 7,000,000, of which more than 87 per cent are in the United States, nearly 4 per cent in Canada, slightly less than 1 per cent in the other countries of North and South America, and 7 per cent in Europe. About 265,000 cars are reported to be registered in Canada, in all the Provinces of which annual registrations are now in force. Probably not more than 65,000 cars are found in all of North and South

America outside of the United States and Canada. The present number of cars in Europe is not known with any degree of accuracy. Estimates based on data available for 1914 would place the total number below 500,000 or about the same as the number of motor cars at present in the State of New York.

The increase in motor-car registrations and revenues in the United States during the past dozen years year. In 1918 the motor-vehicle revenues represented approximately 21 per cent of the total road and bridge expenditures for that year. Furthermore, while in 1906 practically none of the motor-vehicle revenues were applied to road construction or maintenance, in 1918 nearly 91 per cent of the gross returns, or $46,935,691, were devoted to this purpose in 46 States, and of the total amount applied

TABLE I.—Motor-vehicle registrations, licenses, and revenues, 1918.

State.	Automobiles.	Motor trucks and commercial vehicles.	Motorcycles.	Reregistrations or transfers.	Owners' and chauffeurs' licenses.	Manufacturers' and dealers' licenses.	Total gross motor-vehicle registration and license revenues.	Motor-vehicle revenues available for road work.		Average gross revenue return per motor car registration.	Population per motor car.	Motor cars per mile of public rural road.
								By or under State highway department.	Under direction of local authorities.			
Alabama [1]	37,874	8,297	1,180		2,455		$470,273.50			$10.18	51	0.8
Arizona	21,498	2,407	685		444	237	142,288.25	$142,288.25		5.91	11	2.0
Arkansas	41,458	(2)		481	638		410,648.50	410,648.50		9.80	42	.8
California	[3] 407,761	(2)	27,887	40,720	420,480	2,475	3,524,035.61	1,421,319.79	$1,421,319.79	8.64	7	6.6
Colorado	83,244	(2)	3,872	4,580	9,686	2,015	379,559.20	174,432.40	174,432.41	4.56	12	2.1
Connecticut	[4] 70,807	15,260	4,246	10,650	104,000	360	1,285,164.27	1,285,164.27		14.91	14	6.1
Delaware	12,955	(2)	707	889	17,060	328	232,449.00	232,449.00		17.94	17	3.6
District of Columbia	[5] 25,359	[6] 5,131	2,353		17,255	738	220,753.00			7.24	12	
Florida	49,306	[7] 4,880	1,629	1,333	44,934	314	345,775.36	288,775.36		6.38	17	3.0
Georgia	99,676	5,000	1,681		4,762	940	331,816.19		305,872.07	3.17	29	1.3
Idaho	32,289	(2)	707	361	968	429	576,554.61	144,138.65	432,415.96	17.86	14	1.2
Illinois	389,620	(2)	10,834		45,696	3,548	2,764,330.27	2,764,330.28		7.09	16	4.0
Indiana	227,160	(2)	9,112		4,641	990	1,293,128.00		1,162,125.00	5.69	12	3.0
Iowa	278,313	(2)	2,529	59,797		2,454	2,547,595.80	[8] 2,547,595.80		9.15		2.7
Kansas	189,163	(2)	4,173	4,195		1,431	978,837.00		878,500.50	5.17	10	1.7
Kentucky	65,884	(2)	1,479		3,000		402,250.11	355,000.00		6.08	36	1.1
Louisiana	40,000	(2)	399	400		402	240,000.00		216,000.00	6.00	46	1.6
Maine	40,372	4,200	1,497	2,418	54,179	435	570,171.00	570,171.00		14.12	19	1.9
Maryland	67,839	[9] 6,827	5,351	3,474	31,096	2,034	1,189,984.25	827,203.21		15.94	18	4.5
Massachusetts	160,486	33,011	12,862	16,158	235,140	2,493	2,184,821.00	2,135,000.00		11.29	19	10.4
Michigan	235,608	26,517	7,818	13,128	25,007	845	2,875,266.32	1,479,408.48	1,395,857.84	10.97	11	3.5
Minnesota	204,458	(2)	5,021	2,749	6,253	3,985	1,076,811.00	1,076,811.00		5.32	11	2.2
Mississippi [10]	46,000	2,400	1,000				335,000.00		300,000.00	6.92	41	1.1
Missouri	188,040	(2)	3,980	9,385	210,020	1,660	1,394,762.19	1,234,475.03		7.41	13	1.9
Montana	51,053	(2)	852	934	1,470	298	350,913.50	237,720.50	79,240.17	6.87	9	1.3
Nebraska	173,374	(2)	2,900	1,765		2,195	536,897.00		480,000.00	3.09	7	2.1
Nevada	8,159	(2)	121			50	31,082.75	25,288.25	1,939.50	3.81	13	.7
New Hampshire	[11] 22,106	2,711	2,453	2,254	[12] 31,146	195	509,335.10	455,372.09		20.52	18	1.7
New Jersey	139,783	[13] 15,736	12,517	26,890	201,022	1,368	2,431,756.70	2,393,939.33		15.63	19	11.1
New Mexico	17,647	(2)	300			148	105,631.35	45,751.42	45,751.42	5.97	25	1.5
New York	365,874	[14] 93,414	28,597		147,756	2,252	4,945,297.50	2,563,536.81	1,445,329.09	10.76	22	5.8
North Carolina	72,313	(2)	1,333			600	394,738.67	69,079.27	276,317.07	5.46	33	1.4
North Dakota	71,678	(2)	1,659	935		847	471,428.77	314,285.85	157,142.92	6.44	11	1.0
Ohio	412,775	(2)	20,717	9,215	159	3,272	2,125,425.50	1,975,425.50		5.15	12	4.8
Oklahoma	[15] 121,500	(2)	1,622			3,116	1,102,379.77	992,141.79		9.07	18	1.1
Oregon	63,324	(2)	3,501	9,451	3,128	451	461,422.00	419,922.00		7.28	13	1.7
Pennsylvania	363,001	[16] 31,185	26,621	24,734	204,473	7,887	4,048,185.50	4,048,185.50		10.05	22	4.3
Rhode Island	29,178	[17] 7,040	1,464	3,179	38,467	140	385,608.00	385,608.00		10.95	18	16.2
South Carolina	55,492	(2)	1,147	1,368		2,930	300,216.71	60,043.34	240,173.37	5.41	30	1.3
South Dakota	90,521	(2)	1,323	2,437		1,118	282,742.00		240,330.70	3.21	8	.9
Tennessee [10]	63,000	(2)	800			450	390,000.00	351,000.00		6.19	36	1.4
Texas	251,118	(2)	2,496	24,514	22,738	4,002	2,039,588.77	806,349.49	1,019,794.38	8.12	18	1.9
Utah	27,204	5,069	1,298	500	1,474	175	229,203.24	215,598.54		7.10	14	3.6
Vermont	20,681	1,872	734	1,798	27,980	158	398,855.64	368,855.64		17.68	16	1.5
Virginia	72,228	(2)	2,414		4,760	386	684,636.35	650,431.63		9.48	31	1.3
Washington	[18] 101,161	16,117	6,317	11,619		678	875,391.25	790,996.25		7.46	13	2.7
West Virginia [19]	38,750	(2)	825		3,840	569	447,705.11	447,705.11		11.55	36	1.2
Wisconsin	189,436	6,817	7,238			1,500	2,076,701.00	1,505,025.75	501,675.25	10.58	13	2.5
Wyoming	16,200	(2)	313			167	80,000.00			4.94	11	1.1
Total	5,852,726	[20] 293,891	[20] 240,564	[20] 287,311	[20] 1,926,127	[20] 63,065	51,477,416.61	36,161,473.08	10,774,217.44	8.37	16	2.5

[1] Fiscal year ending Sept. 30.
[2] Included under automobiles.
[3] Does not include 701 trailers.
[4] Does not include 3,441 public service registrations.
[5] Does not include 3,222 free permits nor 10,252 nonresident registrations.
[6] Does not include 1,684 nonresident vehicles.
[7] Does not include 151 trailers and commercial cars.
[8] Devoted to State and local road work and payment of registration expenses.
[9] Does not include 73 tractors nor 3,127 motor busses and commercial trucks.
[10] Approximate.
[11] Does not include 1,446 nonresident registrations.
[12] Does not include 1,447 nonresident chauffeurs and owners.
[13] Includes only cars weighing more than 4,000 pounds.
[14] Includes 18,105 omnibuses, but does not include 2,218 trailers.
[15] Includes trucks but does not include 2,674 traction engines.
[16] Does not include 3,103 traction engines and 1,284 trailers.
[17] Does not include 29 tractor registrations.
[18] Does not include 976 exempt cars.
[19] For period July–December, 1918.
[20] Partial total.

represents some interesting comparisons. This is especially true in respect to the use made of the revenues. In 1906 the total registrations were approximately 48,000 cars, paying a gross revenue of about $193,000, or roughly the same as the returns from the District of Columbia for the year 1918. Furthermore, in 1906 the gross registration revenues represented less than three-tenths of 1 per cent of the total rural road and bridge expenditures for that to road work 77 per cent, or $36,161,473, was expended more or less directly under the control or supervision of the State highway departments. The 9 per cent not applied to road work was expended very largely for plates and in carrying out the provisions of the motor-vehicle registration laws of the several States.

The approximate relations and rates of variation of the three factors, total rural road and bridge expenditures, motor-vehicle registration and license revenues, and the number of motor-car registrations from 1903 to 1918, inclusive, are shown graphically in the accompanying chart, page 8.

MOST OF REVENUE FOR ROAD WORK.

On January 1, 1919, every State but Minnesota had made provision for some definite form of annual State registration. In Minnesota the registrations are for a period of three years, beginning January 1, 1918. Consequently, unless the laws are amended, only new cars will pay a registration fee during 1919, which fee will cover the years 1919 and 1920.

At present all or a major portion of the motor-vehicle revenues are applied to road work in all of the States except Alabama, Wyoming, and the District of Columbia. In Alabama the revenues go to the State, county, and city general funds. In Wyoming they are returned to the counties without any stipulation that they shall be used for road work; while in the District of Columbia they are paid into the general fund.

For a number of years a general tendency toward devoting an ever increasing portion of the net motor-vehicle revenues to road work under the control and direct supervision of the State highway departments has been very noticeable. Thus, while the total increase in the motor-vehicle revenues for 1918 over those of 1917 was 27 per cent, the increase in the amount devoted to road work under the State highway departments over that of 1917 was about 35 per cent. This increase in the State-controlled revenues devoted to road work caused a decrease of nearly 10 per cent in the revenues placed under the supervision of local authorities.

TABLE II.—Motor-car registrations and gross motor-vehicle revenues, 1914 to 1918.

	Motor-car registration.[1]					Total gross revenues.				
	1914	1915	1916	1917	1918	1914	1915	1916	1917	1918
Alabama	8,672	11,634	21,636	32,873	46,171	$113,202	$180,744	$203,655	$217,700	$470,274
Arizona	5,040	7,753	12,300	19,890	23,905	34,077	45,579	73,000	117,643	142,288
Arkansas	5,642	8,021	15,000	28,693	41,458	56,420	80,551	150,000	205,176	410,649
California	123,504	163,797	232,440	306,916	407,761	1,338,785	2,027,432	2,192,699	2,846,030	3,524,036
Colorado	17,756	28,894	43,296	87,460	83,244	80,047	120,801	197,795	296,808	379,559
Connecticut	27,786	41,121	56,048	74,645	86,067	406,623	536,970	768,728	1,080,757	1,285,164
Delaware	3,050	5,052	7,102	10,700	12,955	35,672	55,596	85,249	133,883	232,449
District of Columbia	4,833	8,009	13,118	15,493	30,490	20,147	29,396	47,624	55,928	220,753
Florida	[2] 3,368	[2] 10,850	20,718	[3] 27,000	54,186	[4] 6,736	[3] 60,000	127,176	[3] 170,000	345,775
Georgia	20,915	25,000	46,025	70,324	104,676	104,575	125,000	154,735	229,653	331,816
Idaho	3,346	7,071	12,999	24,731	32,289	58,580	121,259	213,758	412,641	576,555
Illinois	131,140	180,832	248,429	340,292	389,620	699,725	924,906	1,236,566	1,588,835	2,764,330
Indiana	66,500	96,915	139,065	192,194	227,160	432,309	587,318	817,285	1,096,159	1,293,128
Iowa	106,087	145,109	198,587	254,462	278,313	1,040,136	1,533,054	1,776,170	2,249,655	2,547,596
Kansas	49,374	72,520	112,122	159,343	189,163	268,471	387,588	585,762	830,878	978,837
Kentucky	11,766	19,500	31,500	47,420	65,884	85,883	117,117	184,741	287,314	402,250
Louisiana	[3] 12,000	11,380	17,000	28,394	40,000	[3] 12,000	75,600	112,000	166,835	240,000
Maine	15,700	21,545	30,972	41,499	40,372	192,542	268,412	363,562	491,696	570,171
Maryland	20,213	31,047	44,245	60,943	74,666	268,231	386,565	565,302	807,395	1,189,984
Massachusetts	77,246	102,633	136,809	174,274	193,497	923,961	1,235,724	1,602,958	1,969,994	2,184,821
Michigan	76,389	114,845	160,052	247,006	262,125	([4])	373,833	1,739,344	2,471,271	2,875,266
Minnesota	67,862	93,269	[5] 46,000	[6] 54,009	204,458	132,398	[3] 160,540	82,469	100,000	1,076,811
Mississippi[3]	5,694	9,669	25,000	36,600	48,400	51,146	76,700	175,000	250,000	335,000
Missouri	54,468	76,462	103,587	147,528	188,040	235,873	323,289	439,315	617,942	1,394,762
Montana	10,200	14,540	25,105	42,749	51,053	27,000	33,120	52,768	290,936	350,914
Nebraska	16,385	59,000	101,200	148,101	173,374	34,325	[3] 183,000	311,334	451,303	536,897
Nevada	1,487	2,009	4,919	7,160	8,159	4,331	7,875	20,116	31,166	31,083
New Hampshire	9,571	13,449	17,508	22,267	24,817	185,288	257,776	344,434	425,305	509,335
New Jersey	62,961	81,848	109,414	141,918	155,519	814,536	1,062,923	1,406,806	1,923,164	2,431,757
New Mexico	3,090	5,100	8,228	14,086	17,647	19,663	29,625	47,865	80,843	105,631
New York	168,223	255,242	314,222	406,016	459,292	1,529,852	1,991,181	2,658,042	4,284,144	4,945,298
North Carolina	14,677	21,000	33,904	55,950	72,313	89,580	123,000	206,101	321,923	394,739
North Dakota	17,347	24,908	40,446	62,993	71,678	55,964	79,245	125,283	211,536	471,429
Ohio	122,504	181,332	252,431	346,772	412,775	685,457	984,622	1,286,405	1,766,427	2,125,426
Oklahoma	13,500	25,032	52,718	100,199	121,500	13,500	154,892	555,011	853,659	1,102,380
Oregon	16,447	23,585	33,917	48,632	63,324	77,592	108,881	146,232	196,787	461,422
Pennsylvania	112,854	160,137	230,578	325,153	394,186	1,185,039	1,665,276	2,325,057	3,268,025	4,048,186
Rhode Island	12,331	16,362	21,406	37,046	35,218	157,020	206,440	264,737	346,117	385,608
South Carolina[2]	14,000	15,000	[7] 25,000	38,332	55,492	14,000	15,000	10,000	113,557	300,217
South Dakota	20,929	28,724	44,271	67,158	90,521	125,000	[3] 180,000	140,746	210,592	282,742
Tennessee	[8] 19,769	[9] 7,618	[3] 30,000	48,000	63,000	39,538	[3] 34,000	186,953	322,200	390,000
Texas[2]	40,000	40,000	[7] 125,000	192,961	251,118	20,000	20,000	20,000	858,978	2,039,589
Utah	2,253	9,177	13,507	24,076	32,273	4,852	[3] 60,000	93,494	170,707	229,203
Vermont	8,475	11,499	15,671	21,633	22,553	154,267	218,480	297,992	363,541	398,856
Virginia	13,984	21,357	35,426	55,661	72,228	120,814	176,875	271,266	518,566	684,636
Washington	30,253	38,823	60,734	91,337	117,278	60,506	238,717	350,052	519,526	875,391
West Virginia	6,159	13,279	20,571	31,300	38,750	60,648	128,952	198,436	359,339	447,705
Wisconsin	53,161	79,741	115,645	158,637	196,253	293,580	431,977	615,721	861,278	2,076,701
Wyoming	2,428	3,976	7,125	12,523	16,200	12,140	19,880	35,625	57,421	80,000
Total	1,711,339	2,445,664	3,512,996	4,983,340	6,146,617	12,381,951	18,245,711	25,865,370	37,501,233	51,477,417

[1] Does not include motor cycles not dealers' and manufacturers' licenses.
[2] State registrations only.
[3] Estimated.
[4] Registration law declared unconstitutional.
[5] Cars registered during 1916; total number of cars, approximately 138,000.
[6] Cars registered, 1917.
[7] Estimated number of cars in State.
[8] Total cars registered under perennial system.
[9] Registrations 1915 only.

MOTOR REVENUES TO MEET BONDS.

In most States the motor-vehicle revenues are devoted to the maintenance and repair of the State roads or other improved highways. These States thus seem to have solved fairly well the knotty problem of how to secure sufficient funds to maintain the more important roads under the ever increasing traffic requirements. As both the traffic and the revenues increase with the number of cars, there exists a possibility of so adjusting the registration rates as to keep pace with the ever-growing maintenance charges.

Recently, however, a movement to capitalize the motor-vehicle revenues and devote these funds to road construction has been quite noticeable. This is especially true in those States which have a comparatively large number of cars and only a small mileage of improved roads. Thus, Illinois, last November, approved a bond issue of $60,000,000 for the construction of a system of State roads. The interest and principal of these bonds is to be paid entirely from the motor-vehicle revenues. There is no doubt that these revenues will prove sufficient for this purpose. The main question which remains is whether or not a satisfactory source of maintenance revenues can be secured so as to prevent these roads, when constructed, from deteriorating.

CAR DISTRIBUTION NOT UNIFORM.

The total road mileage of the United States outside incorporated towns and cities is about 2,456,000 miles. With a total registration of 6,146,617 motor vehicles there was, therefore, an average of 2.5 motor cars for every mile of public road in the United States. The distribution of cars among the several States, however, is far from uniform. Thus, Nevada has but 2 cars to every 3 miles of road, while Rhode Island has 16 cars to each mile of rural road. Furthermore, while there was an average of 1 motor car registration for every 16 persons in the United States, in the States of California and Nebraska there was 1 car for every 7 persons, and 1 car for every 8 persons in Iowa and South Dakota, but only 1 car for every 51 persons in Alabama, every 46 in Louisiana, or every 42 persons in Arkansas.

At the beginning of 1919 there were still 22 States in which motor trucks were registered at the same rate as pleasure cars. Recent years, however, have shown quite a general tendency to increase the fees required for heavy motor trucks. This increase usually is based on the weight of the truck, its carrying capacity, or a combination of its carrying capacity and its horsepower. However, there is as yet no evidence of any well defined general goal towards which this movement is tending. Some States are placing a definite maximum weight which may not be exceeded except in very special cases; others are evidently relying on discouraging or limiting the use of very heavy trucks by making the registration fees so large as to practically prevent the realization of any profit; while still other States are making no serious efforts except to limit the weight of the wheel loads per inch width of tire. The term, motor truck and commercial vehicle, moreover, is very definite. In some States the term commercial vehicle as used includes all trucks while in others only those vehicles used for hire are classed as commercial.

FEE SYSTEM COMPLICATED.

The amount of fees collected per car for either pleasure or commercial vehicles is as yet far from uniform and is still further complicated by the widely varying requirements for the registration or licensing of chauffeurs, owners, operators, dealers, etc. Thus, if the total gross registration and license revenues be used as a basis of revenue, and the total automobile trucks and vehicles as a basis for motor cars, it is found that for the entire United States the average fee per car was $8.37. On the same basis the State of New Hampshire received in 1918 a gross revenue of $20.52 for each motor car, while Minnesota received only about $1.75 annually for each car, as the registration in that State is for a three-year period.

In most States motor cars are taxed as personal property in addition to the required registration fees. In Delaware, Idaho, Iowa, Michigan, New York, North Dakota, Oklahoma, South Carolina, Pennsylvania, and Vermont the registration fees are in lieu of all other taxes. Therefore, in making any comparisons in fees as between the several States, this fact should be borne in mind.

TABLES FURNISH INDEX.

The registration of automobiles, motor trucks, commercial vehicles, chauffeurs, and operators, dealers and manufacturers, as well as the total gross registration revenues and the amount that is available for State road work, either by the State highway departments or under their supervision, for the year 1918 are given in Table 1. The number of registrations in this table do not necessarily indicate the exact number of motor vehicles of any one or of all of the several classes in actual use or existence in the several States, except so far as the laws of the several States require and enforce an annual registration under these classifications. However, as all of the States now, with the exception of Minnesota, require an annual State registration, these figures should furnish a very definite index of the total number of cars in each State. Many States make no distinction so far as the registration laws are concerned between pleasure cars and commercial vehicles. Consequently, the column headed "Motor trucks and commercial vehicles" does not show the total number of such vehicles except in some States. Reference to the principal requirements in the registration of motor vehicles in Table 4 will serve to make clear what the data in Table 1 represents.

Table 2 gives a comparison of the motor car registrations and total revenues for the years 1914 to 1918, inclusive. For further information in regard to registrations and revenues previous to 1913 the reader is referred to Office of Public Roads Bulletin No. 48, "Repair and Maintenance of Highways," pages 68 to 71.

TABLE III.—Motor-vehicle registration and license fees in force January 1, 1919.

State.	Motorcycles.	Pleasure cars.	Motor trucks and commercial cars.	Chauffeurs.	Owner operators.	Dealers and manufacturers.
Alabama	$3; with side-car attachment, $5.	Less than 25 horsepower, $7.50; 25 to 29 horsepower, $12.50; 30 to 39 horsepower, $17.50; 40 horsepower and over, $20; electric cars, $12.50; steam cars, $15.	Same as pleasure cars, except that those over 40 horsepower pay $25 each.[1]	Original, $5; renewal, $2.50.	None	$25 to $125.
Arizona	$2	25 horsepower and under, $5; 26 to 40 horsepower, $10; over 40 horsepower, $15.	Same as pleasure cars	Perpetual, $5.	do	1 vehicle of each class at pleasure-car rates.
Arkansas	None	All motor vehicles, $10	do	$1	do	Do.
California	$2	Electric cars, $5; all others, 40 cents per horsepower; trailers, $2.	Equipped with pneumatic tires, same as pleasure cars; others pay additional: less than 2 tons unloaded, $5; 2 to 3 tons, $10; 3 to 5 tons, $15; over 5 tons, $20.	Original, $2; renewal, $1.	No fee	5 cars, $25, and $2 for each additional; motorcycles, $5.
Colorado	$2	20 horsepower and under, $2.50; 21 to 40 horsepower, $5; 41 horsepower and over, $10.	Same as pleasure cars	$1	None	5 cars, $5 each.
Connecticut	$2	50 cents per horsepower	½ ton or less, $11; 1 ton, $15, and increasing to $200 for 8 tons, and $100 per ton for each ton additional.	License, $2; examination, $2.	License, $2; examination, $2.	$50 for 5 pair of plates, additional plates, $5 per pair.[2]
Delaware	$5	$2 each 500 pounds gross weight of car and load; passengers figured at 125 pounds each.	Same as pleasure cars	$3	$3; family, $8.	$20 for 2 pairs of tags; extra tags, $10 pair.
District of Columbia.	$2	24 horsepower or less, $3; 25 to 30 horsepower, $5; over 30 horsepower, $10.	do	$2	$2	Regular rates for each car demonstrated on public roads.
Florida[3]	$2	22 horsepower or less, $5; 23 to 27 horsepower, $8; 28 to 35 horsepower, $12; above 35 horsepower, $15; any car seating more than 9 persons, $100.	1 ton or less, $10; 1 to 2 tons, $25; 2 to 4 tons, $50; more than 4 tons, $100. Trailers over 500 pounds capacity same rate as trucks.	$2	None	5 cars, $15.
Georgia	$2	Not exceeding 25 horsepower, $3; 26 to 40 horsepower, $4; over 40 horsepower, $5; electric cars, $4.	Not exceeding 1 ton weight, $3; not exceeding 3 tons, $4; not exceeding 5 tons, $5; exceeding 5 tons, $6.	$2	do	$10 for 2 number plates and $1 for each duplicate.
Idaho	$5	All weighing less than 2,001 pounds, $15; 2,001 to 3,000 pounds, $20; 3,001 to 4,000 pounds, $30; over 4,000 pounds, $40.	Same as pleasure cars	$2	do	$35 for one make and $25 each additional make.
Illinois[4]	$3	10 horsepower or less, $4.50; 11 to 25 horsepower, $6; 26 to 35 horsepower, $9; 36 to 50 horsepower, $16; over 50 horsepower, $20; electric cars of 2 tons capacity or less, $10; over 2 tons capacity, $20.	do	Original, $5; renewal, $3.	do	$10 for 2 plates and $10 for each pair duplicates.
Indiana	$2	Electric cars, $3; others, 25 horsepower or less, $5; 26 to 40 horsepower, $8; 41 to 50 horsepower, $15; over 50 horsepower, $20.	All commerical cars, $5	$2	do	$25; duplicate plates, $1 each.
Iowa	$3	20 horsepower or less, $8; over 20 horsepower, 40 cents per horsepower; all electric and steam cars, $15 each.	Same as pleasure cars	None	do	$15.
Kansas	$2	All cars, $5 each	do	do	do	$15 for 3 sets of tags; extra tags, 50 cents each.
Kentucky	$5	Less than 25 horsepower, $6; 25 to 50 horsepower, $11; 50 horsepower and over, $20.	½ ton or less, $11; 1 ton, $15; and increasing to $75 for 5 tons, and $50 per ton for each ton additional.	Original, $2; renewal, $1.	do	1 registration for each class at regular rates.
Louisiana	$2	25 cents per horsepower, with a minimum fee of $5 per car.	All motor trucks, $7.50 each.	None	do	1 regular registration for each make; second-hand dealers, $10.
Maine	$3	15 horsepower or less, $5; 16 to 35 horsepower, $10; over 35 horsepower, $15.	Commercial cars, $10	$2	$2	$25 for 5 pairs of plates; extra plates, 75 cents each.
Maryland	$5; with side car, $8.	60 cents per horsepower; minimum charge, $10; $1.20 per horsepower if operated for hire.	With solid tires to 3-ton capacity, $20 per ton; 4-ton, $100; 5-ton, $150; 6-ton, $300; 7-ton, $500; electrics, one-half of above rates; trailers to 1-ton capacity, $10; others, $20 per ton.	$3	$2	$25 for 2 sets of tags and $12 for each additional set. For dealers in motorcycles, 4 tags, $20; additional tags, $5 each.

[1] Cars used for transportation of passengers paying fare, 5 or less passenger capacity, $25; 6 to 9 passenger capacity, $40; 10 or more passenger capacity, $60; operating between towns or cities 10 miles or more apart, a flat fee of $40.
[2] In case of manufacturers, $25, plus $1 for each car tested on public roads.
[3] Any county or municipality may charge an additional license tax, not to exceed 50 per cent of State license tax, on motor vehicles used for hire.
[4] Both cars and trucks may be registered in municipality in which owner resides.

TABLE III.—Motor-vehicle registration and license fees in force January 1, 1919—Continued.

State.	Motorcycles.	Pleasure cars.	Motor trucks and commercial cars.	Chauffeurs.	Owner operators.	Dealers and manufacturers.
Massachusetts	$2	Under 20 horsepower, $5; 20 to 29 horsepower, $10; 30 to 39 horsepower, $15; 40 to 49 horsepower, $20; 50 horsepower and over, $25.	Trucks under 1 ton, $5, and $3 for each additional ton.	Original, $2; renewal $1; examination, $2.	Original, $2; renewal, $1;	$10, motorcycles; $25, motor vehicles, and $5 additional for each car over 5 operated on public roads.
Michigan	(1)	Electric cars, $1 for each motor horsepower plus 25 cents for each 100 pounds of weight; others, 25 cents per horsepower plus 25 cents for each 100 pounds of weight.	Electrics, 50 cents per motor horsepower plus 25 cents for each 100 pounds of weight; others, 15 cents per horsepower plus 15 cents per 100 pounds of weight.	$2	None	$50 for 5 cars and $10 for each additional car.[2]
Minnesota	$5	All cars, $5	Same as pleasure cars	Original, $1.50 renewal, $1.	do	$20; extra plates, $1 per set.
Mississippi	State, $2; county, $2.	State, $2; county, electric cars, $4.80; others, 24 cents per horsepower.	4,400 pounds capacity or less, $6.40; over 4,400 pounds, $12.80.	None	do	Regular rates for 4 sets of plates.
Missouri	(1)	Less than 12 horsepower, $4; 12 to 23 horsepower, $6; 24 to 35 horsepower, $10; 36 to 47 horsepower, $14; 48 to 59 horsepower, $16; 60 to 71 horsepower, $20; 72 horsepower and over, $24.	Same as pleasure cars	$1.50	None	$10; for each duplicate, $5.
Montana	$5	23 horsepower or less, $5; 24 to 50 horsepower, $10; over 50 horsepower, $15.	One-ton capacity or less, $5; over 1 ton and less than 2, $15; over 2 tons and less than 3, $25; over 3 tons, $40.	$2	do	Cars, $50; motorcycles, $15.
Nebraska	$2	All cars, $3 each	All $5 each	None	do	Registration for each class, $5.
Nevada	$3	20 horsepower or less, $3; 21 to 40 horsepower, $5.50; over 40 horsepower, $8.	Same as pleasure cars	do	do	$10 for 4 number plates; $1 for each duplicate.
New Hampshire	$2	15 horsepower or less, $10; 16 to 30 horsepower, $15; 31 to 40 horsepower, $20; 41 to 50 horsepower, $25; 51 to 60 horsepower, $30; over 60 horsepower, $40.	do	Original, $5; renewal, $1.	Original, $3; renewal, $1.	Cars, $50; motorcycles, $5.
New Jersey	$2	10 horsepower or less, $4.50; 11 to 29 horsepower, $7.50; 30 horsepower or over, $15.	With solid tires loaded weight ½ ton or less, $6, and $3 additional for each one-half ton gross weight to 2 tons; then $4 for each additional ton; trailers, $3.	$3	$3	$5 per car not to exceed 5.
New Mexico	$2	Less than 12 horsepower, $2; 12 to 19 horsepower, $4; 20 to 29 horsepower, $6; 30 to 39 horsepower, $8; 40 to 49 horsepower, $10; 50 horsepower or over, $12.	Same as pleasure cars	None	None	$12.
New York	$2.50	25 horsepower or less, $5; 26 to 34 horsepower, $10; 35 to 49 horsepower, $15; 50 horsepower and more, $25.	Gross loaded weight 2 tons or less, $10, and $5 each additional ton to 14; 14 tons, $70, and $10 each additional ton.	Original, $5; renewal, $2.	$1	$15, plus $5 for each duplicate set.
North Carolina[3]	$2	26 horsepower or less, $5; 26 to 40 horsepower, $7.50; over 40 horsepower, $10.	Same as pleasure cars	None	None	$10, plus $1 for each duplicate plate.
North Dakota	$3	20 horsepower or less, $6, and 50 cents additional for each horsepower above 20.	do	do	do	$15; extra plates, 50 cents per set.
Ohio	$2	Electric cars, $3; all others, $5	do	$3	do	$5 each make of motorcycle and $10 each make of automobile.
Oklahoma	(1)	50 cents per horsepower first year; second, 40 cents per horsepower; third, 30 cents per horsepower; and thereafter, 20 cents per horsepower.	do	None	do	$15 for 2 tags and $1 each for additional tags.
Oregon	$3	Electric cars, $6; others, 26 horsepower and less, $6; 27 to 36 horsepower, $10; 37 to 40 horsepower, $15; above 40 horsepower, $20.	Electric trucks, $10; others 1½ to 2 tons, $15, and $3 for each additional one-half ton up to 5 tons; over 5 tons allowed only on special permits.	$2	do	$10 for 2 tags and $2.50 for duplicate sets.
Pennsylvania	$3	Less than 20 horsepower, $5; 20 to 34 horsepower, $10; 35 to 49 horsepower, $15; 50 horsepower and above, $20.	With pneumatic tires, same as pleasure cars; others, including load, less than 2 tons, $5; 2 to 2½ tons, $10; 2½ to 5 tons, $15; 5 to 7½ tons, $20; 7½ to 12 tons, $25; trailers, including load, less than 5 tons, $3; 5 to 12 tons, $5.	$2	No fee	$10.
Rhode Island	$2	15 horsepower or less, $5; 16 to 30 horsepower, $10; 31 to 40 horsepower, $15; over 40 horsepower, $25.	Carrying capacity 1 ton or less, $7, with $3 additional for each ton to 4 tons, and then $4 for each ton above 4 tons; over 9-ton capacity, $40 each; trailers, $10 to $30 each.	$1	$1	$25 for 5 vehicles and $5 for each additional vehicle.
South Carolina	(1)	25 cents per horsepower	Same as pleasure cars	None	None	$15 for each make.
South Dakota	$2	All cars $3 each	No registration required	do	do	$5.
Tennessee	(1)	30 cents per horsepower	30 cents per horsepower plus $3 per ton carrying capacity.	do	do	$10.
Texas	$3	35 cents per horsepower	Same as pleasure cars, except when used for hire.	$3	do	$15; extra numbers, $5 each.
Utah	$3	Electric cars, $10; others 25 horsepower and less, $5; 26 to 40 horsepower, $10; above 40 horsepower, $15.	$10	$2	do	$25, and $2 for each set of duplicate plates.

[1] Same rate as pleasure cars.
[2] In case of manufacturers, motorcycles $20, including 10 number plates.
[3] Counties or municipalities may collect additional fees equal to one-half of State registration fee.

TABLE III.—Motor-vehicle registration and license fees in force January 1, 1919—Continued.

State.	Motorcycles.	Pleasure cars.	Motor trucks and commercial cars.	Chauffeurs.	Owner operators.	Dealers and manufacturers.
Vermont	(1)	First registration, $1 per horsepower; second, 75 cents per horsepower; third registration and thereafter, 50 cents per horsepower.	Same as pleasure cars	$3	$2	$50.
Virginia	(1)	40 cents per horsepower	do	$2.50	None	$50.
Washington	$2.50	25 horsepower and less, $5; 26 to 39 horsepower, $7.50; 40 horsepower and over, $10.	Automobiles and busses for hire, $1 per horsepower; motor trucks under one-half ton capacity, $5; 1 ton, $10; 2 tons, $15; 3 tons, $25; 4 tons, $35; 5 tons, $50; 6 tons, $100; 7 tons, $250.	None	do	Cars, $25: extra plates, $5 per pair; motorcycles, $3.
West Virginia	$5	Cars weighing 1 ton or less, $10, and 25 cents additional for each 100 pounds over 1 ton.	Same as pleasure cars	$3	do	Cars, $15 per set of plates; motorcycles, $5.
Wisconsin	$4	All cars $10 each	Capacity less than 2,100 pounds, $15; 2,100 to 5,100 pounds, $20; 5,100 pounds or more, $25.	(2)	do	$25 for 8 plates; extra plates, $1 each.
Wyoming	$2.50	All cars $5 each	Same as pleasure cars	None	do	$10 for 4 plates, $1 for each additional plate.

[1] Same rate as pleasure cars.

[2] Drivers of cars operating for hire may be licensed by municipality.

TABLE IV.—Administrative provisions in force January 1, 1919, affecting motor-vehicle registrations, licenses, and revenues.

State.	Registration and licenses.					Revenues from registrations and licenses.			Revenues from fines and penalties applied to roads.	Traffic regulations made by—
	Official or department in charge.	Renewals.		Requirements for operators' and chauffeurs' licenses.	Non-residents' exemptions.	Applied to—	Proportion expended for roads under supervision of—			
		Car registrations.	Operators' and chauffeurs' licenses.				State highway department.	Local road authorities.		
Alabama	State board of equalization through probate judge.	Annual, Oct. 1.	Chauffeur, annual, Oct. 1.	Chaueffeur must be 18 years old.	Reciprocity.	State, county, and city general funds.	None	None	None	Statute.
Arizona	Secretary of state	Annual, Jan. 1.	Chauffeur, perpetual.	No examination.	6 months	State road tax fund.	All of net	d	d	Statute and local ordinance.
Arkansas	Commissioner of state lands, highways, and improvements.	do	Chauffeur, annual from date.	Chauffeur must be 18 years old.	Reciprocity.	State and county road fund.	One-half	One-half	One-half of penalty for delinquency.	Do.
California	Superintendent of motor-vehicle department.	do	Chauffeur, annual. Jan. 1.	do	3 months	State and county road work.	One-half net.	One-half net.	All, by local community.	Do.
Colorado	Secretary of state.	do	Chauffeur, annual, Jan. 1.	No examination.	90 days	do	do	do	Same as registration revenues.	Do.
Connecticut	Commissioner of motor vehicles.	do	All operators, annual, Mar. 1.	Examination	No limit	Maintenance State roads.	All of net	None	do	Do.
Delaware	Secretary of state.	do	All operators, Jan. 1.	Must be 16 yrs. old; no examination.	Reciprocity.	State highway department.	All	do	None	Do.
District of Columbia.	Automobile board.	do	All operators, perpetual.	Examination	do	General fund	None	do	do	
Florida	State comptroller	do	Chauffeur, annual, Jan. 1.	Chauffeur, examination.	Reciprocity.	State highway department and State maintenance fund.	All of net	do	do	Do.
Georgia	Secretary of state.	Annual, Mar. 1.	Chauffeur, annual, Mar. 1.	Must be 16 years old.	30 days	Net to State road fund for apportionment to counties.	None	All of net	do	Do.
Idaho	State highway commission through county assessor.	Annual, Jan. 1.	Chauffeur, annual.	Chauffeur must be 18 years of age.	Reciprocity.	State highway fund.	25 per cent	75 per cent.	Same as registration revenues.	Do.
Illinois	Secretary of state.	do	Chauffeur, annual, Jan. 1.	Chauffeur, examination.	60 days	State "road fund."	All	None	All, by local community.	Do.
Indiana	do	do	do	do	do	Net, county road work.	None	All of net	Same as registration revenues.	Do.
Iowa	do	do	None	Must be 15 years of age.	Reciprocity.	State and local road work.	(1)	(1)	Local road work.	Do.
Kansas	Secretary of state through county treasurer.	Annual, July 1.	do	Must be 14 years of age.	30 days	Net, maintenance county and township roads.	None	All of net	None	Statute and city ordinance.
Kentucky	Commissioner of motor vehicles.	Annual, Jan. 1.	Chauffeur, annual, Jan. 1.	Chauffeur, examination.	Reciprocity.	Net to State road fund.	All of net	None	do	Statute and local ordinance.
Louisiana	Secretary of state.	do	None		do	Net to parish road work.	None	All of net	Same as registration revenues.	Local ordinance.

[1] Sufficient funds set aside to meet Federal aid, provide maintenance of highway department and expenses of registration; remainder to counties for road work.

TABLE IV.—Administrative provisions in force January 1, 1919, affecting motor-vehicle registrations, licenses, and revenues—Continued.

State.	Registration and licenses.					Revenues from registrations and licenses.				
	Official or department in charge.	Renewals.		Requirements for operators' and chauffeurs' licenses.	Nonresidents' exemptions.	Applied to	Proportion expended for roads under supervision of—		Revenues from fines and penalties applied to roads.	Traffic regulations made by—
		Car registrations.	Operators' and chauffeurs' licenses.				State highway department.	Local road authorities.		
Maine	Secretary of State	Annual, Jan. 1.	All operators, annual, Jan.	Examination optional.	30 days	State road work.	All	None	None	Statute and local ordinance.
Maryland	Commissioner of motor vehicles.	do	Owner, perpetual; chauffeur, annual.	do	Reciprocity; 3 months.	Net 20 per cent Baltimore street work; 80 per cent State road maintenance.	80 per cent of net.	do	Same as registration revenues.	Do.
Massachusetts	State highway commissioner.	do	All operators, annual from date.	Chauffeur, examination.	Reciprocity.	Net 20 per cent small town roads; 80 per cent maintenance State roads.	All net	do	do	Statute, State highway commission, and local ordinance.
Michigan	Secretary of state.	do	Chauffeur, annual, Jan. 1.	No examination.	Reciprocity to 90 days.	State and county road work.	One-half net.	One-half net.	None	Statute and local ordinance.
Minnesota	do	Triennial	do	Chauffeur, examination.	30 days	Net, State road and bridge fund.	All net	None	do	Do.
Mississippi	State auditor and county tax collector.	1918-1920, annual, Jan. 1.	None		60 days	State revenues to general fund; county to county road work.	None	Net county revenue.	Net, same as county revenue.	Local ordinance.
Missouri	Secretary of state.	Annual, Feb. 1.	Chauffeur, annual, Feb. 1.	Must be 18 years of age; no examination.	do	State road fund.	All of net.	None	None	Statutes and local ordinance.
Montana	do	Annual, Jan. 1.	Chauffeur, annual, Jan. 1.	No examination.	No limit.	Net to State and county road work.	One-half net.	One-half net.	do	Do.
Nebraska	Secretary of state through county treasurer.	Annual, Jan. 1.	None	Must be 16 years old.	30 days	Net to county road work.	None	All net	None	Statute and local ordinance.
Nevada	Secretary of state	do	do		do	Net to State road work.	All net	None	do	Do.
New Hampshire.	Commissioner of motor vehicles.	do	All operators, annual. Jan.	Examination, all operators.	20 days	Road maintenance.	do	do	Same as registration revenues.	Do.
New Jersey	do	do	do	do	Reciprocity; 15 days.	do	do	do	do	Statute and motor vehicle commission.
New Mexico	Secretary of state	do	None	Must be 14 years old.	60 days	Net State and county road work.	50 per cent net.	50 per cent net.	None	Statute and local ordinance.
New York	do	Annual, Feb. 1.	All operators, annual, Feb. 1.	Chauffeur, examination.	Reciprocity.	State and local road work.[1]	50 per cent gross.	50 per cent gross.	Maintenance of State roads.	Statute, State highway commission, and local ordinance.
North Carolina.	do	Annual, July 1.	None	Must be 16 years of age.	Reciprocity to 60 days.	Net to State road maintenance.	All net	None	None	Statute and local ordinance.
North Dakota.	do	Annual, Jan. 1.	do		No limit.	Net to State and county road work.	Two-thirds of net.	One-third of net.	do	Do.
Ohio	do	do	Chauffeur, annual, Jan. 1.	Chauffeur, examination.	do	Net to State road fund.	All net	None	do	Statute, State highway department, and local ordinance.
Oklahoma	Department of highways.	do	None		Reciprocity.	10 per cent appropriated for State highway department; 90 per cent county road work.	All		All	Statute and local ordinance.
Oregon	Secretary of state.	do	Chauffeur, annual, Jan. 1.	Must be 18 years of age; no examination.	30 days	Net to Federal-aid road work.	All net	None	County road fund.	Do.
Pennsylvania.	State highway department.	do	do	Affidavits as to competency.	Reciprocity.	State and State-aid road work.	All gross	do	Certain ones locally.	Do.
Rhode Island.	State board of public roads.	do	All operators, annual from date.	Examination, all operators.	Reciprocity 10 days.	Maintenance State roads.	All net	do	Same as registration revenues.	State board of public roads statute, and local ordinance.
South Carolina.	State highway engineer.	Annual, Jan. 1.			30 days	Maintenance highway department and county road work.	20 per cent	80 per cent	None	Statute and local ordinance.
South Dakota	Secretary of state through county treasurer.	do	All operators, annual from date.	Must be 15 years old.	Reciprocity.	85 per cent county road work.	None	85 per cent	do	Do.

[1] Does not apply to revenue collected within New York City, one-half of which goes to the city general fund.

TABLE IV.—Administrative provisions in force January 1, 1919, affecting motor-vehicle registrations, licenses, and revenues—Continued.

State.	Registration and licenses.					Revenues from registrations and licenses.				Traffic regulations made by—
	Official or department in charge.	Renewals.		Requirements for operators' and chauffeurs' licenses.	Nonresidents' exemptions.	Applied to—	Proportion expended for roads under supervision of—		Revenues from fines and penalties applied to roads.	
		Car registrations.	Operators' and chauffeurs' licenses.				State highway department.	Local road authorities.		
Tennessee	State department of highways through county clerk.	Annual, Jan. 1.	All operators, annual from date.	....	30 days	10 per cent to State highway department; 90 per cent to county road work.	All net	....	Same as registration revenues.	Statute and local ordinance.
Texas	State highway department through county tax collector.	...do	Chauffeur, annual, Jan. 1.	Must be 18 years of age.	90 days	Net to State and county highway funds.	50 per cent	50 per cent	County road work.	Do.
Utah	Secretary of state.	Annual, Mar. 1.	...do	No examination.	30 days	Motor vehicle registration fund.	All net[1]	None	None	Do.
Vermont	...do	Annual, Jan. 1.	All operators, annual, Jan. 1.	Examination, chauffeur.	Reciprocity.	State maintenance fund.	...do	...do	...do	Do.
Virginia	Secretary of commonwealth.	...do	Chauffeur, annual, Jan. 1.	No examination.	2 periods of 7 days each.	Net maintenance State aid roads.	...do	...do	...do	Do.
Washington	Secretary of state through county auditor.	Annual, Mar. 1	None	Operators must be 15 years of age, chauffeurs 21.	90 days	Net to permanent highway fund for maintenance.	None	All net	Same as registration revenues.	Do.
West Virginia	State road commission.	Annual, July 1.	Chauffeur, annual, July 1.	Must be 14 years of age.	Reciprocity.	State road fund	All	None	None	Do.
Wisconsin	Secretary of state.	Annual, Jan. 1.	None	Must be 16 years of age.[2]	Reciprocity.	Net to State highway fund and county road work.	75 per cent net.	25 per cent net.	...do	Do.
Wyoming	...do	...do	...do	Must be 15 years of age.	Reciprocity to 90 days.	80 per cent to county.	None	None	...do	Statute.

[1] To pay interest and sinking fund on $2,000,000 State road bond.

[2] Drivers of cars operating for hire may be licensed by municipalities.

ROAD AND BRIDGE BUILDING AND MAINTENANCE FOR 1919

In order to secure a basis for estimating the probable amount of road and bridge work which would be undertaken during the present season by the State highway departments and the local subdivisions, a questionnaire was sent by this bureau to each of the several State highway departments. Fairly complete replies have been received from 20 States. As these States are distributed fairly well over the entire area of the United States, it would seem that they would serve as a reasonable basis for estimating the probable road and bridge work which will be undertaken during the present season. These estimates indicate a total expenditure of $385,000,000 or $110,000,000 above the average expenditure of the years 1916 and 1917. The expenditures are classified as follows:

Work by or under State highway departments.

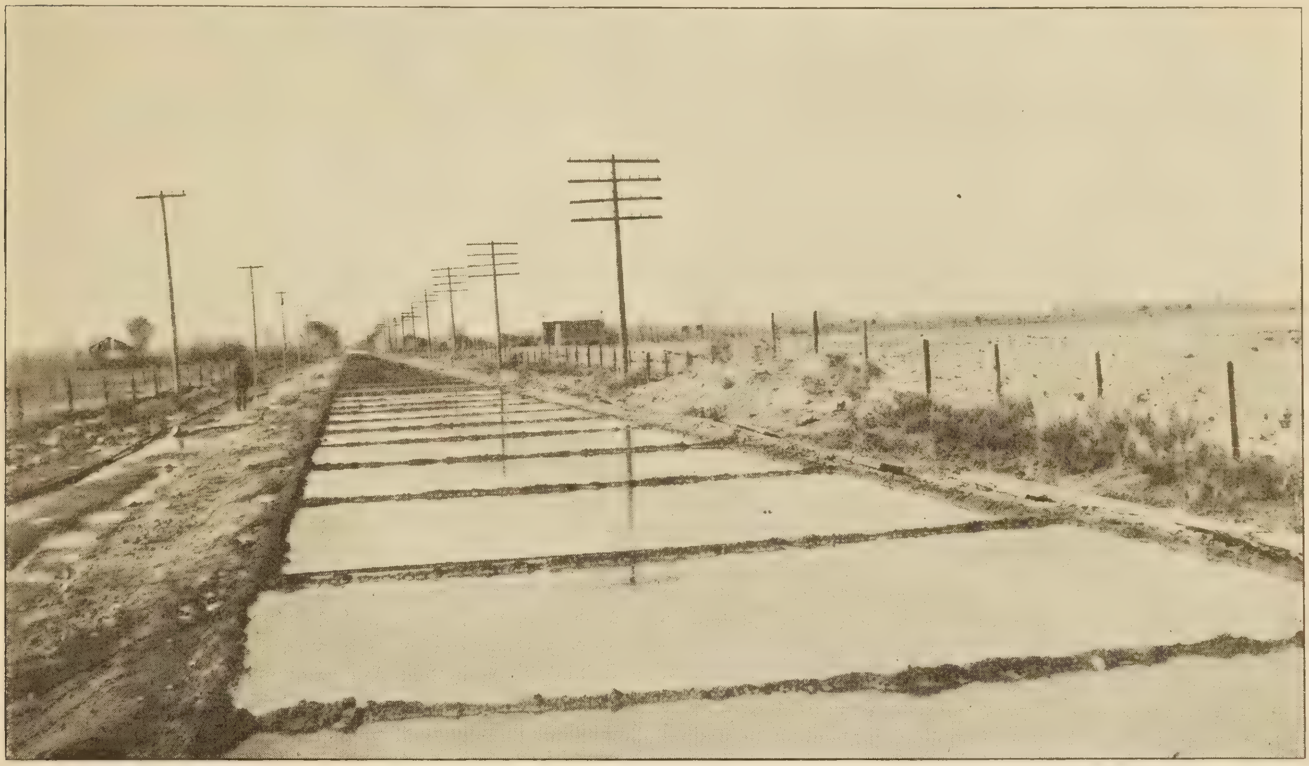
Construction under contract, 5,000 miles	$45,000,000
Construction ready for contract, 4,000 miles	30,000,000
Construction contemplated, 16,000 miles	100,000,000
Maintenance, 200,000 miles	60,000,000

Local road and bridge work by counties, townships, and districts.

Construction, 15,000 miles	$100,000,000
Maintenance, 100,000 miles	50,000,000

The most striking feature in this table is the great increase in the amount of funds under the control or supervision of the several State highway departments as compared with previous years. These funds in 1917 amounted to only $98,000,000 as compared with $235,000,000 for the present season. While a considerable portion of this increase is no doubt due to funds carried over from 1918, attention is called to the fact that these estimates do not include the additional Federal aid appropriations carried by the amendment to the Post-Office Appropriation Bill for the fiscal year 1920, which makes immediately available $50,000,000 of Federal funds and $75,000,000 which will become available July 1 of the present year. It appears, therefore, that the total amount of funds from all sources, Federal, State, and local subdivisions, which will be available for work during the present season will be, in round numbers, $500,000,000.

BUILDING AN ARIZONA PROJECT



PAVEMENT CHECKED AND PONDED FOR CURING.

The Bureau of Public Roads recently received from J. W. Johnson, acting district engineer, a very interesting and illuminating set of photographs, which are herewith reproduced, covering the steps in the construction of a concrete road on Arizona Federal aid project No. 2. This project extends from Phoenix to Temple, in Maricopa County. The photographs were taken by Clyde E. Learned, highway engineer of this bureau assigned to district No. 3, and to show the various stages of construction in order. They also show the modern methods employed and the machinery used. The road was constructed of river gravel, the character of which is very well shown. The subgrade was rolled and wet after being shaped by the road drag. In order to obtain a uniform wearing surface for the concrete road the subgrade was then scarified by the use of a harrow, after which it was wet down and rolled. The final trimming was done with a trimmer, and the surplus windrows were removed with shovels.

One of the interesting photographs is that showing the method of turning the trimmer on an improvised turntable. With the final preparation of the subgrade ready for the construction of the concrete pavement, is shown the method of depositing the materials for the concrete, with the concrete mixer in the distance mixing and laying concrete. There is a close view of a mixer of the bucket and boom type, which was used on this work. It is shown in operation, delivering and dumping a bucket full of concrete on the subgrade.

The concrete surface is prepared for finishing with a screed and the Macon roller and finisher, shown in operation, was used for finishing. A close view is shown of the resulting surface after rolling. On each crossing of the roller it was advanced 2 feet. Hand-floating was done by laborers along the sides after the operation of the roller and before belting. This view also shows the portion of the pavement which has been belted and that which has been rolled.

The finishing belt was then employed with the resulting surface. On the second passage of the belt the men put the final finish to the surface by short strokes. On the third passage the men held the back edge of the belt down and slid it along without any riding movement. A rather novel split float is shown. This was used at the joints to insure an even finish on both sides of the joints, and consequently a smooth pavement. The expansion joint is seen extending above the surface of the concrete road. The concrete road is shown in its various stages of finishing. The method of curing adopted was that of curing the pavement under water.

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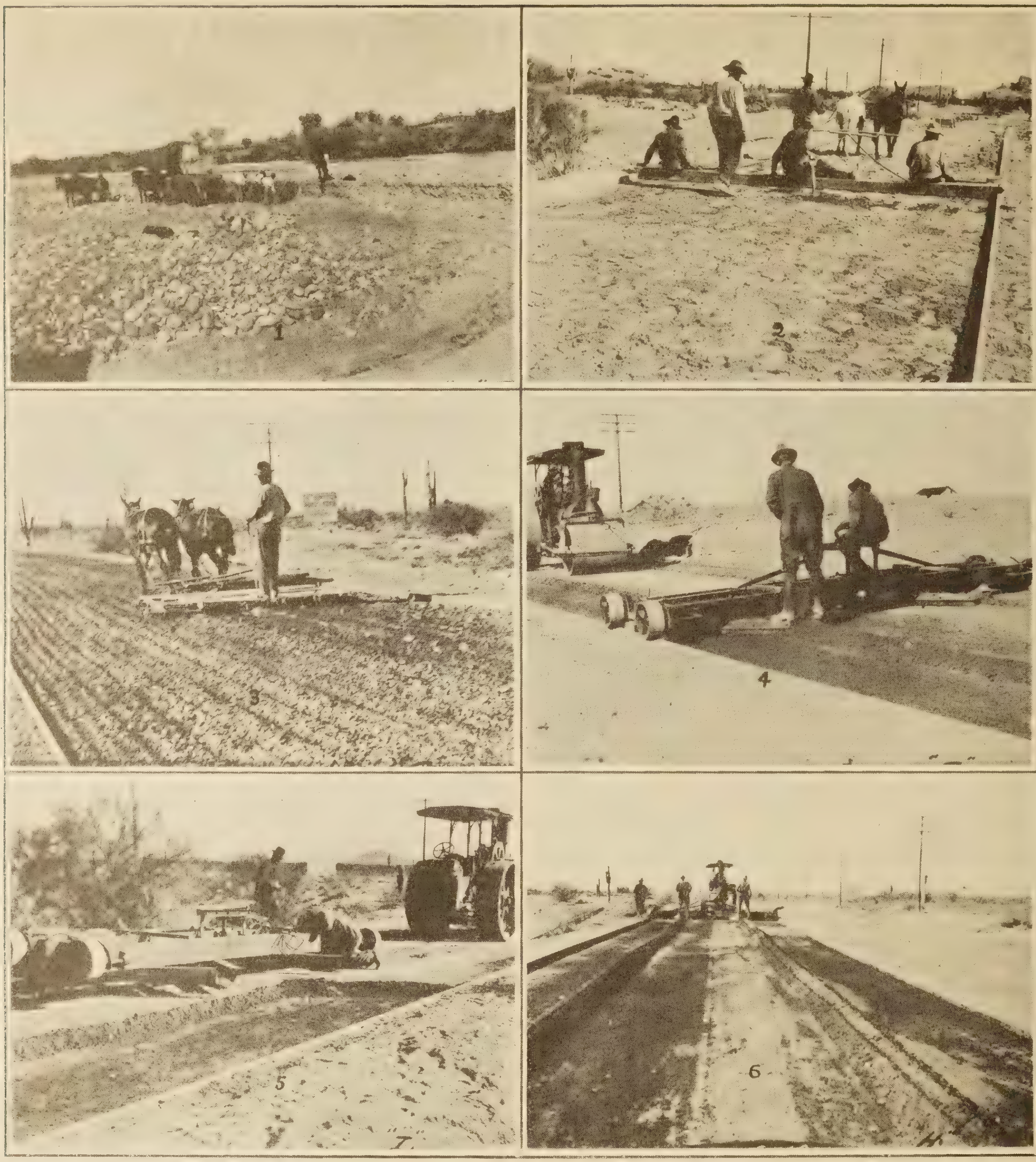


Steps in the Building of an Arizona Project.

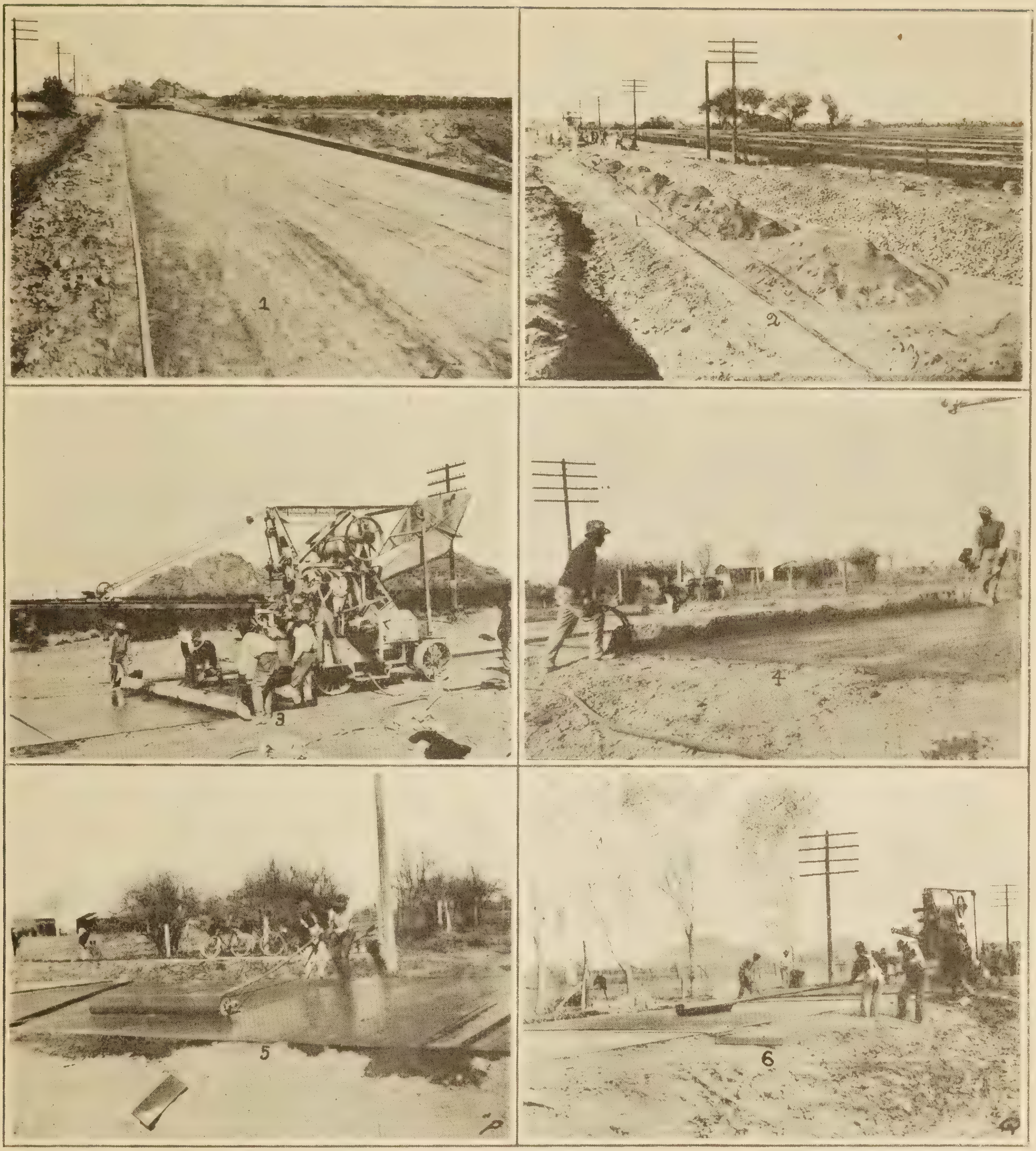
BPR. 16659, 16667, 16663, 16671, 16665, 16672.

(1) PIT IN BED OF SALT RIVER FROM WHICH GRAVEL WAS TAKEN. (2) USING LOG DRAG FOR SHAPING SUBGRADE BEFORE ROLLING AND WETTING DOWN. (3) HARROWING SUBGRADE. (4) USING SUBGRADE TRIMMER. (5) TURNING SUBGRADE TRIMMER ON TURNTABLE. (6) RESULTS OF SUBGRADE TRIMMER. WINDROWS LEFT TO BE REMOVED BY SHOVELERS.

Dams were formed along the sides of the concrete pavement and transversely out of material from the ditches and shoulders frequently enough to insure the complete covering of the surface with water. This method is adaptable to roads in comparatively flat country, but would be somewhat difficult on roads of heavy grade.

BETTER TYPE ROADS IN UTAH.

Utah's State highway department has planned to make use of the increased Federal aid allowance which will come to that State under the provision made in the last Post Office appropriation act by the construction of a higher type of road instead of an



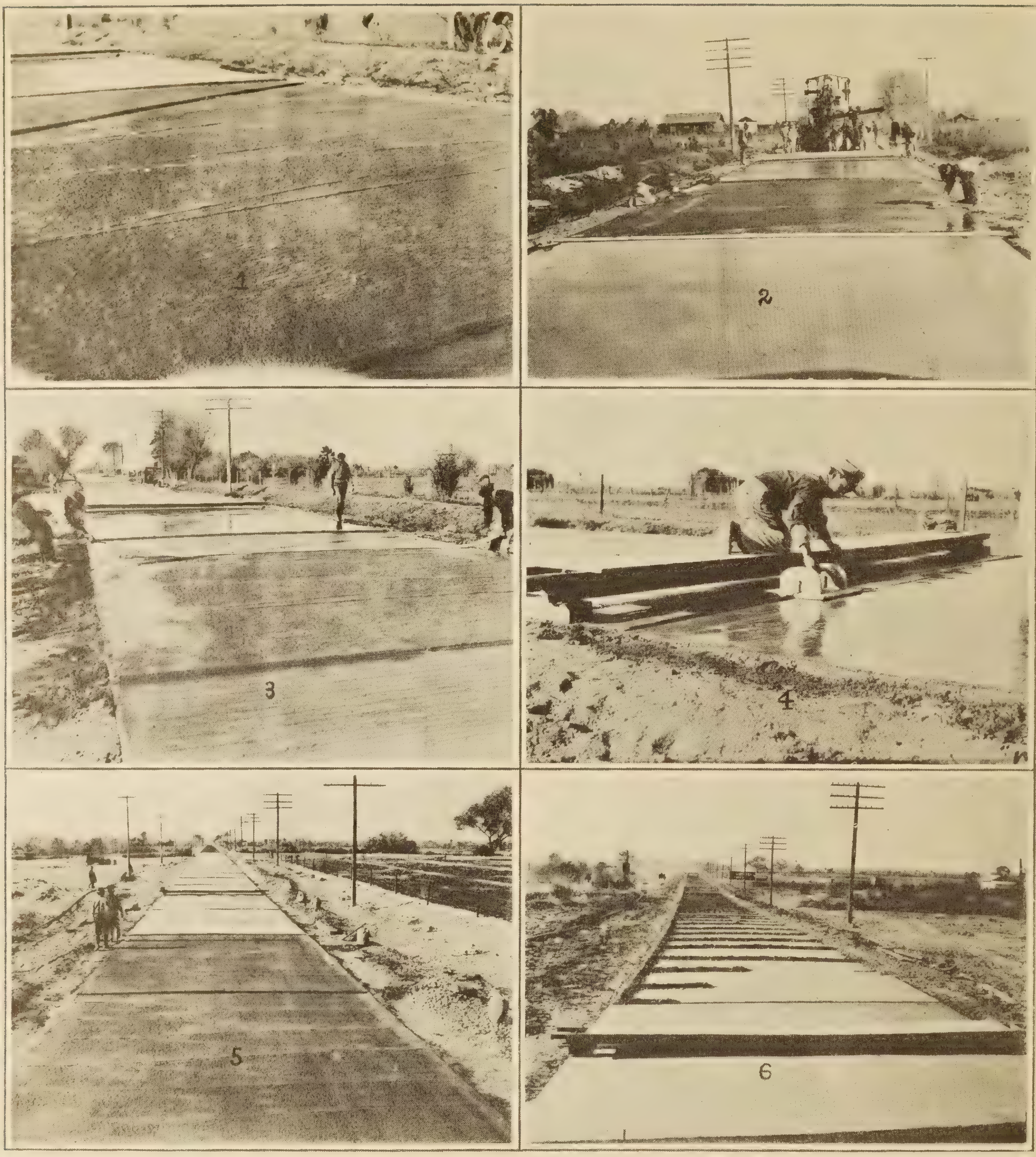
Steps in the Building of an Arizona Project.

BPR. 16669, 16670, 16668, 16674, 16661, 16655.

(1) THE FINISHED SUBGRADE. (2) WINDROWS OF MATERIAL ON SUBGRADE AHEAD OF MIXER. (3) SIDE CONCRETE MIXER SHOWING STRIKING OFF. (4) USING PLOW-HANDLE TYPE OF STRIKE BOARD. (5) USING ROLLER, EXCESS WATER BEING REMOVED IN FRONT. (6) ROLLING PAVEMENT.

increase in the number of projects. This will give not only more satisfactory roads but greatly cut down the cost of maintenance. Utah is to spend all her Federal aid allowance on the State highway system authorized by the legislature.

As originally established this system included 3,600 miles of road, which would cost the State about $1,400,000 annually for maintenance alone, if constructed of the lower type first planned. At the session of the legislature just ended an act was passed eliminating 1,200 miles from the State system and returning it to the counties as county roads to be maintained by the counties. The act provides for a tax levy by the counties for maintaining the roads.



Steps in the Building of an Arizona Project.

BPR. 16664, 16673, 16656, 16666, 16662, 16660.

(1) RESULTING SURFACE AFTER ROLLING. (2) HAND FLOATING ALONG SIDES AFTER ROLLING. (3) FIRST PASSAGE OF FINISHING BELT. (4) USING NEW TYPE OF HAND FLOAT AT JOINTS. (5) A DAY'S RUN; 530 FEET OF 18 FOOT PAVEMENT, WITH A 24-MAN GANG. (6) CHECKING OFF FOR CURING BY PONDING.

This leaves about 2,400 miles in the State highway system, to be improved by the joint use of State and Federal funds, and the increased amounts available will be used to construct the higher type road decided upon by the highway department. A tentative plan for the expenditure of the Federal aid funds available for the State, prepared by Commissioner Browning, shows the expenditure of $5,682,000 on 25 projects, having a total mileage of about 1,030. Half of the cost will be Federal aid.

The legislature at the recent session provided for the issuance of $4,000,000 of road bonds, so that ample funds will be available for the State's cooperation on Federal aid projects, both post and forest roads.

BUREAU OF PUBLIC ROADS IN THE WAR

AT THE time the United States entered the war there were on the rolls of the Bureau of Public Roads 189 male employees. Of this number, 81, or 43 per cent, had entered the military service when hostilities ceased in November. One female employee of the bureau entered the naval service as a landsman. Of the total number who entered the military service, 23, or 12 per cent, had returned to the bureau up to the close of February, 1919.

A list of those who entered the military or naval service from this bureau follows:

Name.	Position with bureau.
Alderman, E. S.[1]	Highway engineer.
Angwin, Henry R	Highway bridge engineer.
Ashby, Wallace	Barn architect.
Ayers, Quincy C.[2]	Junior drainage engineer.
Barrows, Harry H	Senior drainage engineer.
Bartel, Frank C.	Junior drainage engineer.
Barton, Wm., jr.[1]	Computer.
Baxter, Ora G	Senior drainage engineer.
Beebe, Lawrence L	Assistant mechanical engineer.
Bessee, C. F.	Civil engineer draftsman.
Booth, Walter B	Junior drainage engineer.
Boyd, George R	Senior drainage engineer.
Boyd, Joseph R.[1]	Laboratory assistant.
Brown, Robert A	Superintendent road construction.
Brown, William	Clerk.
Chambers, Jos. L	Junior drainage engineer.
Chapman, John H	Clerk.
Chilvere, C. H	Highway engineer.
Comfort, Willis E.[2]	Drainage engineer.
Diesem, Harry Custer	Irrigation engineer.
Dunn, Albert C.[1]	Highway engineer.
Eason, Frank G	Senior drainage engineer.
Fairbank, H. S.[1]	Senior highway engineer.
Franks, W. G	Accountant.
Gray, Bernard E.[1]	Engineer-economist.
Gregory, Wm. B	Irrigation engineer.
Harrison, Robert H	Highway engineer.
Harsch, Raymond [1]	Laboratory assistant.
Haswell, J. R	Senior drainage engineer.
Haynes, Carlos S.[1]	Architectural draftsman.
Helmick, Dan S.[2]	Junior drainage engineer.
Hooper, Arthur L	Junior highway engineer.
Hughes, Robert L	Chief of survey party.
Hutchins, Wells A	Assistant in irrigation economics.
Jeffrey, Wm. M	Junior highway engineer.
Jones, L. A.[1]	Drainage engineer.
Kidder, H. H.[1]	Assistant irrigation engineer.
Kirshmer, Chas	Drainage engineer.
Kohlmeier, I. G	Clerk.
Lane, Albert L	Junior drainage engineer.
Levin, Myer	Clerk.
Lewis, Richard H.[1]	Assistant chemist.
Logan, John W.[1]	Clerk.
Losh, A. R.[1]	Senior highway engineer.
Lucal, Ira D	Clerk.
Lynch, Wm. H.[1]	Senior highway engineer.
Lyons, F. Russell	Junior highway engineer.
McCalla, W. A	Senior highway engineer.
McCarthy, Thomas H	Assistant irrigation engineer.
Manville, Vasco	Clerk.
Menikheim, Irvin G	Do.
Miller, C. A	Draftsman.
Miller, Frank S	Clerk.
Moorefield, Chas. H	Senior highway engineer.
Moorehead, Philip S	Clerk.
Morris, C. C.[1]	Senior highway engineer.
Munger, Edna A	Clerk.
Nelson, Bert E.[1]	Do.
Osterhoudt, Percy J	Do.
Pauls, Jarl T.[1]	Highway engineer.
Pearson, Roderic [1]	Junior highway bridge engineer.
Petrée, H. E	Clerk.
Phillips, Clyde [1]	Do.
Powell, Orman N	Highway engineer.
Proudley, Charles Earl [1]	Laboratory assistant.
Rideout, Percy A.[2]	Junior highway engineer.
Rhodes, Wm. H	Senior highway engineer.
Rohwer, Carl	Assistant irrigation engineer.
Schuyler, J. T	Senior highway engineer.
Skeggs, John H	Do.
Sleight, Reuben B	Assistant irrigation engineer.
Sloan, William G	Drainage engineer (irrigated lands).
Smith, Guy L	Junior drainage engineer.
Stanley, Fred W.[1]	Senior irrigation engineer.
Stirton, James C	Instrument man.
Sweetner, Charles H	District engineer.
Tobin, James J	Engineer economist.
Toms, Raymond E	Senior highway engineer.
Waugh, Wm. H	Do.
Whittle, George D.[1]	Highway bridge engineer.
Woolf, Donald O.[1]	Laboratory assistant.

[1] Returned to the bureau prior to Feb. 28, 1919.
[2] Distinguished service cross.

The distinguished service cross was won by four men and an equal number made the supreme sacrifice. Thus the service flag of the bureau contains 77 blue and 4 gold stars.

Percy A. Rideout, who occupied the position of junior highway engineer with the bureau and who was appointed as a private and promoted to first lieutenant, was killed in action on the Verdun front, France, October 8, 1918. The distinguished-service cross was awarded to him posthumously.

H. E. Petree, who was a clerk in the bureau, went into the aircraft service as a private, was promoted to first lieutenant, and killed while making a flight back of the German lines on September 26, 1918. Official investigation discloses Lieut. Petree as one of the outstanding heroic figures of the war. French spectators of the air fight in which he met his death declare in affidavits that Petree alone engaged seven enemy scout planes back of their own lines. The investigating officer reports as follows:

> First Lieut. Harris E. Petree, pilot, One hundred and thirty-ninth Aero Squadron.—Killed September 26, 1918, near Delut (15 kilometers southeast of Longuyon), and buried in the village cemetery at Delut. Lieut. Petree, according to the village people, single-handed attacked seven German scout planes over their own field, which was near Delut and far inside the German lines. In the combat which lasted one hour, Lieut. Petree had many opportunities to escape, but he returned again and again to the attack until he finally was shot down. Lieut. Petree must have known the final outcome of the battle, but he refused to retreat. He chose to die fighting. He is the hero of the war to the village people of Delut and has made the name of an American the symbol of courage and fortitude among these simple French folk. Lieut. Petree's papers, watch, and 165 francs were taken by Kommandatur Nicolai, of Thuringia, Prussia. The German squadron was at Marville. M. Jules Vivier and his daughter, Madelaine Vivier, buried this aviator and promised to take care of his grave. We promised them that his parents would make fitting recompense.

According to Maj. Augstrom, commanding the One hundred and thirty-ninth Aero Squadron, recommendation will be made for the award of the distinguished-service cross posthumously.

Willis E. Comfort, who was employed in drainage investigations as a drainage engineer, was appointed as a lieutenant with the first expedition to be sent to France in 1917. Later he was promoted to captain and was killed in action near Soissons on July 18, 1918. The distinguished-service cross was awarded to him posthumously.

William Brown, who held the position as auditor in the district office at Portland, Oreg., was called for service in June, 1918, and died of an influenza attack at Camp Meade, Md., in October. He was a member of the 154th Depot Brigade and held the rank of private.

ROAD WORK.

Eighteen engineers were detailed by the Bureau to prepare plans and superintend the construction of roads in the 16 national army cantonments and one guard mobilization camp located as follows:

Camp Devens, Ayer, Mass.
Camp Upton, Yaphank, L. I.
Camp Dix, Wrightstown, N. J.
Camp Meade, Admiral, Md.
Camp Lee, Petersburg, Va.
Camp Jackson, Columbia, S. C.
Camp Gordon, Chamblee, Ga.
Camp Sherman, Chillicothe, Ohio.
Camp Taylor, Louisville, Ky.
Camp Custer, Battle Creek, Mich.
Camp Grant, Rockford, Ill.
Camp Pike, Little Rock, Ark.
Camp Dodge, Des Moines, Iowa.
Camp Funston, Fort Riley, Kans.
Camp Travis, San Antonio, Tex.
Camp Lewis, American Lake, Wash.
Camp McClellan, Anniston, Ala.

These men were assigned in July, 1917, and the period of their assignments varied from three months to a year or more. The total construction planned and supervised by these engineers aggregated several hundred miles and included practically all of the common types of construction from sand clay to first class bituminous surfaces and concrete roads.

In addition to this work other activities in road construction not heretofore separately mentioned were as follows:

Roads were planned and their construction supervised for the Marine Corps, at Quantico, Va., and for the Bureau of Ordnance at the Edgewood Arsenal, Gunpowder, Md.

Roads were planned and their construction supervised outside of cantonments, usually from the cantonment to a city in the vicinity at the following places:

Alexandria, Va., to Camp Humphreys.
Alexandria, La., to Camp Beauregard.
Little Rock, Ark., to Camp Pike.
Columbia, S. C., to Camp Jackson.
Spartanburg, S. C., to Camp Wadsworth.
Greenville, S. C., to Camp Sevier.
Petersburg, Va., to Camp Lee.
Anniston, Ala., to Camp McClellan.

Several of the above projects were carried out in cooperation between the Federal Government and the State highway departments under the Federal aid road act.

One engineer was loaned to the United States Housing Corporation as consulting engineer on roads and streets necessary in connection with housing developments. This assignment was made in July, 1918, and the engineer gave his entire time to the work until shortly after hostilities ceased.

One highway engineer was detailed to assist the Emergency Fleet Corporation in planning roads and streets in connection with shipyard developments. He gave his entire time to this work from March 5, 1918, until shortly after the cessation of hostilities.

MAP WORK.

Complete and detailed highway maps were made, utilizing as far as practicable topographic sheets of the United States Geological Survey, covering all of Maryland east of the meridian passing through Washington, all of the coast counties of New Jersey, and all of Florida south of Jacksonville. These maps were delivered to the Corps of Engineers. In addition to these detailed highway maps, the principal highways in a zone extending from Boston to Newport News, through New York and Washington, were plotted on topographic sheets for the use of the Geological Survey in the preparation of aeroplane maps. Detailed route maps were prepared covering the Army truck route from Detroit to Baltimore, this work being done in cooperation with the United States Geological Survey and the Corps of Engineers.

DEVICE FOR TESTING EXPLOSIVES.

At the request of the Frankford Arsenal, Philadelphia, this bureau worked on a device for testing the power of explosives with the idea of obtaining an autographic record of the force and speed of the explosive.

PAGE IMPACT MACHINE.

Our large Page impact machine was borrowed by the American University for research work in connection with high explosives. At the present time impact machines of the type employed by this bureau are now being used in practically all of the arsenals throughout the country in their routine investigations of explosive materials.

COOPERATION WITH THE U. S. SHIPPING BOARD.

In cooperation with the concrete ship department of the Shipping Board, the testing laboratory of this bureau was requested to make several series of tests in order to obtain desired information looking to the safer design of reinforced concrete ships. The tests are described as follows:

Bond tests.—In view of the uncertainty of the protection of the steel by the concrete against the action of salt water, tests were made with bars protected with various kinds of paint coatings and metal coatings to determine (*a*) the protection offered by these coatings against corrosion, and (*b*) the effect of the coatings on the bond strength. Some 24 coatings were tested, involving about 250 specimens.

Shear tests.—In the design of a concrete ship the shear stresses are very high, and in order to use as little steel and concrete as possible it was necessary to use a very much higher unit stress in shear than in ordinary reinforced concrete construction. As no test results were available to indicate what would be a safe unit stress to use with the exceedingly rich mixture of concrete, it was necessary to make a number of beam tests to determine this point. A series of tests made at this bureau involved 12 beams in span length from about 5 feet to 10 feet. The materials were supplied by the Shipping Board.

Pouring tests.—Because of the extremely thin walls containing a large percentage of reinforcing steel, it was necessary to determine how best to pour the concrete so that it would entirely surround the steel and form smooth surfaces and yet be of dry enough consistency to produce the densest possible concrete. A specimen resembling the shell of a concrete vessel was made up and concrete was poured into the form and the form rapidly vibrated by hammering the sides. The forms were later stripped off and the specimen observed. The first method of pouring was a complete success and no further experiments were necessary.

Concrete bulkhead specimens.—Assistance was given to the Bureau of Standards in the pouring of a large reinforced concrete specimen designed to resemble a concrete bulkhead for use in producing water-tight compartments in steel vessels. This specimen was 18 feet high and 6 feet wide. During the pouring, measurements were taken of the pressure exerted by the concrete against the forms, using the soil pressure cells designed in this bureau.

Pressure of concrete against forces.—This series of tests was started in order to determine the pressures exerted by concrete poured so as to fill the forms at different rates. This information is useful in facilitating the economical design of the wooden forms.

Bonding of new concrete to old concrete.—There are many places in reinforced concrete ships where the concrete can not be poured continuously, but where it is necessary to join the old concrete to the newly poured concrete with as strong a bond as possible. A number of different methods for obtaining a strong bond were investigated.

Manufacture of strain gauges.—In connection with tests made for the Shipping Board at other laboratories, it was necessary to have instruments that would register exceedingly minute changes in length. At the request of the Shipping Board, this Bureau made three such test instruments after designs furnished by the Shipping Board. The Invar steel for the sides of these instruments was furnished by the Shipping Board, as were also the Amos dials. These instruments are proving very satisfactory.

UNITED STATES HIGHWAYS COUNCIL.

Origin and organization.—In the last week in May, 1918, the Secretary of Agriculture wrote to the Secretary of War, the Director General of Railroads, the Fuel Administrator, and the chairman of the War Industries Board, suggesting that each designate a representative to serve jointly with a representative of the Department of Agriculture in the handling of street and highway problems during the period of the war. In response to the Secretary's suggestions, representatives were designated to serve for the War Department, the Railroad Administration, the Fuel Administration, and the War Industries Board. Later, upon the ggestion of the council the Director General of the nited States Employment Service named a representative of that organization to serve with the council.

The members met on June 8 and organized as the United Highways Council. It was decided at that meeting to take over the cooperative arrangements which were already in operation between the Office of Public Roads and the Capital Issues Committee relating to highway bond issues, and between the Office of Public Roads and the Fuel Administration regarding the distribution of road oils, asphalts, and tars.

Purpose and policy of the council.—The purpose and policy of the council were set forth in an announcement issued by the council June 20, explaining the functions of all Government agencies so far as they related to streets and highways, so as to eliminate delays, financial loss, and uncertainty incident to the handling of street and highway questions with each Government agency in turn. The policy of the council was more fully set forth in Bulletin No. 1, dated August 5, which urged the restriction of street and highway work to the most essential needs and outlined the character of the work the council would be disposed to recognize favorably. This bulletin was followed by Bulletin No. 2, dated August 27, explaining the policy of procedure as to petroleum, asphalt, and tar products for highway work; and by Bulletin No. 3, dated September 23, dealing with highway bridges. Letters were sent from time to time to the State highway departments further explaining policy.

Procedure of the council.—It was provided at the outset that application for approval of highway and street work should be submitted through the respective State highway departments to the council on a prescribed form, known as "H. C. 3," and that approval of the council should be by minute and the issuance of formal notice of approval by the secretary of the council. To expedite the handling of individual applications a subcommittee was formed to meet daily for the purpose of taking initial action on applications, which initial action was later subject to confirmation either by the council in full meeting or by the member of the council not present at the subcommittee meeting whose department was directly concerned. Two representatives of the Office of Public Roads also served as a subcommittee, passing upon applications for approval of bituminous materials for highway maintenance. Permits were issued by the Fuel Administration to carry out the findings of the council as to oils, asphalts, and tars for highway purposes, and the War Industries Board issued Circular 21, dated September 3, in which it was set forth that highway projects approved by the United States Highways Council needed no further license, permit, or priority. The Railroad Administration, by Car Service Circular No. 13, dated

May 24, just prior to the actual formation of the council, recognized the recommendations of the representatives of the Government agencies holding membership on the council in the granting of cars for the transportation of highway materials. Thus was established the coordination of the various agencies concerned. The cooperation of the United States Employment Service brought to the council effective cooperation in connection with the important element of labor.

Work performed.—From the first meeting, June 8, to the last, December 31, 1918, the full council held 27 meetings and the subcommittee 112. These meetings were in addition to the service rendered by the subcommittee of the Office of Public Roads.

Applications for approval, including those which had been submitted to the Office of Public Roads prior to the establishment of the council, reached a total of 7,307. Many of these were considered several times by reason of requests for reconsideration, or of requirements by the council for further information, so that the total number under consideration aggregated 9,712. No statement as to the exact number of approvals or disapprovals can be given, as many cases were merely deferred and not disapproved, others were conditionally approved or disapproved, others were reconsidered, and still others were affected by an amendment issued September 26 by the War Industries Board to Circular 21, permitting the completion to November 1 of projects substantially under way. Still other projects were pending at the time the council ceased its activities, and in consequence it is impossible to segregate those applications which might be considered as definitely disapproved. A quantitative table dealing with the materials, transportation, and funds involved and showing such proportion as had been definitely approved has been prepared, however, and is submitted, as follows:

TABLE I.

Item.	Unit.	Requested.	Approved
Capital issued [1]	Dollars	$49,538,075	$7,334,821
Road oil	Gallons	68,280,401	44,269,826
Tar	do	56,608,832	53,533,441
Asphalt	Tons	190,207	159,475
Cement	Barrels	5,657,390	2,139,769
Brick	Thousands	109,125	52,239
Steel:			
Structural	Pounds	10,663,250	694,820
Reinforcing	do	22,281,275	3,231,301
Crushed stone	Tons	3,639,819	1,827,795
Gravel	do	1,204,552	432,707
Sand and screenings	do	2,216,481	982,479
Slag	do	520,152	250,428
Corrugated iron culverts	Linear feet	107,815	23,704
Piling timber	do	154,102	43,588
Pipe:			
Vitrified drain	do	2,165,419	99,699
Cast-iron drain	do	47,052	43,740
Lumber	Feet (B. M.)	5,530,196	1,651,635
Granite blocks	Blocks	1,420,500	156,500
Miscellaneous	Tons	123,206	49,513
Cars:			
Open top	Cars	55,059	26,361
Box	do	8,543	3,376
Flat	do	3,705	605

[1] Includes applications acted on by Bureau of Public Roads prior to formal organization of United States Highways Council, requested $28,748,084, approved $3,114,381. The Capital Issues Committee has jurisdiction and the council served merely as an aid to the committee.

The approval of the council obtained for highway purposes the equivalent of 99,000,000 gallons of road oils and tars and 159,475 tons of asphalts at a time when serious doubt existed as to whether any substantial amount of bituminous material could be made available for street and highway purposes. In other words, critics of the council might bear in mind not so much the negative action of the council as its constructive help to highways in securing a vast amount of material which might otherwise have been difficult to obtain. It is further worthy of comment that in the matter of railroad cars no action by the council restricted in the slightest degree the opportunities of shippers to obtain cars from local railroad companies. The requests, therefore, that came to the council for cars were for constructive aid rather than for approval. Through the activities of the council more than 30,000 cars were obtained for highway purposes. This number constitutes a distinct net gain to highway needs over and above the supply which the local railroads were able to furnish of their own accord.

The restriction of highway work undoubtedly served to provide for the most worthy projects such materials as were available and to bring about on the parts of the States, cities, and counties a much more thorough sifting of the various projects comprised in this form of public improvement than would otherwise have been possible. Had the war continued this conservative and selective consideration would have become more and more useful and necessary, even though it might have been desirable to change the method in which the work of the council was conducted.

Cost of activities.—On account of the facilities made available by the office of public roads the active work of the council was largely conducted and most of the quarters, personnel, and equipment furnished by that office. A summary of the cost of the handling of the applications received is shown in the following table:

TABLE II.

(Number of applications, 7,307.)

Feature.	Cost.	Cost per application.
Registry and entry	$1,220.87	$0.17
Records of action	1,095.39	.15
Correspondence and supervision	2,284.30	.31
Permits and advice	2,265.36	.31
Executive	2,363.20	.32
Administration	1,084.53	.15
	10,333.65	1.41

Records and papers, all applications, correspondence, statistical records, announcements issued, and forms used have been arranged in orderly manner and are fully segregated on the record of the Bureau of Public Roads. These papers will be kept a reasonable length of time for such disposition as may be ordered by the personnel of the council, or by the Secretary of Agriculture.

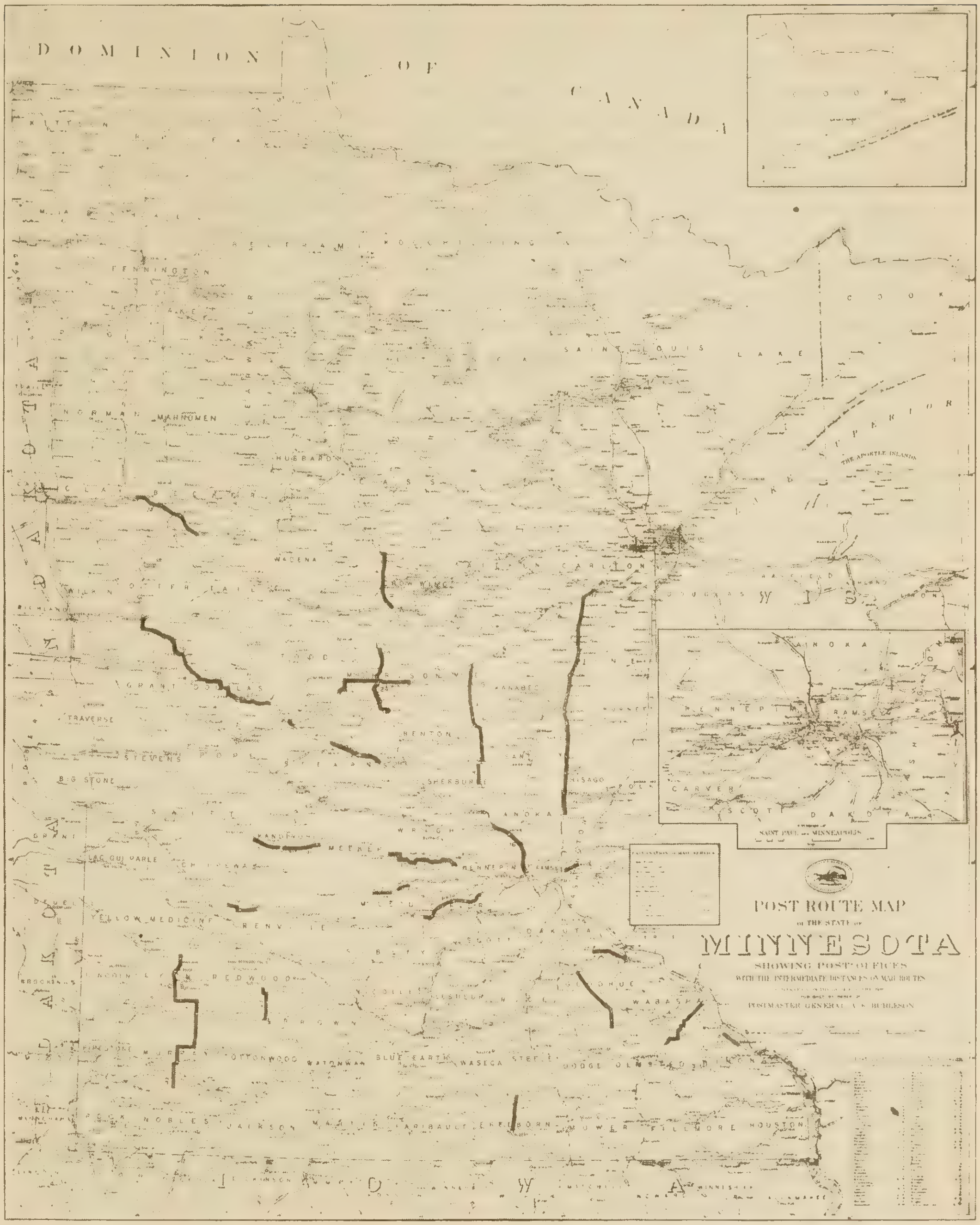
COOPERATION BY STATE HIGHWAY DEPARTMENTS.

The patriotic and thorough cooperation extended to the council by the respective State highway departments served to render the activities of the council effective throughout the entire Nation with remarkable promptness and completeness. The State highway departments lost no time in communicating with the various counties and municipalities and in making the policy of the council thoroughly understood. The State highway departments passed conscientiously upon the various applications submitted to them and for the most part disapproved at the outset those projects which had no justification under war conditions.

FEDERAL AID STATE MAPS

One of the most interesting, as well as one of the most valuable records which the Bureau of Public Roads possesses is its series of large State maps, on which Federal aid projects are entered as they are approved. The accompanying map of Minnesota shows the general scheme used, except that on the maps themselves the routes are colored yellow when the project statement is approved, which color is changed to red when the plans are approved, and this in turn to black when the project is completed.

The maps are always available for reference and are invaluable as a means of showing the relation between the projects in each State. Indeed, one of the facts which these maps already reveal, is that Federal aid is developing systematically and that what have, at times, seemed to be hopelessly isolated sections of road are in fact important links in well thought-out highway systems.



TYPICAL FEDERAL AID STATE MAP SHOWING GENERAL SCHEME AND TENDENCY TO MAKE THE PROJECTS IMPORTANT LINKS IN COMPLETE HIGHWAY SYSTEMS.

PENNSYLVANIA SEES END OF MUD AGE

By WM. C. SPROUL, Governor of Pennsylvania.

LAST fall I covered many miles of road in northern Cambria County in an automobile. The trip was a delightful one. The dirt roads were in splendid condition; but as we whirled along the highway I though of conditions when winter came, and in my mind glimpsed the sodden ribbon of mud that must come with the rain and snow—a mud ribbon that would throttle trade, prevent neighborly intercourse, and cause tremendous monetary loss. I seemed to see mired automobiles, teams of tired horses steaming from the effort to get to market loads of produce woefully small because of road conditions, and as the Cambria County people with me in the automobile pointed out the glories of the countryside I could not help but wonder how long it would be before Pennsylvania awoke to the fact that its poor roads are a brake on the wheels of progress.

A short while afterwards came the November election, and the people of Pennsylvania gave a majority of 262,000 votes to the proposition to bond the Commonwealth for $50,000,000 for road purposes. I knew then that we in Pennsylvania were nearing the end of the mud age. Since that time we have completed our plans for Pennsylvania's system of primary highways—planned to give the State a network of north-south and east-west thoroughfares which will connect every county and, meeting the highways of other commonwealths at our boundaries, place Pennsylvania in communication with a multitude of markets and sources of supply.

USE ROADS WHILE PAYING FOR THEM.

In the work of permanentizing Pennsylvania's highways we are being joined by a large number of counties. We have been promised many millions of dollars to be used in conjunction with our funds on State-aid highways, while the majority of counties in the State are also preparing to spend their own money on the construction of necessary laterals or crossroads, connecting our primary highways. The administration is particularly pleased with the willingness of county commissioners to cooperate in highway construction. And we are pleased that the people themselves look at the proposition in such a broadgauged manner and are urging their county authorities not only to spend all available money possible for better roads, but to borrow money for construction.

It seems to me that the theory that we should have the use of our improved roads while paying for them is a proper one. We buy our homes and occupy them while paying for them. We borrow money for the purpose of extending our business. We bond the State to pay for roads the use of which we have while paying the bills. A county bonds itself for road purposes, and the construction of better highways increases property values and lessens production costs.

But it is important to remember that borrowing money with which to build roads which will have disappeared or are useless before the borrowed money has been repaid is an economic fallacy. When we buy home we expect—we know—that the house with proper care will be practically as good as ever when we have finished paying for it. Under the construction method planned by the Commonwealth the life of the roads will be much longer than the life of the bonds issued to pay the bills. It is important that construction by counties be of the same durable nature. Taxpayers are never averse to spending money when they know that| the return is 100 cents for every dollar expended.

BAD ROADS A LIABILITY.

During the next four years the Commonwealth of Pennsylvania will spend approximately $100,000,000 for better roads, and we are going to have $100,000,000 worth of roads. Not only that, we are going to continue to have that $100,000,000 worth of roads for years after we have paid the bills, which is, after all, the most important thing to remember.

Pennsylvania must not stop with that initial expenditure. It must continue to construct permanent highways until every hamlet and every farm is either on an improved highway or within a very short distance of one. There are 10,235 miles of road in the State's highway system—the system of roads controlled by the Commonwealth. There are approximately 90,000 miles of roads of all sorts in Pennsylvania. The State is bearing the entire cost of constructing the primary system. It asks that each county expend on secondary routes the money that it would have spent on primary routes had not the State shouldered the burden.

The State of Pennsylvania has innumerable assets, and it has one liability which we hope soon to wipe from the slate—bad roads.

HIGHWAY ENGINEERING COURSE.

The regents of the University of Nebraska have been asked to institute courses of instruction in highway engineering in conjunction with the course in civil engineering. It is argued that road building in the State is just now beginning and will continue for many years, and there will be a big demand for men trained especially for this line of work.

USE OF CALCIUM CHLORIDE AS DUST PREVENTIVE FOR GRAVEL ROADS

By W. LEROY ULRICH, Superintendent Repairs, Connecticut State Highway Commission.

CALCIUM chloride, used as a dust preventative on gravel roads passing through sparsely settled sections, has proven to be a very satisfactory treatment. The results obtained with several types of gravel roads under various climatic and traffic conditions, while differing considerably, have in each case justified its use.

This material is a deliquescent salt which may be purchased in solution, in a granular form, or as a solid. It is most economical to purchase granular chloride. In this condition it may be applied dry, which is very advantageous in sections where water must be pumped to make a solution of proper strength.

This material is put up in metal drums, holding about 350 pounds per drum, and costs at the present time between $20 and $30 per ton at the point of shipment. The price varies with the amount purchased. The drums will be painted by the shippers without extra charge if requested. If this is done, material may be stored for future use in any reasonably dry place. If it is not done, the drums, being very light-gauge material, quickly rust out, exposing the chloride to the air, from which it immediately attracts moisture and solidifies, in which form it is very expensive to handle. If properly sealed and handled, when the drum is opened it will roll out in the form of kernels about the size and appearance of popcorn. When spread upon the surface of the road it attracts and holds moisture, melting down and sinking into the surface, leaving it damp exactly as if it had been lightly watered.

In order that this application may be most successful, the surface of the road to which the material is applied must be such that it will of its own nature assist the chloride in retaining the water attracted by it. For this reason any road which has previously been treated with oil, even of the lightest consistency, should not be treated with chloride.

The surface of graded and gravel roads, as generally constructed, conform almost perfectly to the requirements of this material. Specifications for these types usually require the addition of a certain per cent of clay or earth binder whenever the native material is dry and sandy. Graded roads are usually constructed in locations which do not warrant the use of a dust layer. Chloride may be used on macadam roads, but such treatments are not generally successful unless the traffic is too light to warrant the expense of bituminous covering or where local conditions make the use of such bituminous covering objectionable, as in the case of some park drives. The most practical application for this material is upon the surface of gravel roads.

DRAG ROAD BEFORE TREATMENT.

In order to obtain the best results the surface of the road to be treated should be kept in shape by the use of a drag for about two weeks previous to the application of the material. This will insure proper cross section and a reasonably smooth surface for receiving the material. The application may be made by laborers spreading with shovels, but this is not satisfactory on long sections, as it is too slow and expensive. A uniform distribution can not be obtained by this method. Any ordinary lime sower will spread the chloride, but it is economical to purchase the most practical machine for this purpose. This is one which has a double set of agitators and an adjustable opening to regulate the amount delivered. These machines may be purchased in different widths for use with a single horse or a pair.

In making application with the use of horses the drums are distributed along the road at regular intervals, one at a point if a narrow machine is used, and two if the wider. The necessary interval is determined by the amount of material to be applied. About 1½ pounds per square yard is necessary for the first application, which should be followed by a second treatment at 1 pound per square yard. The interval between applications depends upon the quality and condition of the surface on which the material is spread and the character and volume of the traffic carried. Under moderate traffic a good surface would not require more than two applications per year; under heavy traffic three may be necessary. The best results are obtained if the material is spread on the road after a rain, when it is wet, as a better penetration is obtained at this time.

METHOD OF DISTRIBUTION.

In making an application with a two-horse machine with a spread of 10 feet, two drums are distributed every 220 feet. This machine will hold the contents of two drums and after filling is run up one side and down the other and then up the middle of the road, stopping at the point where the next two drums have been placed. This applies a little less than 1 pound per square yard on each edge of the road and nearly 2 pounds on the center 10 feet. This method has proven more satisfactory than making an even distribution over the entire surface. The same method may be followed with the one-horse machine.

In order to eliminate the necessity for the distribution of the drums, the machine may be hauled behind and fed directly from an automobile truck. Eighteen drums may be carried on a 3-ton truck, which, running continuously in one direction, will cover one width for about 6,200 feet. Three trips will complete the treatment of this length of road. This has proven a little more economical than distributing the drums and spreading with horses.

During the handling of the material, all workmen should wear rubber boots, as the chemical action of the chloride is very detrimental to leather. It is also well to provide cotton gloves, otherwise the hands will soon become sore. The hoofs and hocks of the horses, which are working on the distributor, should be cleaned and greased night and morning. After the chloride is melted on to the surface of the road, it will not cause injury to horses or to automobile tires.

SMOOTH AND DUSTLESS ROAD.

Proper application of calcium chloride results in a smooth and practically dustless surface, making a road with almost ideal riding qualities. While not considered as a binder this treatment does toughen the surface, making it less liable to ravel. One of the greatest advantages of roads treated in this manner is the ease with which the resulting surface may be maintained. All that is required is a light dragging at intervals in order to keep the surface smooth. On account of the moisture held in the surface this may be done whenever necessary without waiting for a rain.

The surface of most gravel roads softens up in the spring when the frost is leaving the ground and the calcium treatment does not overcome this condition. The results in Connecticut show that the treated roads do not mud up any more than untreated roads of the same quality and not as much as roads of this quality which have been treated with a nonasphaltic oil. The continued use of chloride has an accumulative effect. After two or three years, with two applications per year, the effect of the material is plainly noticeable in the spring, after the road has settled.

The cost of application of the material varies according to labor and local rates for teams and trucks. During the year of 1918, with labor at approximately \$2.75, teams at \$7.50, 3-ton trucks at \$25, the cost of this treatment in Connecticut per square yard per year (two applications) has been \$0.031, divided as follows: Chloride \$0.026, handling and application \$0.005.

WORK ON OHIO PROJECT NO. 1 RUSHED TO MOVE ARMY TRUCKS

IN August, 1917, the State highway department of Ohio submitted to the Federal Government a project (No. 1) statement for the improvement of the portion of the National Pike located between Zanesville and New Concord, in Muskingum County. The National Pike is one of the historic roads of the county, being the direct road between Cincinnati, Columbus, and Washington. In the early days it was used for communication and transportation between Washington and the West.

The national highway has been improved and modernized, although a great many of the old masonry structures remain and are in comparatively good shape. On account of its importance as a direct route for trucks between Detroit, Cleveland, Columbus, Cincinnati, and other points west, to Washington, it has been kept in very good shape, with the exception of a few stretches. One of these unimproved sections was this section presented by the State of Ohio as a Federal project under the Federal aid act.

It was proposed at the time the project was submitted to proceed with the work in the regular fashion, letting the work to contract after duly advertising for bids. Early in 1918, however, the Federal Government advocated the early completion of this contract in order to facilitate the movement of Army trucks and other war munitions east. The matter was taken up with Gov. Cox, of Ohio, and through the State highway department, with the approval of the Secretary of Agriculture, a contract was let on a cost-plus basis with a time limit, and a bonus for completion under this time limit, and a penalty for failure to complete within the time limit.

The length of the project was 13.63 miles, and the estimated cost nearly \$500,000, on which the Federal Government agreed to pay \$136,300 as its share of the cost. This Federal aid was the maximum amount allowed under the law at that time, namely, \$10,000 per mile. The type of construction finally selected was a brick with a mastic filler on a sandstone rolled foundation. The contract was dated the 22d day of March, 1918. Work was started about the 1st of May, 1918, and practically completed about the latter part of October. It may be said that the entire 14 miles were completed in approximately six months. The cost was undoubtedly more than it would have been by the usual form of contract, but it was considered that the time gained was well worth the difference.

USE OF SAND CLAY FROM SALT FLATS IN SURFACING TEXAS ROADS

By RICHARD H. PHILLIPS, County Engineer Aransas County, Tex.

THE MATERIAL heretofore used for road surfacing in Aransas County, Tex, has generally been oyster shells in varying forms and condition. At some points heavy shell were used, followed with coating of finer shell mixed with sand. At other points the final coating was partially disintegrated oyster shell, while at others the final coating consisted of small fine shell (other than oyster shell), obtained from banks thrown up on the beach.

The best surfacing, locally obtainable, has been what is known as mud shell from reefs out in Aransas Bay. This mud shell—that is, the particular mixture suitable for surfacing, consists of shell from one-fourth inch up to full sized oyster shells. The voids in this shell are filled with mud sand. This is very fine silica sand, the grains of which are coated with silt, which acts as a binder, and when the mixture is solidified under traffic a very firm road bed results. This silt, coming from the salt water of the bay, holds the moisture and adds to the binding quality of the mixture.

In times of very low water these mud shell reefs can be reached with wagons by building up a temporary road from mainland, but this renders the supply uncertain. Resort was had to barges, the material being shoveled onto the barges at the reefs, and thence into wagons after the barges had been towed to the mainland. However, the demand has not been sufficient to provide steady employment for those equipped to deliver either by barge or wagon; hence it has been difficult to obtain deliveries when needed.

This condition led to a trial of material from salt flats adjacent to the roads, its composition being about the same as that part of the "mudshell" which filled the voids of the coarser material.

SAND CLAY IN THE SALT FLATS.

The deposits of sand clay in salt flats vary in composition, but for use in road making enough silt or earthy matter must be present to form a film or coating to the grains of fine sand, so that when drained of excess moisture and compacted under traffic it will form a uniform wearing surface. It develops that this material is primarily a mixture of Epsom salts and gypsum, with some impurities.

The writer has not had at hand the means for making minute tests or analyses of this material, but the following has been noted:

The deposits drawn from are located in what are known as salt flats, distant anywhere from 100 to 3,000 feet from low water at the bay shore.

Some seasons these flats are covered four to six months of each year with salt water, but most of them from which road material is obtained are covered for only two to three and one-half months of each year.

In the spring when these flats are becoming dry the salt crystallizing on the weeds and lowest points becomes quite noticeable.

Local rains cover the lowest points with water and tend to dilute the salt content, but the surface of these flats soon becomes dry through evaporation.

In some deposits the earthy content is a black silt, some dark brown, and other deposits are of a light yellowish brown. While designated as sand clay from salt flats, the sand, as can be gathered from the above description, largely predominates.

There is an excess of moisture in most deposits, which generally drains out while being hauled to the road, leaving the mass in a suitable condition for spreading. This material, evenly spread, readily compacts under traffic. Any depressions that appear are filled with shovels or by use of a blade machine or a three-blade drag.

When properly surfaced the top of the road is somewhat like a sheet asphalt surface in dry weather.

It becomes slippery in wet weather, and for that reason the crown should be made slight (not to exceed ½ inch to 1 foot). If the proper attention is paid to maintenance and repair a slope of ¼ inch to 1 foot will be sufficient.

WIDE SURFACING NECESSARY.

The roads on which sand clay has been used were surfaced in varying widths, 10, 12, 14 feet and a small amount of 16 feet, none of which were wide enough.

Vehicles, in passing, even on 16-foot widths generally have their outside wheels off the improved surface, especially where the crown is steep. In such cases the wheels, in getting back on to crowned surface, break through the edges. This being frequently repeated, soon renders the entire road unfit for heavy hauling and makes exceedingly rough going for auto traffic, either light or heavy.

To obviate this condition all roads in Aransas County designated as State highways and on which sand clay surfacing is to be used are laid out 24 feet wide with shoulders not less than 2 feet wide to be solidly rolled to same slope as the sand clay surfacing. This makes a clear width of 28 feet between curbs of bridges and culverts.

With this width of traveled roadway the wear of the surface is comparatively uniform and more easily maintained in good condition.

The data covering the use of sand clay in Aransas County can be somewhat summarized as follows:

(*a*) Width of original surfacing varied from 10 to 16 feet.

(*b*) Thickness of original surfacing varied from 3 to 6 inches.

(*c*) Foundation for surfacing: Some places used old traveled way (sandy loam), at other points graded with slips or fresnos and dragged without rolling, at other points the surfacing material dumped on the swamp or prairie grass after the side ditches had drained the roadbed, the grass in the latter case providing a better foundation than where the roadway was newly graded.

(*d*) The material was dumped without being evenly spread with the result that ruts and humps were numerous; some stretches were surfaced with material with scarcely any clay or salt content. Such stretches rapidly approached the condition that exists where deep loose sand is encountered.

LAYOUT OF IMPROVED ROADS.

The roadway for improved highways recently planned, especially that section of State highway No. 12 (Jefferson Davis Memorial Highway) between Aransas Pass and Rockport, has been laid out as follows:

1. Width of surfacing 24 feet, shoulders not less than 2 feet between culverts, curbs 12 feet.

2. Slope of crown ½ inch to to 1 foot.

3. The old traveled road is not disturbed and where possible the additional width of subgrade is brought up to the level of that of the old road. It is found that the moist sand clay will form a close bond to even the most solidly compacted surface; hence, when the new surface material has been used on undisturbed portions of the old road, the latter is found to provide a foundation of the very best.

4. Generally, the new surfacing is to be not less than 6 inches thick, but at some points where there is already an unbroken thickness of sand clay only enough is added to bring the top to uniform grade.

5. In some sections there are a few stations where the grade of old road has to be brought up to established grade with material from the side.

6. Surfacing material consists of selected sand clay from salt flats adjacent to the road, the haul varying from ¼ to 2 miles.

7. In some deposits there is from 1 to 6 inches clear sand on top. Generally there is sufficient clay present to admit of the use of 1 inch or more of the clear sand top, but in no case is any material allowed that will not properly compact under traffic or road roller when excess moisture is drained out.

THE COST OF SURFACING.

8. The cost of this surfacing has varied from 25 cents to 42½ cents per cubic yard for first ¼-mile haul, including loading and unloading, and from 5 cents to 7½ cents per cubic yard for each additional ¼-mile haul.

The spreading costs from 5 cents to 25 cents. The range in prices is due partly to care with which material was selected, the manner in which it was spread, and also the time when the work was done.

Shipyard construction and other building activities in vicinity of Rockport and Aransas Pass has tended to raise the price of both labor and teams, so that the maximum figures mentioned just about cover the cost at this date. Labor costs—that is, common labor—25 cents to 35 cents per hour and teams 55 cents to 75 cents per hour.

9. Material has generally been loaded into wagons by shoveling, but at a number of points the conditions are favorable to use of the Maney four-wheeled scraper.

10. The salt content in well-selected sand clay from salt flats prevents the surface from becoming unduly dry during the hottest seasons, and overnight sufficient moisture is absorbed to enable one to quickly distinguish roadway surfaced with this material from other portions surfaced with material from which the salt content is absent.

11. Annual wear is estimated at about three-sixteenths inch, which is approximately 73.33 cubic yards per mile. Add to this amount, say, 50 cubic yards per mile for filling depressions that develop under traffic and figuring the material at 75 cents per cubic yard applied, the maintenance cost for surfacing will run to about $100 per mile annually.

12. When a county is able to provide the equipment, a motor truck of about 2½ yards capacity provided with a bed having four doors operated separately by the driver and a special type of three-blade drag will prove to be an economical method of keeping the roadway surface in first-class condition. In addition to this, use a suitable drag or road machine promptly after rains to shape up the shoulders and ditches. An 8-ton roller will be a valuable addition to be used for compacting the shoulders and such portions of the roadway as may need attention from time to time.

13. The sand clay surfacing is somewhat slippery in wet weather, but it should be noted that the most unsatisfactory condition obtains where the surface has been allowed to become filled with ruts and humps, and the latter along with a slope already excessive present a slope as great as 1 to 2 inches to the foot. If proper maintenance of the surface is observed and no greater slope than one-half inch to the foot is allowed it will be found that but little sliding will occur on a roadway 24 feet wide, such a width being sufficient for autos to pass at usual speed without having to swerve out of direct line.

TREATING SLIPPERY SECTIONS.

14. Sections which under traffic develop a slippery surface in wet weather will be benefited by using about 50 cubic yards of fine shell (either

partially disintegrated oyster shell of size $\frac{1}{32}$ to 1 inch or fine shell other than oyster) spread evenly over the surface or use an equal amount of dry sand free from earthy matter.

15. It should be particularly noted that the life and easy maintenance of a roadway surfaced with sand clay from salt flats are predicated largely on one condition, and that is the treated width should never be less than what is required for vehicles to pass without one or both having to get off the treated surface.

Observation of the condition of various widths and with different treatments will show that the lack of width is the cause of rapid deterioration, but particularly true of sand clay roads. The wheels, in turning out, cut the edges and in returning grind off the edges still more and the raveling started spreads quickly to the surface farther in, with the result that any attempt to keep the narrow roadway in reasonably good condition takes more time and material than a roadway of proper width.

16. The surface treatment of shell or sand clay roads with either light road oil or heavy bitumen is not favored in this locality, and in no case has proven a success as far as the writer has been able to learn; that is, where the surface exposed to wear is composed of sand or shell bound with bitumen. Such treatment exhibits effect from abrasion as great as untreated sand clay from salt flats and it is more expensive to maintain than an equally uniform surface free from pockets that wear rapidly when once started to ravel.

17. The best bituminous-treated surface tried in this vicinity for dry shell road consists of a priming coat of about 0.3 gallon refined coal tar (about 1.15 specific gravity), followed with a coat of about 0.45 gallon refined coal tar (about 1.25 specific gravity), both coats applied hot.

The second coat to be followed with a layer of trap rock of size five-eighths inch down with two-thirds of the fines screened out, the amount of trap rock to be from 60 to 70 pounds per square yard. Occasional spots of bleeding to be blotted with clean dry sand, but in general the coating of trap rock should be sufficient to prevent the tar from being picked up by wheels in traffic.

18. The same kind of bituminous trap-rock treatment can be given the sand clay surface after a coating of fine dry shell free from earthy matter has been spread and ground into the sand clay surface by traffic. The sand clay surface without the dry shell will not allow sufficient bond of the bituminous trap-rock treatment.

GEORGIA TO USE FEDERAL AID FOR BUILDING PAVED ROADS.

SEVENTY per cent of the Federal-aid funds allotted by the Georgia State Highway Commission will be spent in the construction of paved roads, nearly all of which are to be concrete. That is the feature of action taken by the commission on March 20.

The highway commission sent notices to all the counties in the State that $1,320,000 of Federal-aid funds would be allotted to counties which were financially prepared to meet the necessary requirements and to begin work promptly. The result was that representatives were present at the meeting of the commission to present claims for allotments. One county asked for $2,000,000, another for $1,000,000, and practically all for sums in excess of the amount received.

In making the allotments the commission rejected a number of applications because counties making them had not yet begun work or had not made satisfactory progress on projects under previous allotments. Others were refused because counties proposed to raise the funds for meeting their obligations by bond issues and there was doubt as to the issue being authorized.

The allotments were distributed to 32 counties and ranged from $6,000 up to $200,000. The largest were $200,000 each to Bibb and Chatham Counties and $100,000 to Colquitt County. All allotments were made conditionally. Each county was to have its project statement prepared and financial arrangements completed within 10 days. Engineers were assigned for the various projects, with instructions to begin at once the preparation of project statements.

BIG PENNSYLVANIA PROGRAM.

The present legislature of Pennsylvania has appropriated over $14,000,000 for the highway department. Of this amount $5,000,000 are for permanent highway construction, $800,000 for repair of State highways within boroughs, $400,000 for maintenance of State-aid highways, $300,000 for the State's share of construction of State-aid highways, $500,000 for turnpike condemnations, $1,142,049 for second-class township road bonus, and $3,626,000 for the administration of the highway department. Another law was passed reorganizing the highway department, centralizing the authority so as to meet present demands.

USE OF LABOR-SAVING DEVICES IN CONCRETE ROAD CONSTRUCTION

By L. I. HEWES, General Inspector, Bureau of Public Roads.

AT A RECENT meeting of the Washington State Association of County Engineers in Spokane, I suggested that the study of labor-saving devices in the construction of concrete roads would be a fruitful subject for investigation and report. An analysis of the operations involved show that they consist of the following:

1. Collection and storage of materials.
2. Measuring and mixing of materials.
3. Depositing and manipulation of the concrete mass.
4. Curing of the concrete in place.

Assuming a standard design, to economize labor in the above operations without overburdening the cost by interest and depreciation on machinery remains the main object. A brief analysis of the customary operations show that current methods involve considerable theoretical waste. It is common, for example, to elevate material several times before it is finally in place: 1. It is raised by a derrick from cars on the side track and deposited in a storage pile. 2. It is raised from the storage pile to a storage bin. 3. It is raised in the delivery truck and shot into the mixer skip. 4. It is raised in the mixer skip and dumped into the mixer.

Any combination of these operations that would eliminate one or more motions would theoretically decrease the cost. A study of the four main operations is suggested by the following:

COLLECTION AND STORAGE OF MATERIALS.

The collection and storage of materials tends to be on an increasing scale as operations demonstrate the economy of longer jobs. Limitations on the length of a job appears to be (*a*) financial, (*b*) seasonal, (*c*) organization of construction operations. The financial limitation could certainly be overcome by more intelligent administration which could concentrate funds allotted for several years or borrowing money by bond issues to make funds available. The season limitations in the length of jobs must be overcome by the early execution of plans and contracts and by the use of larger machine units or a larger number of smaller machine units. The organization of operations tends to greater speed, but offers much opportunity for betterment.

It is reasonable to assume, therefore, that an analysis of a possible method for handling larger jobs is pertinent. For such larger-scale operations material will doubtless be delivered by freight at railroad sidings. The use of a derrick and bucket to unload cars into bins or storage piles has already come. Recently measuring bins have been added to the storage bins, and motor trucks with batch compartments have been used to transport the partially mixed sand and aggregate to the portable mixer at the point of placement. This chain of operations has eliminated the services of a number of shovelers at the cars and the mixers; but is not a further combination of the process possible?

MEASURING AND MIXING.

In the processes of collection and storage outlined above the measuring of the sand and aggregate has occurred in the measuring bin and is preserved in the compartment motor truck. A discussion of the relative cost of an increasing size of the measuring bin or an added number of measuring and storage bins, as against the cost of a second elevation from the storage piles to such bins, is open for investigation. It may be assumed, however, that the economy of the measuring bin in itself is undisputed. Is it not possible, then, to use the potential energy of the sand and aggregate in the measuring bin to combine and mix them when passing from the bin to the motor truck or conveyor to the job? The mixing of dry aggregate and sand, or of the complete list of concrete ingredients, is now based somewhat on the principle of the mixing bowl in the kitchen. Essentially, however, mixing of different ingredients requires their dispersion in order that they may recombine in a homogeneous distribution. Possibly a combination chute for sand and aggregate passing from the bin to the truck could be designed for simultaneous dispersion and recombination of these materials.

DISTRIBUTION AND HANDLING OF CONCRETE MASS.

The transportation by motor truck, or otherwise, of the sand and gravel to the mixer is really a part of the operation of depositing the concrete. While the truck-haul method is doubtless superior to piling sand and aggregate along the subgrade and the use of shovels and wheelbarrows, it is not yet perfect, for it is necessary (*a*) that the truck more or less damage the completed subgrade, (*b*) that the motor truck turn around and back up to the mixer to deposit the sand and aggregate in the skip. The damage to the subgrade is particularly severe in the turning and the loss of time correspondingly great. The actual mixing time while the batch is in the mixer is but a fraction of the interval between the arrival of the truck load of mixed sand and aggregate and the depositing of the wet concrete on the subgrade. The progress of the work is largely limited by the speed with which the material arrives.

If wooden header planks, "ribbons" or side forms for the concrete road were replaced by suitable channel irons such irons could probably be used as rails and material brought to the point of placement by a self-propelled truck running on this broad-gauge track. Already machines spanning the width of the paved way have been used in so-called monolithic brick construction at Paris, Ill., and on the Wayne County, Mich., roads for tamping and smoothing concrete. It might be possible to go a step farther in the construction operations on concrete roads and (*a*) either mix the concrete in stationary plants or by semiportable plants at a limited number of positions and dump into a swiftly traveling carriage running on the side channel rails to the point of placement; or (*b*) to introduce the dry ingredients of the concrete properly mixed into a modified carriage and to perform the necessary mixing and addition of water in the combined mixer and carriage while in transit to the point of placement from the measuring bins.

Both methods offer objections to be considered. Concrete must not be "killed" in transit and under method (*b*) it would be necessary to operate heavier rolling units on the channel rails and they would require careful foundation to preserve the grade. There is apparently no reason why such broad gauge channel rails could not successfully be constructed with the necessary switches, turnouts, and loops connecting the road to be constructed with the railroad sidings or sources of material, but ample play for wheel flanges would be required on the sharper curves of highways. The possibility of increased speed with a number of such rolling units combined with the use of approved striking, tamping, and smoothing machines deserves consideration.

CURING OF THE CONCRETE IN PLACE.

Additional speed in handling the curing process of concrete roads may be secured by mounting the canvas protection on rolling frames at any desirable height above the surface of the road. Such an arrangement is particularly desirable to protect new work from sudden rain and may be designed with an outer flange wheel. The necessary water supply for curing the concrete must be planned with great care. The system of flooding the surface in "checks" is to be preferred wherever the prevailing grades will permit its use.

PINS RECORD PROGRESS OF FEDERAL AID PROJECTS.

To control a large organization its chief must have before him at all times a visual record of the status of the work which his organization is doing. This is not so much for the purpose of directing individual undertakings as it is for the purpose of detecting and regulating general tendencies. Having this in mind a large map of the United States has been hung in one of the principal offices of the Bureau of Public Roads, and in this map a pin has been stuck for each Federal aid project. When the project statement is received a white pin is placed on the route of the project. When the plans are received this pin is taken out and a yellow pin put in. When construction starts a red pin replaces the yellow one. If work is too long delayed a blue ring is hung on the red pin. Other designations represent other stages of the project.

These pins have heads about a quarter of an inch in diameter, and on these heads numbers have been drawn in black. These numbers correspond to the numbers of the projects which the pins represent, so that if more information in regard to any project is desired, it can be readily obtained by calling for the files on this project.

Those who are dealing with these projects become very familiar with the location and the status of every project which has been unusual in any respect, or which, for any reason, has been delayed or has caused trouble, and a glance at the board each morning serves to show whether, during the preceding day, there has been any change in the status of such projects. However, the board is more useful still as a means of gaining a view of the status of the work of the bureau over the country as a whole. A little study of this board shows which States and which districts are pushing their work, in what regions the work is dragging, where the program of highway improvement is State wide, and where it seems to be sectional. These and many related matters stand out very clearly on this board, and the information gathered in a study of the board is constantly made use of in determining what, if any, special effort may be desirable to adjust the tendencies which are observed.

THE MASTER RECORD OF FEDERAL AID

EVERY large institution finds that there is a constant demand for carefully tabulated, accurate, and complete information as to the nature, the cost, and the progress of the work which it handles. This demand has led to the designing of a new master record covering the administration of Federal aid by the Bureau of Public Roads, which record is of more than ordinary interest, both because of its purpose and of the manner in which the information carried is to be made available to those who desire to use it.

The purpose of the record is to have at hand a tabulation which is at all times complete—that is, a tabulation which can be referred to with full confidence that all of the information in hand has been recorded. To that end, the data needed for this record is entered as soon as it is received at the bureau. In fact it is planned that as soon as the system becomes established, all information will be entered before the close of the day during which it is received. This will make it possible to furnish accurate and comprehensive information as to the status of Federal aid, as of any day, with full confidence that the information is beyond question.

CARRIES EXTENSIVE RECORDS.

The master record naturally carries the information which is most necessary for the administration of Federal aid by the bureau itself, but, in its design, the fact that the bureau is constantly called upon for miscellaneous information as to the rate at which Federal aid is being allotted, the kind of roads which are being built with Federal aid, the kind of bridges which are being constructed, not to mention minor miscellaneous information, has led to the inclusion of rather extensive records on types of construction, and such related data as experience has indicated may be of general interest.

The master record is kept by States. This is the natural division for many reasons, but the all important reason for this division is that a record so subdivided is of as much value to the States as it is to the Bureau of Public Roads, and its installation in its present form is largely due to a desire to place at the disposal of Congressmen, State officials, and legislators and others who may have proper use for this information, comprehensive records of the Federal Aid activities within their jurisdictions.

MAKES DATA AVAILABLE TO ALL.

The accompanying cut shows a sheet from the master record, from which the nature of the data recorded can be readily determined. At first glance there may seem to be some duplication, but it has been found by actual experience that, for instance, there frequently are differences between the type of construction and the estimated cost as proposed in the project statement and as submitted in the plans and the detail estimate. Other seeming duplications are for the purpose of revealing other changes which are likely to develop as the project is advanced and concerning which full and complete data is often of great value.

To make all of this data available to interested officials or to others who may have proper use for it, the master sheets have been made up on a semi-transparent white paper, and all entries are made in India ink. This has been done so that blue-print copies of a sheet or of any part of a sheet can be readily prepared, it being the purpose to supply blue prints of these sheets to inquirers instead of making typewritten copies.

SOUTH'S LARGEST PROJECT PLANNED IN NORTH CAROLINA.

The State highway engineer of North Carolina has just reported the prospect of the immediate development of what seems likely to prove the largest road project in the South. For the present, the work to be undertaken is confined to Wake County, where a permanent type pavement is to be built from the Johnston County line to the Durham County line, a distance of approximately 27 miles. The surfacing will be 18 feet wide, of the most modern design, and is expected to cost somewhat more than $600,000. The route selected is that of the central highway, the most important highway in the State.

Durham County, Orange County, and Alamance County are also considering a change in the Federal-aid projects which have already been approved within their boundaries, their intention being to modify these projects so that hard surfaces shall be used wherever sand-clay surfaces were originally contemplated. The approved projects will also be extended to cover any gaps between the county boundaries.

Guilford County is also contemplating such changes in its program as may be necessary in order to connect Greensboro with the Alamance County line. If this is done, as it now appears likely that it will be, North Carolina will have a hard-surfaced highway extending from the Johnston County line below Raleigh to Greensboro, a distance of nearly 100 miles.

This notable improvement is made possible by a recent change in the North Carolina laws by which the county pays one-fourth of the cost of improvements of this kind, the State one-fourth, and the balance is met from Federal aid.

Projects of this nature show the far-sighted view taken by the State and county officials, and are to be commended as indicative of thorough appreciation of the value of through highways, connecting the State's principal centers of population, business, and agriculture.

APPORTIONMENT FOR F.Y.		TOTAL
1917 —	82,689	
1918 —	165,378.20	248,067.30
1919 —	250,018.47	498,085.77
1920 —	336,091.81	834,177.58
1921 —		

FEDERAL AID POST ROAD PROJECTS

STATE - - ARK.

			PROJECT STATEMENTS SUBMITTED								PROJECT STATEMENTS APPROVED				PLANS, SPECIFICATIONS AND ESTIMATES										PROJECT AGREEMENTS				
PROJ. NO.	COUNTY	LOCAL NAME OF ROAD	TYPE OF CONSTRUCTION	REC'D D.E.	REC'D CH. ENG.	FOR'D	TOTAL EST. COST	FED. AID REQUESTED	LENGTH MI.	COST PER MILE	APP'D BY SECY	TOTAL EST. COST	FED. AID REQUESTED	LENGTH	TYPE OF CONSTRUCTION	STRUCTURES OVER 20 FT. NO.	STRUCTURES OVER 20 FT. COST	REC'D D.E.	REC'D CH. ENG.	REC'D FOR APPR'L	TOTAL EST. COST	FED. AID REQUESTED	LENGTH	COST PER MILE	EXEC'D SECT.	TOTAL EST. COST	FED. AID ALLOTTED	LENGTH	REF. NO.
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	BB	CC	DD
1	Carroll.	Eureka Spg.-Seligman	Gravel & Earth.	3-31-17	4-14-17	4-14-17	11,891.55	5,945.77	3.110	3,823.65	9-4-17	11,891.55	5,945.77	3.110	Gravel.	—	TOTAL / FA	9-8-17	9-13-17	10-5-17	11,891.88	5,945.77	3.110	3,823.65	10-10-17	11,891.88	5,945.77	3.110	
2	Pulaski.	Batesville-Mt. Vernon	Bituminous Concrete.	7-5-17	7-7-17	7-11-17	125,933.12	53,000.00	5.300	23,760.97	7-16-17	125,933.12	53,000.00	5.300	Bituminous Concrete.	—			7-19-17	R-12-10-17 7-26-17	112,788.77	55,492.00	5.5492	20,325.96	R-1-18-18 9-13-17	112,788.77	55,492.00	5.5492	
3	Sevier.	DeQueen-Gilham.	Gravel.	8-27-17	9-4-17	9-8-17	26,340.88	10,000.00	7.950	3,313.32	9-15-17	26,340.88	10,000.00	7.950	Gravel.	—		9-8-17	9-12-17	R-5-31-18 9-24-17	19,610.73	9,805.36	7.950	2,466.76	R-8-2-18 10-9-17	19,610.73	9,805.36	7.950	
4	Miller.	Texarkana-Garland Cy.	Gravel.	9-20-17	9-26-17	9-26-17	34,883.05	17,441.52	5.994	5,819.66	10-4-17	34,883.05	17,441.52	5.994	Gravel.	—		9-22-17	9-28-17	10-9-17	34,883.09	17,441.52	5.994	5,819.67	10-17-17	34,883.09	17,441.52	5.994	
5	Lawrence.	Walnut R'ge-Cache Riv.	Gravel.	9-24-17	10-5-17	10-16-17	29,541.49	11,590.86	5.681	5,200.97	10-11-17	29,541.49	11,590.86	5.681	Gravel.	—			10-15-17	10-31-17	29,541.49	11,590.86	5.680	5,200.97	11-20-17	29,541.49	11,590.86	5.680	
6	Lawrence.	Walnut R'ge-N. Co. Line	Waterbound Macadam.	9-29-17	10-5-17	10-6-17	12,308.65	2,500.00	3.000	4,102.88	10-11-17	12,308.65	2,500.00	3.000	Water-bound Macadam.	—		9-29-17	10-12-17	10-31-17	8,596.76	2,500.00	3.000	2,865.58	11-20-17	8,596.76	2,500.00	3.000	
7	Miller.	Fulton Road.	Gravel.	9-29-17	10-5-17	10-6-17	12,732.47	2,558.48	2.000	6,366.23	10-11-17	12,732.47	2,558.48	2.000	Gravel.	—		9-29-17	10-12-17	10-31-17	12,397.67	2,558.48	2.000	6,198.83	11-20-17	12,397.67	2,558.48	2.000	
8	Lonoke.	England-Keo.	Water-bound Macadam.	11-19-17	11-23-17	11-26-17	8,871.72	3,169.00	1.970	5,312.02	12-4-17	8,871.72	3,169.00	1.970	Water-bound Macadam.	—			5-8-18	5-11-18	8,871.72	3,169.00	1.970	4,503.41	5-29-18	8,871.72	3,169.00	1.970	
9	Monroe.	Brinkley-Clarendon	Gravel-Surf Treated.	11-24-17	12-10-17	12-14-17	74,943.66	37,471.83	8.080	9,275.20	5-10-18	74,943.66	37,471.83	8.080	Gravel-Surf. Treated.	—			5-8-18	5-11-18	75,183.68	37,471.83	8.080	9,304.91					
10	Cross.	Wayne-Memphis	Gravel.	11-24-17	12-1-17	12-4-17	4,532.15	2,266.07	1.450	3,125.61	12-10-17	4,532.15	2,266.07	1.450	Gravel.	—			5-8-18	5-11-18	4,532.15	2,266.07	1.460	3,104.21	5-29-18	4,532.15	2,266.07	1.460	
11	Woodruff.	Cotton Plant-Des Arc.	Bituminous Macadam.	12-3-17	12-8-17	12-12-17	22,459.69	10,000.00	2.990	7,511.60	12-18-17	22,459.69	10,000.00	2.990	Bituminous Macadam.	—			5-8-18	5-11-18	22,459.69	10,000.00	2.990	7,511.60	5-29-18	22,459.69	10,000.00	2.990	
12	St. Francis.	Wheatley-Bon Air.	Gravel.	12-31-17	1-8-18	1-9-18	29,427.20	10,000.00	7.600	3,871.97	1-21-18	29,427.20	10,000.00	7.600	Gravel.	—			5-8-18	5-11-18	22,368.50	10,000.00	7.600	2,943.22	5-29-18	22,368.50	10,000.00	7.600	
13	St. Francis	Fishing Lake.	Gravel.	12-31-17	1-11-18	1-12-18	26,180.00	5,467.10	4.940	5,299.59	3-14-18	26,180.00	5,467.10	4.940	Gravel.	—			5-8-18	5-11-18	26,180.00	5,467.10	4.940	5,299.59	5-29-18	26,180.00	5,467.10	4.940	
14	Jefferson	Sheridan Road.	Gravel.	2-25-18	3-11-18	3-13-18	21,400.50	10,000.00	5.170	4,139.36	3-19-18	21,400.50	10,000.00	5.170	Gravel.	—			5-8-18	5-11-18	21,400.50	10,000.00	5.150	4,155.44	5-29-18	21,400.50	10,000.00	5.150	
15	Prairie.	Des Arc-Calcтchie Bay.	Gravel-Surf. Treated	2-25-18	3-11-18	3-16-18	25,197.83	10,000.00	4.500	5,599.51	3-25-18	25,197.83	10,000.00	4.500	Gravel.	—			5-8-18	5-11-18	25,197.83	10,000.00	4.500	5,599.52	5-29-18	25,197.83	10,000.00	4.500	
16	Lawrence	Walnut R'ge-Egypt	Water-bound Macadam	3-22-18	4-30-18	5-6-18	22,698.22	7,500.00	4.570	4,966.78	5-10-18	22,698.22	7,500.00	4.570	Water-bound Macadam.	—			5-8-18	5-11-18	22,698.22	7,500.00	4.570	4,966.78	5-29-18	22,698.22	7,500.00	4.570	
17	Craighead.	Nettleton, Lake City and Bay.	Surf. Treated Water bound Macadam	3-22-18	4-30-18	5-6-18	69,509.55	10,000.00	5.810	11,963.77	5-10-18	69,509.55	10,000.00	5.810	Water-bound Macadam.	—			5-8-18	5-11-18	69,509.55	10,000.00	5.810	11,963.77					
18	Benton.	Eureka Spg.-Seligman	Gravel.	3-22-18	4-15-18	4-20-18	14,236.47	7,118.23	6.050	2,353.13	5-6-18	14,236.47	7,118.23	6.050	Gravel.	—			5-8-18	5-11-18	13,537.98	6,768.99	6.050	2,237.68	6-7-18	13,537.98	6,768.99	6.050	
19	Craighead.	Jonesboro-Nettleton.	Bituminous Concrete.	7-8-18	8-2-18	8-7-18	102,013.56	30,836.16	5.000	20,410.88	3-7-19	102,013.56	30,836.16	5.000					8-3-18										
20	Poinsett.	Harrisburg-Truman.	Gravel.	7-8-18	8-5-18	8-12-18	61,029.10	30,000.00	8.840	6,926.37	9-12-18	61,029.10	30,000.00	8.840	Gravel.	5	1771 / 885		8-6-18	10-24-18	59,885.65	29,942.82	8.850	6,766.74	11-30-18	59,885.65	29,942.82	8.850	
21	St. Francis	Wheatley-Forrest City	Gravel.	11-8-18	11-14-18	11-16-18	34,333.72	15,000.00	7.930	4,329.60	11-23-18	34,333.72	15,000.00	7.930															
22	LaFayette	Buckner, Stamps and Lewisville	Gravel.	11-8-18	11-14-18	11-18-18	48,950.95	22,205.52	15.420	3,174.51	12-4-18	48,950.95	22,205.52	15.420	Gravel.	—			11-25-18	1-6-19	48,950.95	22,205.52	15.420	3,174.51					
	TOTAL																												

THIS SHOWS THE MASTER RECORD OF FEDERAL AID PROJECTS FOR A STATE, KEPT BY THE BUREAU OF PUBLIC ROADS.

FEBRUARY FEDERAL AID ALLOWANCES

FEBRUARY'S record of Federal aid was allowances in 69 projects of $2,126,913.26. Of these projects 41 were approvals and 28 final agreements. The estimated cost of the 643.344 miles of road they represent is $5,316,749.34. These roads will be of almost every kind of construction. Twenty-eight of them with an aggregate mileage of 228.046 are to be gravel. Earth roads aggregate 95.74 miles, topsoil construction 10.064 miles, earth and macadam 21.77, earth and gravel 8, sand clay 37.686, macadam and sand clay 12.896, gravel and sand-clay 28.9, earth and sand clay 28, macadam 60.92, plain macadam 21.8, and simple grading 2.184. There are to be 25.963 miles of concrete, 26.48 of concrete or macadam, 5.45 of reinforced concrete, 1.99 of brick or concrete, 3.234 of bituminous macadam, and 2 miles of bituminous.

The States receiving the largest allowances are: Illinois, $207,685.26 for 20.671 miles of concrete, bituminous macadam, and gravel roads, estimated to cost $509,267.05; New Mexico, $175,527.59 for 61.35 miles of plain macadam, gravel, and sand clay, having an estimated cost of $351,055.18; New Jersey, $169,230 for 16.923 miles of concrete construction, estimated to cost $716,907.20; Ohio, $164,297.85 for 17.29 miles of brick, concrete, or bituminous macadam, estimated to cost $452,261.96.

The largest allowance for a single project was $160,175.26 for 15.92 miles of concrete and bituminous macadam road in Dupage, Kane, Dekalb, Ogle, Lee, and Whiteside Counties, Ill., estimated to cost $395,898.41. This road is a portion of the Lincoln Highway. The single project in Utah which is listed has the greatest mileage. It is to be 52.8 miles long, in Millard County, its estimated cost is $172,381.44, and the allowance asked is $86,190.72. It will be a macadam road.

FEDERAL AID RECORD PROJECTS IN FEBRUARY, 1919.

State.	Project No.	County.	Length, in miles.	Type of construction.	Project statement approved.	Project agreement executed.	Estimated cost.	Federal aid allowed.
Alabama	39	Madison	8.00	Gravel	Feb. 2		$58,685.00	$29,342.50
Arizona	5	Mohave	2.184	Grading	Feb. 12		50,930.00	21,840.00
Georgia	16	Merriwether	12.46	Earth, surfaced with topsoil		Feb. 28	44,899.03	21,000.00
	18	Dooly	10.42	Sand clay		Feb. 24	36,139.15	16,000.00
	19	Bleckley	7.65	do		do	38,312.40	19.000.00
	33	Troup	5.95	do		Feb. 28	44,416.70	22,000.00
Idaho	6	Idaho	21.77	Macadam and earth		Feb. 14	[1] 288,465.60	[1] 144,232.80
Illinois	1	Dupage, Kane, Dekalb, Ogle, Lee, Whiteside.	15.92	Concrete and bituminous macadam.		Feb. 4	395,898.41	160,175.26
	1		4.751	do		Feb. 21	113,368.62	47,510.00
Kentucky	5	Mercer	5.00	Macadam	Feb. 4		42,909.47	21,954.00
	11	Trigg	17.86	Gravel	Feb. 18		115,960.00	57,980.00
Louisiana	1	Rapides	16.90	do		Feb. 22	[2] 84,370.69	[2] 35,000.00
	24	Ouachita	4.82	do		Feb. 7	25,560.70	12,500.00
	25	do	7.00	do		do	44,697.15	15,000.00
	28	Iberia	8.59	do		do	46,255.22	22,000.00
	31	Avoyelles	4.27	do	Feb. 20		39,668.35	19,834.17
Minnesota	2	Chisago	31.50	do		Feb. 7	[3] 205,962.80	[3] 80,000.00
Mississippi	14	George	13.666	Sand clay		Feb. 24	26,791.68	10,000.00
	42	Pike	9.90	Gravel	Feb. 10		71,500.00	35,000.00
	44	Lawrence	11.00	do	Feb. 19		48,125.00	24,000.00
Montana	1	Wibaux	4.47	do	Feb. 3		21,607.00	10,803.50
	10	Cascade	18.00	do	Feb. 5		77,932.80	38,966.40
	35	Wibaux	5.10	do	Feb. 3		21,685.95	10,842.97
Nebraska	27	Dodge-Saunders	31.53	Earth	Feb. 12		50,050.00	25,025.00
	31	Dixon	19.60	do	Feb. 26		27,500.00	13,750.00
	32	Adams-Webster	28.00	Earth and sand clay	Feb. 24		30,204.00	19,602.00
	33	Knox	11.50	Earth	do		24,414.50	12,207.25
Nevada	20	Douglas	2.00	do	Feb. 26		11,734.58	5,867.29
New Hampshire	13	Grafton	1.60	Gravel		Feb. 24	15,806.45	7,903.22
	18	Hillsborough	0.90	do		Feb. 13	9,070.05	4,535.02
	19	Cheshire	.60	do		do	9,128.84	4,564.42
New Jersey	4	Monmouth	1.58	Concrete	Feb. 25		109,054.00	15,800.00
	5	Atlantic	3.873	do	do		161,403.00	38,730.00
	6	do	5,870	do	do		242,428.56	58,700.00
	8	Cape May	2.025	do	do		74,211.74	20,250.00
	9	do	3.575	do	do		129,809.90	35,750.00
New Mexico	5	Quay	21.80	Plain macadam		Feb. 1	[4] 112,575.18	[4] 44,550.30
	13	Valencia	28.90	Gravel and sand clay	Feb. 12		163,933.00	81,966.50
	14	Santa Fe	10.65	Gravel	Feb. 10		74,547.00	37,273.50
New York	16	Wayne-Ontario	7.45	Bituminous macadam or concrete.	Feb. 24		149,000.00	74,500.00
	17	Wayne	5.45	do	Feb. 20		109,000.00	54,500.00
	19	Franklin	2.83	do	Feb. 17		56,600.00	28,300.00
North Carolina	39	Union	12.896	Macadam and sand clay	Feb. 7		48,593.00	9,700.00
North Dakota	40	Bottineau	8.00	Earth and gravel	Feb. 17		10,175.00	5,087.00
Ohio	9	Knox	1.99	Brick or concrete		Feb. 14	71,000.00	16,666.87
	25	Highland	4.55	Macadam or concrete		Feb. 28	80,261.96	40,130.98
	26	Van Wert	10.75	Concrete or bituminous macadam.	Feb. 24		301,000.00	107,500.00
Oregon	14	Grant	2.13	Gravel		Feb. 28	42,898.46	21,449.23
	16	Wasco	2.00	Bituminous	Feb. 1		41,492.00	18,746.00
Pennsylvania	12	Northampton	5.45	Reinforced concrete		Feb. 21	250,388.71	54,500.00

[1] Revised agreement. Estimated cost increased from $250,368.03 and Federal aid allowance from $86,000.
[2] Revised agreement. Estimated cost increased from $70,047.60 and the allowance from $21,014.28.
[3] Revised agreement. Estimated cost increased from $110,000 and allowance from $55,000.
[4] Revised. Estimated cost increased from $89,101.68 and allowance from $56,287.59.

FEDERAL AID RECORD PRODUCTS IN FEBRUARY, 1919—Continued.

State.	Project No.	County.	Length, in miles.	Type of construction.	Project statement approved.	Project agreement executed.	Estimated cost.	Federal aid allowed.
South Dakota	11	Union	9.04	Gravel	Feb. 4		41,283.00	16,412.70
	12	Minnehaha	21.79	do	Feb. 10		100,606.00	39,433.64
Texas	73	Guadalupe	3.256	do		Feb. 7	12,316.25	5,000.00
	74	Travis	3.89	do		Feb. 25	23,771.41	11,345.23
	75	Falls	1.00	do	Feb. 15		11,957.64	5,978.82
	77	Taylor	11.61	do	Feb. 17		50,157.00	20,000.00
Utah	9	Millard	52.80	Macadam	Feb. 25		172,381.44	86,190.72
Virginia	12	Franklin	10.064	Topsoil		Feb. 17	66,814.99	33,407.49
	22	Caroline-Essex	4.71	Gravel	Feb. 24		32,879.60	16,439.80
	25	Pittsylvania	3.234	Bituminous macadam		Feb. 7	37,265.05	18,632.52
	26	Surry-Prince George	4.05	Gravel		Feb. 12	35,302.80	17,651.40
West Virginia	27	Barbour	3.12	Macadam		Feb. 10	45,650.00	12,000.00
	28	Tyler	1.50	Concrete		Feb. 15	36,300.00	15,000.00
Wisconsin	55	Door-Kewanee	8.66	Gravel	Feb. 19		51,003.21	17,001.07
	56	Kewanee	4.70	do	Feb. 17		22,577.50	7,529.16
	57	Shawano	7.70	do	do		58,512.85	19,504.28
	58	Outagamie	4.38	Concrete	Feb. 25		90,883.32	30,294.44
	62	Washington	2.91	do	do		62,372.64	20,790.88
	65	Winnebago	.25	do	do		5,292.99	1,764.33
			643.344				5,316,749.34	2,126,913.26

YEAR'S WORK IN ILLINOIS.

The highway construction planned for Illinois this year aggregates 700 miles of hard-surface road, to be built of brick, concrete, or bituminous macadam, of an average width of 15 feet, according to the program of the State highway department. The cost will be $14,000,000, one-half of which is the Federal aid available for Illinois. The other half is to be appropriated by the legislature now in session. More than the amount needed is in the State treasury, realized from automobile fees. Of the total $4,900,000 unexpended because of the war conditions must be reappropriated, $2,700,000 were paid in by automobilists in 1918 and this year $3,000,000 more will come in this year from the same source. None of this money comes from the $60,000,000 bond-issue fund.

It is planned to do the earliest work on the Dixie Highway route between Chicago and Danville, the Lincoln Highway from Chicago to Fulton on the Iowa line, the Ivy trail from Chicago to East St. Louis and the Cumberland Highway from East St. Louis to Marshall, via Vandalia.

The law creating the highway department designated a system of State highways, having an aggregate length of 1,450 miles. Up to the end of last year the department had permanently located 242 miles of this system.

NEVADA'S FEDERAL AID PLANS.

Nevada's Legislature of 1917 met one of the requirements of the Federal aid act by the creation of a State highway department. The first report of the directors of the department, covering the years 1917–1918, has just been issued. A considerable portion of the report is made up of the discussion of the application of Federal aid to Nevada roads, and a reading of it shows that to date most of the activities of the department have been confined to Federal aid projects. Up to the end of 1918 the department had made application to the Secretary of Agriculture for aid in 20 Federal aid projects and one forest reserve road project. Of the 20 applications, 13 had been approved and final agreements signed for 8 of them up to December 31, the date the report closes. Since that date the remaining 6 projects have been approved. These roads will have a total mileage of 225.5, with an estimated cost of $1,194,263.68. The forestry project is 16 miles long and is estimated to cost $32,000.

TEXAS' $75,000,000 BOND LAW.

[Houston Chronicle.]

Every member of the legislature who voted for the constitutional amendment providing for issuance of $75,000,000 of bonds for the purpose of building good roads deserves the thanks of the people of Texas.

* * * * *

No man can adequately forecast what it will mean to Texas to be threaded with a system of substantial highways.

They will increase taxable values five times $75,000,000 in five years.

They will save every year more than enough on the wear and tear of vehicles to pay the interest on the $75,000,000 at 5 per cent.

This statement is easily proved. If there are 4,000,000 people in Texas—and there are more—that means 800,000 families.

If there is only one vehicle worth $50 to a family, the aggregate is $40,000,000. If good roads save only 10 per cent of wear and tear each year, it will be $4,000,000. Five per cent on $75,000,000 is only $3,750,000.

The tax on autos will meet the interest and sinking fund, but if there was no auto tax, 20 cents on the $100, or $2 on the $1,000, is the utmost limit of tax that can be levied.

The aggregate taxable values of Texas is about $2,750,000,000. Divided between 800,000 heads of families, it averages in round numbers $3,450. The tax at full 20 cents would be about $6.89 per head of family.

Two trips saved hauling 8 bales of cotton to market 15 miles over good roads will pay the tax, to say nothing of the wear and tear of vehicles and teams, because on good roads two good mules can haul four bales at a load; whereas over ordinary dirt roads in fall and winter they can scarcely haul two, and frequently can not haul an empty wagon. * * *

TESTS OF ROAD BUILDING ROCK IN 1918

DURING 1916 Department of Agriculture Bulletin No. 370, entitled "The Results of Physical Tests of Road Building Rock," was published. This bulletin contains the results of all tests made in the laboratories of the Bureau of Public Roads up to January 1, 1916, together with brief descriptions of the tests and interpretation of the results. Tests of road building rock made since 1915 have been published about the first of each succeeding year in bulletin form, the latest bulletin, No. 670, containing results of all tests made in 1916 and 1917. As a relatively small number of rocks were tested during 1918, it has not been deemed advisable at this time to issue a revision of Bulletin No. 670 but to defer such revision until the end of 1919.

For the use of engineers interested in these tests, the following tables show results obtained in 1918. These tables may be considered as a supplement to Department of Agriculture Bulletins Nos. 370 and 670.

Results of physical tests of road building rock from the United States from Jan. 1, 1918 to Jan. 1, 1919.

Serial No.	Town or city.	County.	Name of material.	Weight per cubic foot.	Absorption per cubic foot.	Per cent of wear.	French coefficient of wear.	Hardness.	Toughness.	Cementing value.
	ALABAMA.									
				Pounds	*Pounds.*					
13387	Anniston	Calhoun	Limestone	170	0.22	6.8	5.9	14.7	4	23
13388	do	do	Magnesian limestone	174	.64	6.0	6.7	17.3	9	40
13389	Anniston (near)	do	Limestone	169	.269	4.8	8.3	14.7	9	33
13390	Anniston	do	Siliceous dolomite	175	.295	4.6	8.7	17.3	6	48
13504	Weavers Cave	do		172	.885	7.2	5.5	(1)	(1)	28
13506	Anniston	do	Sandstone	154	1.33	6.1	6.5	19.1	10	(1)
13507	do	do	Limestone	169	.157	4.7	8.5	15.3	8	34
13508	do	do	do	172	.68	11.6	3.4	(1)	(1)	27
13509	do	do	do	140	.123	5.4	7.4	16.0	6	21
13510	do	do	Dolomite	175	.376	5.0	8.0	16.0	8	28
13505	Birmingham	Jefferson	Chert	147	5.82	(1)	(1)	(1)	(1)	48
12757	[2]	Morgan	Limestone	168	.106	3.8	10.5	14.5	9	35
12758	[2]	do	do	166	.378	5.4	7.4	11.9	7	47
12812	[2]	do	do	167	.19	6.0	6.7	13.3	6	31
	ARKANSAS.									
12993	Little Rock	Pulaski	Quartzite	165	0.38	3.3	12.1	19.3	26	9
12994	do	do	do	165	.27	3.3	12.1	19.0	23	(1)
13295	White Cliffs	Sevier	Argillaceous limestone	(1)	(1)	13.9	2.9	0.0	(1)	43
	DELAWARE.									
12839	Faulkland	New Castle	Hypersthene gneiss	184	0.044	4.0	10.0	18.0	14	(1)
13033	Yorklyn	do	Hornblende gneiss	173	.225	3.2	12.5	18.3	10	(1)
13838	Faulkland	do	do	181	.31	3.7	10.8	18.7	12	(1)
	FLORIDA.									
13788	Floral City	Citrus	Weathered chert	(1)	(1)	17.9	2.2	(1)	(1)	9
13568	Montbrook	Levy	Chert	148	4.22	15.6	2.6	17.3	16	39
13301	Chipley	Washington	Limestone	156	2.37	12.3	3.3	14.4	5	28
	GEORGIA.									
12933	Near Cartersville	Bartow	Dolomite	174	1.02	3.9	10.2	16.0	8	12
12957	do	do	do	173	.345	3.9	10.3	18.0	6	11
13845	Macon	Bibb	Granite gneiss	168	1.2	5.9	6.8	18.0	9	(1)
13502	Lithonia	Dekalb	Granite	166	.49	6.1	6.6	(1)	8	(1)
13533	do	do	do	164	.54	5.4	7.4	(1)	9	(1)
	ILLINOIS.									
13297	Lehigh	Kankakee	Dolomite	162	2.60	4.6	8.7	12.7	7	17
	INDIANA.									
12889	Bedford	Lawrence	Limestone	143	7.745	(1)	(1)	0.0	4	(1)
	KENTUCKY.									
12754	Grayson	Carter	Limestone	167	0.18	5.1	7.8	15.0	11	43

[1] Test not made. [2] Exact locality not known.

Results of physical tests of road building rock from the United States from Jan. 1, 1918, to Jan. 1, 1919—Continued.

Serial No.	Town or city.	County.	Name of material.	Weight per cubic foot.	Absorption per cubic foot.	Per cent of wear.	French coefficient of wear.	Hardness.	Toughness.	Cementing value.
			MAINE.							
				Pounds.	*Pounds.*					
12755	Portland	Cumberland	Sericite schist	170	0.18	4.1	9.8	17.3	14	(1)
12756	do	do	Granite	166	.24	3.8	10.5	18.0	10	(1)
13854	Vinal Haven	Knox	do	(1)	(1)	3.3	12.1	18.7	13	(1)
			MARYLAND.							
12802	Port Deposit	Cecil	Hornblende biotite schist	169	0.012	2.8	14.3	17.3	17	(1)
12930	Near Frederick	Frederick	Argillaceous limestone	172	.14	2.6	15.4	(1)	(1)	53
13669	Kingsville (near)	Harford	Amphibolite	191	.41	4.0	10.0	17.3	10	(1)
12765	Ellicott City	Howard	Altered diabase	186	.154	(1)	(1)	(1)	(1)	40
12766	Dickerson	Montgomery	Diabase	181	.118	2.6	15.4	(1)	(1)	25
12607	Near Bethesda	do	Mica gneiss	168	.33	3.4	11.8	18.7	9	(1)
13728	[2]	Prince Georges	Diabase	(1)	(1)	1.6	25.0	(1)	(1)	(1)
			MASSACHUSETTS.							
13566	Peabody	Essex	Altered diorite	181	0.20	2.9	13.9	18.0	16	28
12852	West Townsend	Middlesex	Biotite granite	163	.26	6.9	5.8	17.3	6	(1)
13148	do	do	Granite	(1)	(1)	(1)	(1)	18.0	10	(1)
13560	Malden	do	Altered andesite	169	.11	2.0	20.0	18.7	19	20
13563	do	do	Altered rhyolite	165	.11	3.0	13.3	18.7	17	19
13562	Quincy	Norfolk	(a) Granite porphyry	166	.41	2.7	14.8	18.0	11	18
			(b) Altered slate	175	.16			14.0	17	
			(c) Granite	164	.40			18.7	11	
			(d) Granite	163	.35			18.0	9	
13559	Jamaica Plains	Suffolk	Rhyolite breccia	166	.71	4.4	9.1	18.7	8	15
13561	do	do	Conglomerate	160	.63	5.0	8.0	18.0	7	16
13564	West Roxbury	do	Altered granite	168	.18	3.4	11.8	18.7	10	(1)
13565	Boston	do	Diorite	182	.25	2.8	14.3	18.0	13	35
13567	Roxbury	do	Altered rhyolite	172	.39	4.4	9.1	17.3	11	19
			MINNESOTA.							
13725	[2]	[2]	Sandstone	187	0.24	3.8	10.6	18.7	18	13
			MISSISSIPPI.							
12692	Pontotoc	Pontotoc	Limestone	160	0.92	7.0	5.7	17.0	9	68
			NEW YORK.							
13558	Stoneco	Dutchess	Siliceous dolomite	174	0.25	2.6	15.4	16.3	29	43
12729	Buffalo	Erie	Limestone	169	.18	4.2	9.8	14.0	8	50
12727	North Le Roy	Genesee	do	168	.3	3.9	10.3	15.3	13	44
13557	Cedarcliff	Orange	do	176	.17	3.1	12.9	14.0	19	28
12714	Oregon	Putnam	Granite gneiss	166	.267	5.2	7.7	18.7	9	(1)
			NORTH CAROLINA.							
13027	New Bern	Craven	Shell limestone	(1)	(1)	49.0	0.81	(1)	(1)	23
12770	Canton	Haywood	Granite gneiss	157	1.156	20.3	2.0	17.3	6	53
13050	Dover	Jones	Fossiliferous limestone	150	3.85	10.6	3.8	(1)	(1)	25
12883	Pollocksville	do	Shell limestone	(1)	(1)	16.9	2.4	(1)	(1)	35
12888	Castle Hayne	New Hanover	Limestone	152	4.88	9.8	4.1	12.7	5	33
13527	Mount Airy	Surry	Gneiss	162	.61	5.4	7.4	(1)	11	(1)
			OHIO.							
12890	Berea	Cuyahoga	Sandstone	124	7.414	(1)	(1)	0.7	5	(1)
12891	Euclid	do	do	139	6.55	(1)	(1)	2.7	9	(1)
13073	Sandusky	Erie	Limestone	169	1.07	4.8	8.3	15.9	10	30
13074	do	do	do	166	1.56	4.7	8.5	12.4	8	69
13095	Bellevue	Huron	do	157	5.85	6.3	6.3	10.3	5	49
13093	Toledo	Lucas	Dolomite	172	.49	6.1	6.6	12.7	6	34
13179	Waterville	do	Slate	171	.40	8.6	4.6	16.0	14	39
13397	do	do	Limestone	165	.231	4.0	10.0	16.0	19	37
			PENNSYLVANIA.							
13129	Tyrone	Blair	Sandstone	160	0.134	3.3	12.1	18.7	12	6
12908	[2]	Cambria	do	152	1.48	7.4	5.4	15.3	9	(1)
13174	[2]	do	do	153	.273	6.7	6.0	18.3	8	(1)
13178	[2]	do	do	152	.274	8.2	4.9	16.7	7	(1)
12767	Berwick	Columbia	do	164	.354	4.8	8.3	18.7	14	(1)
12929		Lycoming	Limestone	169	.18	7.5	5.3	15.3	5	46
12688	Bethlehem	Northampton	do	174	.043	4.9	8.1	15.0	10	41
12690	do	do	do	171	.14	5.2	7.7	14.7	7	46
12691	do	do	do	167	.28	6.2	6.5	11.8	8	48

1 Test not made. 2 Exact locality not known.

Results of physical tests of road building rock from the United States from Jan. 1, 1918, to Jan. 1, 1919—Continued.

Serial No.	Town or city.	County.	Name of material.	Weight per cubic foot.	Absorption per cubic foot.	Per cent of wear.	French coefficient of wear.	Hardness.	Toughness.	Cementing value.
			SOUTH CAROLINA.							
				Pounds	*Pounds.*					
12863	Rock Hill	York	Altered gabbro	188	0.10	3.2	12.5	18.0	17	19
			SOUTH DAKOTA.							
13729	[2]	Minnehaha	Quartzite	([1])	([1])	([1])	([1])	19.7	17	([1])
13730	[2]	do	do	([1])	([1])	([1])	([1])	19.7	30	([1])
			TENNESSEE.							
12703	Chattanooga	Hamilton	Limestone	168	0.106	3.9	10.3	16.0	10	50
12740	do	do	do	168	.199	4.2	9.8	16.0	9	53
13064	do	do	do	169	.08	4.5	8.8	15.7	8	25
			TEXAS.							
13106	Austin	Travis	Nephelite basalt	195	0.059	2.8	14.3	18.7	29	94
			VIRGINIA.							
12853	Charlottesville	Albemarle	Mica schist	166	0.13	4.1	9.8	18.0	6	([1])
13298	[2]	do	Biotite gneiss	176	.77	6.2	6.5	16.7	7	([1])
13299	Ivy	do	Amphibolite	194	.28	3.0	13.3	17.4	14	11
13712	do	do	Biotite gneiss	176	.86	4.6	8.7	18.0	8	([1])
12915	[2]	Augusta	Siliceous limestone	174	.314	3.5	11.4	16.3	15	38
12916	[2]	do	Feldspathic sandstone	163	1.25	3.5	11.4	16.0	11	44
12917	[2]	do	do	178	.45	3.1	13.0	16.0	24	58
12918	[2]	do	Sandstone	168	.34	3.1	12.9	18.0	6	([1])
13499	Staunton	do	Limestone	175	.087	3.06	13.06	16.0	19	15
13724	Buchanan (near)	Botetourt	Argillaceous limestone	173	.27	3.3	12.2	17.3	23	37
12834	[2]	Campbell	Hornblende schist	184	.27	13.5	3.0	16.3	5	([1])
12954	Lynchburg	do	Biotite schist	166	1.60	6.8	5.9	16.0	6	([1])
12984	[2]	Chesterfield	Biotite granite	163	.873	3.9	10.3	18.7	12	([1])
13193	[2]	Clarke	Limestone	166	.051	6.4	6.3	15.0	7	24
13195	The Plains	Fauquier	Epidosite	188	.50	2.4	16.6	18.3	22	13
13196	do	do	do	186	.69	7.9	5.6	16.0	17	11
13197	do	do	do	202	.54	1.8	22.2	18.3	19	8
13765	Shores	Fluvanna	Schist	181	.44	2.4	16.7	18.3	10	20
13194	Near Winchester	Frederick	Limestone	169	.018	7.5	5.3	15.3	7	27
12878	Stickleyville	Lee	Argillaceous limestone	167	.167	9.1	4.4	14.3	8	47
12879	do	do	Limestone	165	.17	5.4	7.4	13.3	6	27
12880	do	do	Ferrugineous sandstone	167	.31	5.3	7.5	8.0	8	38
13176	do	do	Limestone	169	.013	6.2	6.4	16.0	8	35
13641	[2]	do	do	168	.21	5.4	7.4	15.3	11	41
12835	[2]	Nelson	Biotite gneiss	171	.204	6.5	6.2	18.0	11	([1])
13071	[2]	Pittsylvania	Quartz	165	.196	13.8	2.9	([1])	([1])	([1])
13529	[2]	do	Biotite gneiss	172	.49	4.2	9.5	18.7	10	([1])
13041	Glasgow	Rockbridge	Limestone	170	.188	4.7	8.5	16.3	9	16
13042	do	do	do	168	.203	6.4	6.3	12.7	17	15
13043	do	do	Quartzite	165	.20	3.0	13.3	([1])	([1])	([1])
12788	Hansonville	Russell	Argillaceous dolomite	169	.742	3.6	11.1	16.7	14	28
12789	[2]	do	Dolomite	175	.0789	3.3	12.1	16.7	21	56
12840	[2]	do	Limestone	171	.078	5.8	6.9	15.3	8	45
			WEST VIRGINIA.							
12728	Sattes	Kanawha	Feldspathic sandstone	155	4.67	4.6	8.7	3.0	6	([1])
13706	[2]	do	do	157	3.88	12.2	3.3	12.0	7	([1])
13396	Rivesville	Marion	Limestone	163	.502	4.3	9.3	16.0	9	24
12787	Nitro	Putnam	Feldspathic sandstone	152	2.158	11.6	3.4		6	66
13571	Spencer	Roane	Micac. sandstone	156	4.22	8.9	4.5	2.0	8	([1])
13806	do	do	Calcareous sandstone	156	1.78	4.4	9.1	10.7	6	[3] 33
13296	Fetterman	Taylor	Feldspathic sandstone	154	3.91	9.2	4.3	11.7	5	([1])
			WISCONSIN.							
12615	[2]	Milwaukee	Dolomite	166	2.84	4.0	10.0	13.3	7	40
12616	[2]	do	Argillaceous dolomite	161	2.42	6.4	6.3	12.0	7	29
12617	[2]	do	do	164	3.21	4.5	8.9	14.3	10	22
12618	[2]	do	Dolomite	175	.14	6.5	6.1	16.0	6	46
12619	[2]	do	Argillaceous dolomite	167	2.66	3.7	10.8	14.3	10	46
13537	Milwaukee	do	Limestone	166	2.15	6.0	6.7	15.3	9	112

[1] Test not made. [2] Exact locality not known. [3] Not reported.

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