FIFTH BIENNIAL REPORT

OF THE

STATE ENGINEER

TO THE

GOVERNOR

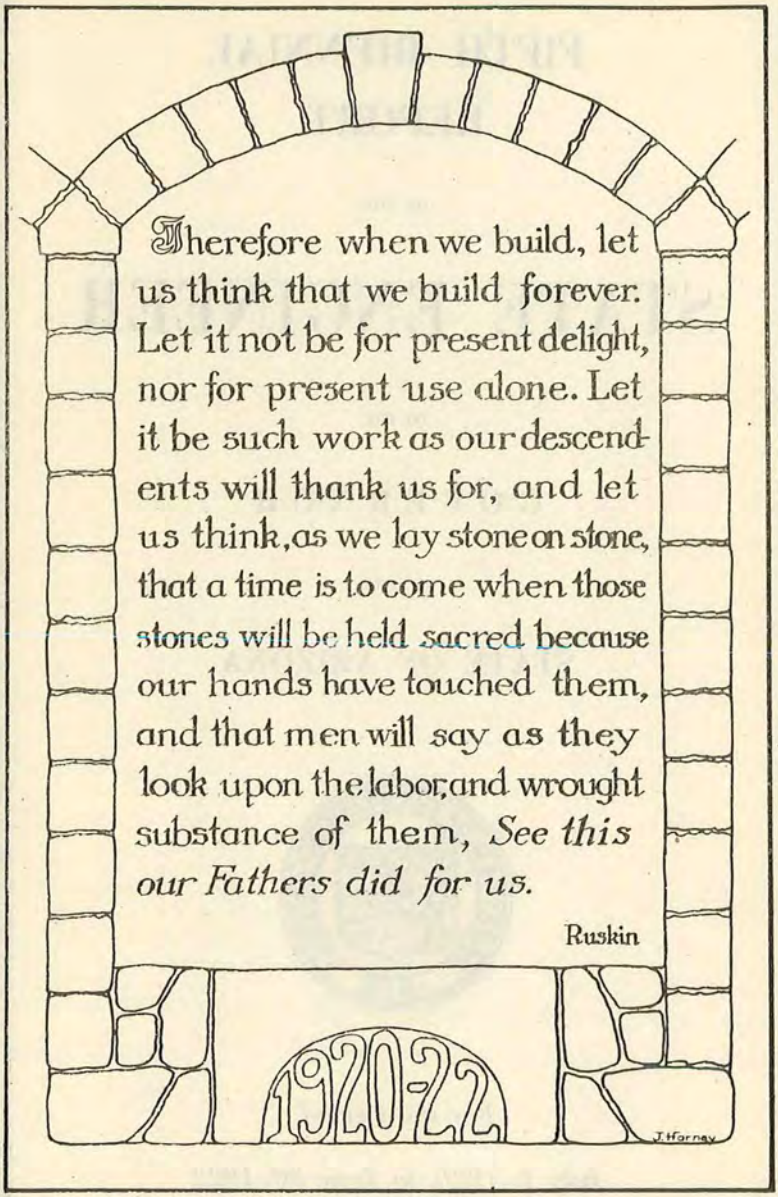
OF THE

STATE OF ARIZONA

For the Period

July 1, 1920, to June 30, 1922

WATKINS PRINTING CO., PHOENIX


Therefore when we build, let us think that we build forever. Let it not be for present delight, nor for present use alone. Let it be such work as our descendents will thank us for, and let us think, as we lay stone on stone, that a time is to come when those stones will be held sacred because our hands have touched them, and that men will say as they look upon the labor and wrought substance of them, See this our Fathers did for us.
Ruskin
1920-22
J. Harney

Honorable Thomas E. Campbell,
Governor of Arizona,
State House, City.

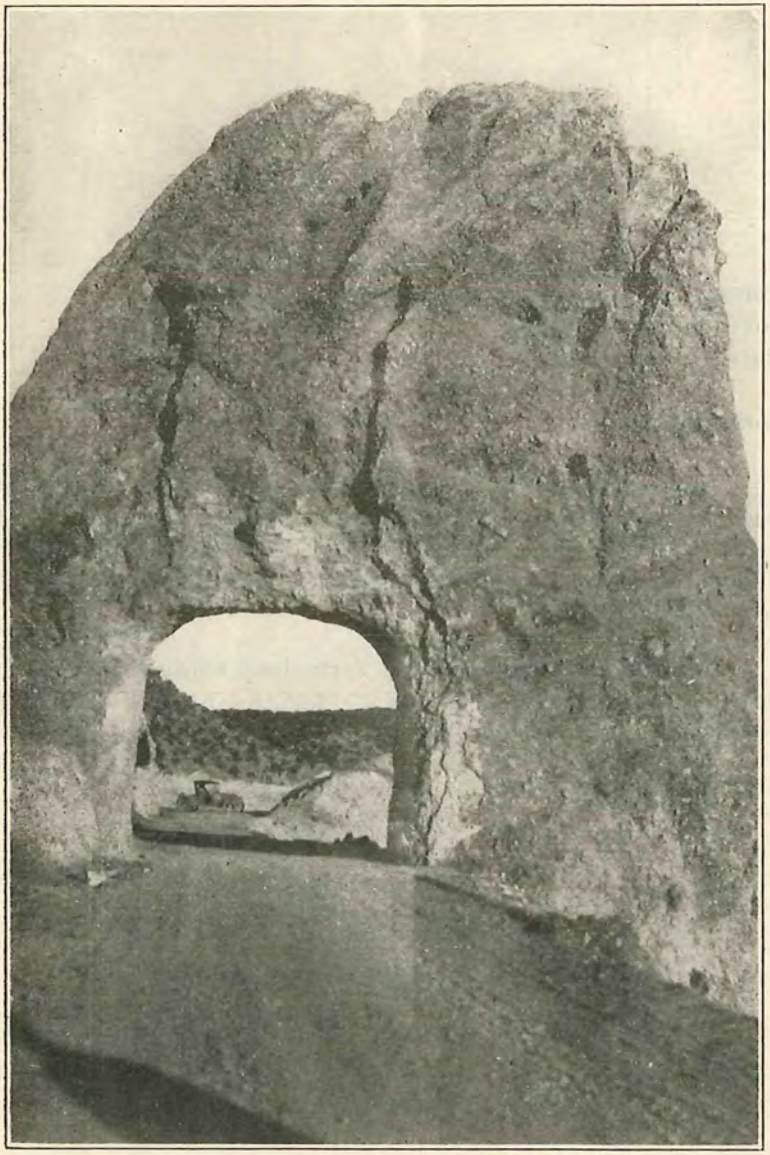
Dear Sir:

I am transmitting to you herewith State Engineer's biennial report of the State Highway Department, for the fiscal years ending June 30, 1921 and 1922. Tabulations of receipts and expenditures for these years are furnished, as provided by law.

Additional information is furnished bringing the report down to the latest possible date for the benefit of the Executive and the Legislature.

Yours very truly,

THOS. MADDOCK,
State Engineer.



SHORTEST TUNNEL IN THE WORLD—MULE CREEK, GREENLEE COUNTY

STATE HIGHWAY DEPARTMENT

JUNE 30, 1922

THOS. MADDOCK.....State Engineer
F. N. HOLMQUIST.....Assistant State Engineer
W. R. INGHRAM.....Chief Clerk
W. J. JAMIESON.....Office Engineer
C. C. SMALL.....Chief Locating Engineer
E. A. WOLFE.....Chief Construction Engineer
F. E. ALLEN.....Asst. Chief Construction Engineer.
MERRILL BUTLER.....Bridge Engineer
C. F. PRICE.....Purchasing Agent
J. H. ALLEN.....Superintendent of Equipment
R. M. HANSEN.....Testing Engineer
S. R. STANIFORTH.....Traveling Auditor
H. N. GRAHAM.....Office Auditor
T. P. JOHNSON.....Accountant
O. B. RUGGLES.....Right-of-Way Agent

Maintenance Engineers

I. P. FRAZIER.....Southern Division
W. C. GOETZ.....Central Division
SHEPARD HISCOX.....Northern Division

Field Engineers

R. E. ALLISON
J. L. BONE
J. M. BROWN
GEO. L. BURNS
J. K. FOREMAN
F. N. GRANT
T. A. GREENE
HARRY HAGEN
L. A. HICKS
A. W. JENKINS
R. E. LAWRENCE
G. B. LITTLE
GEO. LUKESH
S. M. MORSE
T. S. O'CONNELL
JAS. A. PARKER
R. E. STALLINGS
LOGAN STILLWELL
L. H. THOMPSON
A. W. VAN FLEET
W. W. VAN FRANK
W. B. WEAST
G. T. WEST
H. B. WRIGHT

Foremen

L. B. BOOTH
LEE BURDWELL
L. J. BRISTOL
GEO. DILLER
E. J. ENNEKING
JULIUS IRION
GEO. KELLER
DAN KILLIAN
CLYDE KNIGHT
A. A. LILLARD
OSCAR LYONS
HARRY C. MALLOY
J. F. MCDONALD
JACK MILLER
FORREST MOORE
JOHN MUNN
FRANK MURPHY
LUKE NEVINS
W. W. OLIVER
T. B. REYNOLDS
A. E. ROUNDTREE
H. SALYER
H. W. SMITH
REX SMITH
WM. SMITH
M. E. TAYLOB
G. H. WEBB
JOHN WEBSTER

The following men resigned positions with the Department:

Alexander, H. D. Resigned to enter contracting business.

Bone, C. R. Resigned to enter contracting business.

Bone, J. L. Resigned to accept position of County Engineer for Maricopa County.

Coleman, W. C. Resigned to accept position at Humboldt with Smelter Company.

Fraizer, I. P. Resigned during period of Legislature.

Harter, A. F. Resigned to accept position of County Engineer for Maricopa County.

Hastings, E. F. Resigned to accept position with Ingersoll-Rand Company, Mexico City.

George, A. H. Resigned to enter service with Yavapai County Highway Commission.

Piper, W. B. Resigned to enter service with Yavapai County Highway Commission.

Porter, George J. Resigned to enter service with Yuma County Highway Commission.

Shepherd, R. E. Resigned to accept position of County Highway Engineer for Apache County.

Twitchel, F. G. Resigned to accept position in Mexico.

INTRODUCTORY

During your administration the office of State Engineer has become in reality the Arizona Highway Department. While certain duties still exist in regard to the irrigation of land, the highway work has so greatly increased that the Highway Department has become the largest single business in the State of Arizona. Few people realize that in recent years the transportation on roads, including construction, maintenance and equipment, has involved greater expenditures than those of the railroads, which were largely constructed a few decades since. Practically all of the increased agricultural and manufacturing business of this country has been handled by road transportation, supplementing rail transportation installed to take care of less than half of the business now done in the United States.

A portion of the cost of all railroad transportation must go to pay interest on the cost of construction and operation; necessarily the same thing is true with road transportation, represented by taxation instead of by freight rates. It is easy to realize that if the Government took over the railroads, it would be necessary for the taxpayers to pay the present owners for them. Could the complicated system of railroads be operated by the Government at reduced rates, the people would cheerfully pay the taxation necessary to cover the cost of the railroads, if they were compensated by a reduction in transportation rates. But, many people fail to appreciate that in the construction and maintenance of roads and in the equipment for use thereon, they have in their joint ownership, created in the last few years, values nearly as great as the values of all the railroads in the United States.

The Arizona Highway Department has endeavored to keep up with the changing conditions of our time and construct the thru roads in the State in such a manner that they will not only carry the present traffic, but that their location will anticipate future increased traffic. And, when this traffic is realized, hard-surfaced pavements can be laid over the present grades and drainage structures and the

original investment will not be lost, as has been so frequently the case in the past.

In order to handle a big job it has been necessary to create a big Department. This growth has been so gradual as to not be distinctly noticeable, and can be realized perhaps only by comparison.

The Arizona Highway Department is supervising the work of more employees than any individual or corporation in this State.

This Department is the largest employer of engineers in the State.

Our storehouse and yards contain material and supplies greater in extent than the stocks held by any wholesaler in the State. Most of these supplies were received from the Federal Government.

Our equipment is eight times as large as any single contractor in the State. During the last two years from fifteen to twenty state camps have been engaged in road construction, and from twenty-five to thirty contractors have been engaged on road and bridge construction. Approximately 200 men have been working on road maintenance.

We have one of the largest machine, boiler, paint and carpenter shops in the State, for the handling of repairs for State equipment.

The Highway Purchasing Department contracts for more supplies for our various camps than are bought by the State Purchasing Agent for all of the other State Institutions.

This Department is handling more funds and employing more men and women than all the other State Departments combined.

LOOKING FORWARD

In addition to locating present roads so that they can be paved without changes in the grading and drainage structures, we have laid many small stretches of paving in the State. We realize that it is impossible for any State agency to succeed with any policy not backed by a majority of the people within the State. We believe that these short stretches of paving will convince the State taxpayers that all of the thru roads should be paved. We anticipate a State bond issue to be submitted to the people during the 1924 election. We believe that by that time the financial condition of the country will be better and that a bond issue will carry.

Many different types of paving have been laid in the State which will have ample time to demonstrate their worth at the time the State bond issue is carried. Fifteen miles of paving 2" thick has been contracted, ten miles of which is complete. This light paving has only been advisable because of the excellent present surface. Great care should be exercised in avoiding the use of this light grade paving on improper foundations.

During the last two years many of the links in the State highway system have been connected, so that our road system, instead of consisting of a few miles of widely scattered highway, is complete except for a few sections, which should be constructed within the next twelve or fifteen months. The State highways as outlined will reach the immediate vicinity of over ninety-five per cent of the State population.

In addition to roads already built, under contract or those on which Federal Aid has already been requested, the State or counties should be considering the following extensions which are placed according to our opinion of their relative importance in the various counties, considered from a State standpoint:

APACHE COUNTY

In Apache county the reconstruction of the road west of St. Johns and East from Springerville and the improvement

of the road between Hunt and the Petrified Forest, to complete the southern branch of the Old Trails Highway. The Holbrook-Lupton road should be continued to the Navajo county line and surfacing material placed on several of the worst adobe flats and sandy ridges.

COCHISE COUNTY

The paving should be completed between Bisbee and Tombstone and extended toward Benson. Work on concreting the dips on the Douglas-Rodeo and Tombstone-Benson should also be continued. Additional road construction should include the north and south highway connecting Cochise with Graham county.

COCONINO COUNTY

The east and west highway is undoubtedly of first importance. The construction of the road from Flagstaff to Canyon Padre by the Forest Department and the building of Federal Aid Project No. 74, from Winslow to Canyon Diablo, will leave only 12 miles of highway to be improved between the Padre and Diablo bridges. The further improvement of the road to Grand Canyon and Oak Creek will be of great scenic value.

GILA COUNTY

The construction of a highway from the Livingston bridge toward Globe and Miami, by the way of Wheatfield, is of first necessity. Paving on the central highway thru Gila county should be the next consideration.

GRAHAM COUNTY

The improvement of the road between Solomonville and the Greenlee county line and the further improvement of the road thru the Indian Reservation following the receipt of definite information in regard to the construction of the San Carlos Reservoir, are of first consideration, after which a connection south to Cochise county would be extremely desirable.

GREENLEE COUNTY

The principal improvements in Greenlee county should be the widening and surfacing of existing highways.

MARICOPA COUNTY

Maricopa county's large number of local paved highways should be connected with paved highways to the adjoining counties. Additional road should be constructed from Chandler southward toward Casa Grande, and the Black Canyon highway should be improved between the Arizona Canal and the Agua Fria River.

MOHAVE COUNTY

The State outfit now working on the 17 mile hill west from Kingman, when this work is completed, should be moved to the vicinity of Crozier, or contract made to reconstruct four miles in this vicinity. The two underpass crossings have already been built on this new location as a result of arrangements made between the Arizona Highway Department and the Santa Fe Railroad. There is still 2½ miles of road to improve west of Oatman. Construction on the Boulder Canyon dam road has been held up waiting the definite location of the damsite, but this work should begin as early as possible after definite information can be secured, as the road would be of great value in the construction of this dam. It will also assist in securing much of the business resulting from this dam construction to Arizona merchants, towns, etc.

NAVAJO COUNTY

The further improvement should be made on the Navajo county portion of the Holbrook-Lupton highway. Of next consideration is the road from Holbrook south as this highway, in connection with the Forest road construction from Livingston thru Young, to Heber, will constitute a second north and south highway.

PIMA COUNTY

The Pima county portion of the Tucson-Nogales highway should be paved. The new paving should be located on the west side of the railroad, avoiding two railroad crossings, shortening the distance and better serving the Santa Cruz Valley. The road from Tucson to Vail should be straightened as this construction with caterpillars and blades can be handled quite easily and cheaply. The present curved alignment is not justified by the topography. The 50 mile incompleted section of the Tucson-Ajo highway should no

doubt be constructed in order to finish this road similar to the 80 miles of already built type of construction. This road, however, is of little value to the State in general and decidedly secondary to the road from Tucson to Gila Bend, by the way of Casa Grande.

PINAL COUNTY

The Ray-Superior highway should be completed, also connection between Casa Grande and Gila Bend. Additional surfacing should be placed on the Tucson-Casa Grande road and this highway continued northward from Casa Grande across the Sacaton dam toward Chandler.

SANTA CRUZ COUNTY

As fast as funds can be secured, the paving should be continued from 4 miles north of Nogales toward Tucson, also the road from Patagonia to Nogales should be reconstructed on a new location to eliminate much excessive distance and sharp curvature.

YAVAPAI COUNTY

The Yavapai county program forms good connections with the other counties of the State. The completion of all of the roads in this program in a first class manner should be of first consideration.

YUMA COUNTY

As the funds available in the Yuma county program will provide for the construction of the gravel surfaced road from Yuma toward Phoenix and also for the roads in the northern part of Yuma county, any additional funds available for Yuma county should be expended on the paving beginning at Yuma and running eastward. This paving should not be delayed too long or the present gravel and macadam surfaces will have little value as base for paving. On some of this highway a light 2" paving on top of the existing surfacing material will be sufficient.

FEDERAL AID MATCHED

At the beginning of your administration, only one-sixth of the Federal Aid appropriated to Arizona had been matched with State funds on projects which could early be completed. To date project statements have been submitted for every dollar of Federal Aid appropriated. In addition the program has been so outlined that two-thirds of the Federal Aid available July first, 1923, can be immediately used on the construction of the projects already submitted.

RECOMMENDATIONS

PROVIDE FOR INJURED EMPLOYEES

Provision should be made by law for the State Highway Department or some other State Agency to provide for those injured in State employ. Roads are constructed for the benefit of all. Accidents are inevitable in the handling of construction work where tremendous forces are directed against natural obstacles. It is but right that the general public should pay the entire cost, including accident costs on road construction, rather than that the occasional unfortunate individual employee should make an undue contribution to the betterment of transportation.

BONDS FOR PAVING

State bonds should be issued for the purpose of paving the main thru highways of the State of Arizona. The present State roads have been held to a minimum and the grading and drainage structures placed with a view of paving in the immediate future.

The annual expenditures for road transportation and equipment in Arizona are approximately $10,000,000. Not over one-third of this sum is being expended by the taxpayers for road construction and maintenance. The expenditures for road equipment are out of proportion to road construction, as two-thirds of our expenditure for roads is a permanent investment, while our motor vehicles last about three years. If a greater amount is expended on improving roads, increased life of the motor vehicles will much more than pay for the additional road expenditure. It is hardly possible to build a road without the saving on the operation greatly exceeding the cost of construction. On main line highways this difference is so large as to be startling.

There is no question from a financial view-point that the paving of trunk line highways is justified. The ability to pay for all of this work at one time is the only limiting feature.

A state bond issue overcomes this difficulty. Paving is justified by existing traffic; future increase of traffic would be extra benefits. All the main thru roads in Arizona will be paved within the next ten years. Why not pave them now and use them in our development? If Arizona progresses, paving will be justified many times over. If the State does not go ahead, paving construction is no more a mistake than the permanent buildings we are erecting for homes, farms and business.

ABOLISH 75% FUND

I believe that the dual control of State Funds by the Board of Supervisors and the State Engineer is no longer advisable, but that the authority and responsibility for State roads should be placed solely with the State Engineer, reporting directly to the Governor, and the county roads with the County Eugineer reporting to the Boards of Supervisors. The mileage of State roads should be held to a minimum, in which case there is justification for the expenditure of funds largely originating in one county, in an adjoining county, on the construction or maintenance of the main thru highways, which are a necessity for all of the people in the State. The dual control of the 75% Fund has not heretofore been embarrassing as there was much road needing construction in the wealthy counties. As the roads thru the wealthy counties are now largely constructed, there should be no restriction on the expenditure of State funds anywhere within the State, provided these expenditures are held to the thru lines of transportation.

RIGHT OF WAY

It is my opinion that arrangements should be made by the Legislature to permit the State Engineer and the County Highway Commission to secure rights of way, etc., for roads to be constructed with funds at their disposal, similar to the method now permitted of securing rights of way by the Board of Supervisors, retaining to private property owners their same rights of legal appeal to the court as now possessed in the method provided for securing county road rights of way.

LEGAL ROADS

I do not believe that the present law which provides that a road is not a legal road unless it has been surveyed and the

notes recorded with the County Recorder, has been satisfactory. Many roads in use in the State for twenty or thirty years have been fenced by property owners or leasers, without any other outlet being provided for the continuation of traffic. Roads long in use, and on which the counties have expended large sums of taxpayers' money, have been fenced by homesteaders. In my opinion the law should be changed to protect the many taxpayers against the few fence builders, as there are but few county roads in the State which, under our present laws, could not be closed by fences.

BOND AND IMPREST FUND

In order to provide sufficient funds to carry the pay rolls and take advantage of discounts on materials purchased, the Imprest Fund of the Arizona Highway Department should be increased to $150,000, or the equal of the expenditures of the Department for two weeks.

In my judgment the bond of the State Engineer should be increased to an amount equal to the Imprest Fund placed under his control.

BUS AND TRUCK LINES

It is imperative, in my judgment, that the Legislature immediately provide larger funds for maintenance of our completed highways, by the enactment of laws which will secure real financial returns to the State from the franchises granted to privately owned, motor truck and bus lines. This recommendation is in line with my belief that most of the revenue for the maintenance of roads should be derived from the users of the roads and not from State or local taxpayers.

USE OF COUNTY FUNDS BY STATE

The present laws regarding use of county funds in connection with Federal Aid Projects are vague and should be revised. Laws regarding the use of funds secured from the sale of county bonds provide that these funds shall be spent under the direct supervision of the County Highway Commissions. The Federal Highway Act provides that Federal Aid Projects shall be constructed under the direct supervision of

the State Highway Department. Recent rulings of the Bureau of Public Roads require that when county funds are to be used they shall be deposited with the State prior to the execution of the project agreement by the Bureau of Public Roads.

Legislation should be enacted providing for the use of county funds by the State Highway Department in the same manner as they are now authorized to be used by the United States Department of Agriculture in the construction of roads built jointly by counties and the Forest Service.

The State Finance Code passed in 1922 authorizes the State to use county, city or town funds in the construction of Federal Aid Projects, but does not extend corresponding authority to the counties, cities and towns to turn their money over to the State to secure the benefits of Federal Aid. This was no doubt an oversight on the part of the framers of the State Finance Code, and should be corrected.

Quoting

THOMAS H. MACDONALD

Chief, U. S. Bureau of Public Roads.

No reason can be offered not to plan well for the future, for we are yet near the beginning of Highway building activity in its major sense. There are not the same uncertainties that confronted the railroad builders. The early railroads were built largely on the strength of prospective and to an extent problematic traffic. The highways are being built for a traffic already waiting.

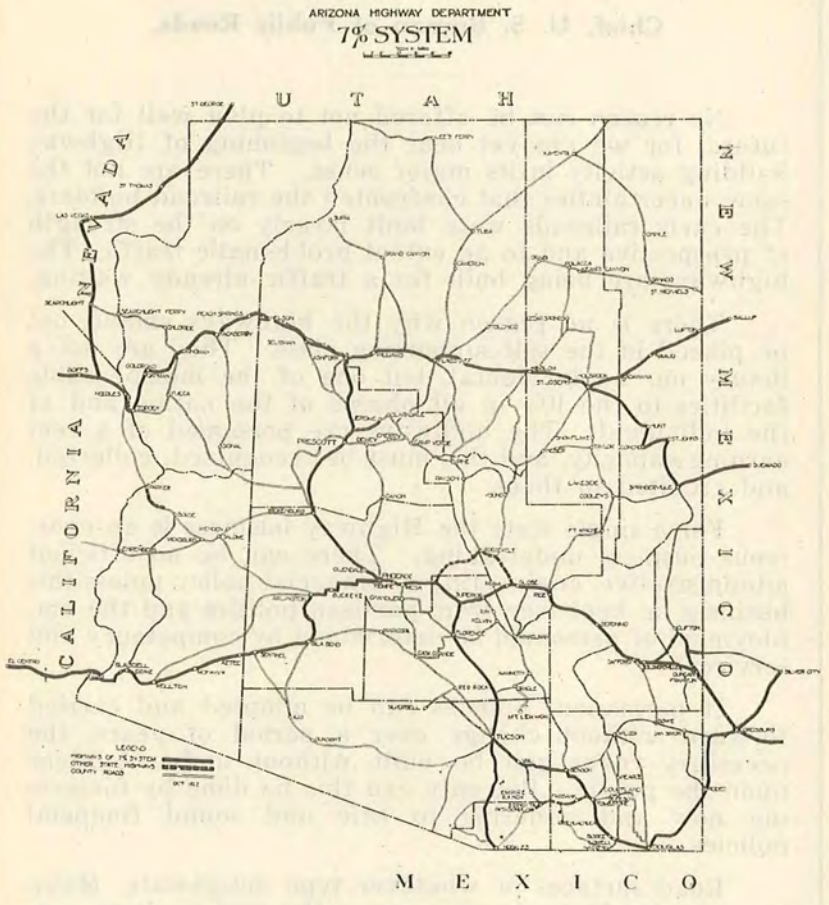
There is no reason why the highways should not be placed in the self-supporting class. They are not a luxury nor an incidental, but one of the indispensable facilities to the life in all phases of the nation and of the individual. The highways are possessed of a real earning capacity, and this must be recognized, collected, and credited to them.

For a single state the Highway business is an enormous business undertaking. There can be no efficient administrative, engineering or financial policy unless this business be kept free from partisan politics and the employment of personnel be determined by competency and service.

If permanent policies can be adopted and carried forward without change over a period of years, the necessary roads can be built without undue burdens upon the public. But only can this be done by foreseeing now and adhering to safe and sound financial policies.

Road surfaces of whatever type deteriorate. Maintenance should begin as soon as the surface is thrown open to traffic, and, the higher the cost of the road, the more careful in detail should be the maintenance.

Sufficient revenues must be derived from the users of the highways to pay all of the maintenances and a percentage of any reconstruction charges.



MAP OF ARIZONA 7% SYSTEM

SEVEN PER CENT SYSTEM

INTERSTATE ROAD PROGRAM

The Arizona Seven Per Cent Highway System was approved September 1st, 1922, this being one of the earliest approvals of such systems in the United States. A map of the Arizona Seven Per Cent System is shown in this report. A glance will show the routes embraced. It connects with the California road system at Topock and Yuma. With New Mexico there are four connections, one near Lupton, Arizona; one near Springerville, Arizona; one at Franklin, Arizona, and one at Rodeo, New Mexico. There are two connections with the Republic of Mexico, one at Nogales and the other at Douglas. Connections with Nevada and Utah are made through a line running diagonally across the extreme northwestern corner of the State in the vicinity of Littlefield.

The Arizona Seven Per Cent System embraces approximately 1460 miles of Federal aid road, 900 of which are already improved or under construction. Ninety per cent of the roads previously constructed by the state and territory are included in the system, the ten per cent exception being the road between Parker and Bouse, 26 miles of the Prescott-Jerome highway, the Apache Trail, the Clifton-Solomonville and Clifton-Duncan roads, the Mule Creek connection with Silver City, New Mexico, and the Tombstone-Patagonia road.

NATIONAL AND STATE SYSTEMS

The National Seven Per Cent System of highways constitutes approximately 180,000 miles of roads which the federal and state highway authorities consider of greatest value. The seven per cent legislation was passed by Congress in a desire to concentrate federal road expenditures on the main arteries of transportation. The highway act provides for

co-operation by the federal government with the states in the improvement of but seven per cent of the total road mileage in each state, hence the name "Seven Per Cent system."

The seven per cent was divided into three per cent primary or interstate, and four per cent inter-county, but in the eleven western public land states practically the entire seven per cent will be absorbed in the construction of interstate roads.

To date no differentiation has been made by the federal law or by the rules and regulations of the Bureau of Public Roads between the primary and secondary highways, as to funds available from the government, the width of the road or the type of surfacing.

In length Arizona's portion of the seven per cent system is less than one per cent of the total seven per cent mileage in the United States. A glance at the map indicates that these roads pass through nearly every large city and town in Arizona. Nearly two-thirds of Arizona's Seven Per Cent system is already improved.

The federal government has authorized the expenditure of $50,000,000 on the national system for this fiscal year, $65,000,000 for next year and $75,000,000 for the year following. Arizona's proportion is approximately 1.4 per cent of the total.

At the present rate of progress, it is conservatively estimated by the Arizona Highway Department that Arizona's Seven Per Cent system will be so improved within the next fifteen months that it will be possible to average thirty miles per hour in traversing any road across the State.

In addition several important state road connections with the system will be made during this period.

Counties Consulted

The Federal Highway Act approved November 9th, 1921, contains the following provisions:

"Sec. 6. That in approving projects to receive Federal aid under the provisions of this act the Secretary of Agriculture shall give preference to such projects as will expedite the completion of an adequate and connected system of highways, interstate in character.

"Before any projects are approved in any State, such State, through its State Highway Department, shall select or designate a system of highways not to exceed 7 per cent of the total highway mileage of such State as shown by the records of the State Highway Department at the time of the passage of this act.

"Upon this system all Federal aid apportionments shall be expended.

"Highways which may receive Federal aid shall be divided into two classes, one of which shall be known as primary or interstate highways, and shall not exceed three-sevenths of the total mileage which may receive Federal aid, and the other which shall connect or correlate therewith and be known as secondary or intercounty highways, and shall consist of the remainder of the mileage which may receive Federal aid.

"The Secretary of Agriculture shall have authority to approve in whole or in part the systems as designated or to require modifications or revisions thereof."

The bill was before Congress for several months, and was practically sure of passage with certain amendments. Anticipating its passage, the State Highway Department considered it of the utmost importance to determine the mileage of roads in Arizona, in order that it might be available at the time of the passage of the act. Letters were, therefore, written to the County Engineers of every county in Arizona, asking them to furnish this Department with a map of their respective counties, showing the roads, together with a report as to the total mileage. It was difficult in many cases to get a definite report, owing to the fact that many of the desert and mountain trails were not included. Subsequent letters were sent out asking that every road which could reasonably

be called a road, be included. The mileage as finally reported on by counties is shown in the following table:

Apache	1,030.0	miles
Cochise	1,500.0	"
Coconino	1,500.0	"
Gila	732.5	"
Graham	1,033.5	"
Greenlee	424.0	"
Maricopa	2,444.0	"
Mohave	2,500.0	"
Navajo	879.0	"
Pima	1,310.5	"
Pinal	3,430.0	"
Santa Cruz	517.5	"
Yavapai	2,111.0	"
Yuma	1,988.0	"
Total	21,400.0	"

It will be noted that the total mileage of roads reported is 21,400. Seven per cent of this is 1,498 miles, which is the limit that could be included in the seven per cent system to be submitted to the Secretary of Agriculture, for approval. This mileage compared closely with what had already been recognized as the State Highway System.

That system was therefore submitted to the Secretary of Agriculture for approval, and is described as follows, the controlling points being indicated:

Yuma, Gila Bend, Phoenix, Comet Peak, Florence, Tucson, Benson, Douglas, New Mexico Line near Rodeo. (Comet Peak is located near the junction of the Mesa-Superior and Florence-Superior roads).

Comet Peak, Globe, Safford, Duncan, New Mexico Line.

Topock, Kingman, Ashfork, Flagstaff, Winslow, Holbrook, Lupton, New Mexico Line.

Ash Fork, Prescott, Wickenburg, Phoenix.

Tucson, Nogales.

Nogales, Tombstone.

Following is copy of letter transmitting map of proposed seven per cent system to the Bureau of Public Roads, and answer received:

System Proposed by State Engineer

Phoenix, Arizona, December 30th, 1921.

E. S. Wheeler, Dist. Engr., ,
U. S. Bureau of Public Roads,
Albuquerque, New Mexico.

Dear Sir:

We herewith submit tentative 7 per cent system of Arizona.

The mileage of roads in the various counties of the State is approximately 21,400 miles, which compels us to limit our 7 per cent system to approximately 1,500 miles. This is a reduction of approximately 300 miles from the roads suggested by your office, but this action is in accordance with the instructions of Mr. MacDonald, contained in the first paragraph beginning on page nine of his report to the Secretary of Agriculture, for the fiscal year 1921:

> "The present policy is to assent to no expansion of the existing State system, to encourage a reduction of the systems as revisions are made, and as individual projects are considered to assure that they lie on routes which are sufficiently important to warrant complete improvements as construction work is continued over a period of years."

SUGGESTED BY YAVAPAI

You will note that this changes our former routing between Prescott and Phoenix, making it by way of Wickenburg instead of Canyon. This is the desire of the Highway Commission of Yavapai County, who have $1,500,000 from the sale of a bond issue to expend. It will result in the inclusion in the north and south highway and our 7 per cent system of No. 33, Federal Aid Project between Phoenix and Glendale; No. 10, the Agua Fria Bridge, and No. 31, Wickenburg Bridge. We can also early submit an additional Federal Aid Project from Glendale to Marinette in Maricopa County.

We have eliminated the road from the junction of the Apache trail east of Mesa thru Holbrook to Lupton, as we have not sufficient mileage for this road nor have we the

funds in sight for its construction. The major portion of the road from the junction east of Mesa to Holbrook also lies within the forest reservation so it will no doubt be taken care of by forest funds.

BOND MONEY IS SCARCE

We will endeavor to construct a road from Holbrook to Lupton, but in view of the fact that there is hope of little Apache county bond money being placed on this road and very small possibility of securing an appropriation from the legislature sufficient to construct this to Federal Aid standards, we believe that even if we had the mileage available we should not indirectly pledge the state to its early construction by incorporating it in the 7 per cent system.

We have also left off the road from Clifton to Duncan as this is a spur road. However, outside of the 7 per cent system, it will connect at Clifton with the forest road to Springerville, the state road over the mountain to Solomonville and a connection into Silver City, New Mexico, by way of Mule Creek. We are building this latter connection at the present time but not on Federal Aid standards.

PRIMARY ROAD SUGGESTED

We are submitting 95 miles of this 7 per cent system as primary. This will begin at the Hassayampa river, 10 miles west of Buckeye, where the road forks, one branch going southwest to Yuma, the other northwest to Ehrenberg and Parker.

From the Hassayampa the primary system will go thru Buckeye, Phoenix, Tempe, Mesa and southeastward to the junction of the roads runnings to Superior-Miami-Globe, etc., and the road running to Florence, Tucson, etc. We believe that this entire distance should be paved within a reasonable length of time as approximately half of it is paved at the present time.

Included in this section are several large river crossings which are going to require heavy expenditures in the near future. These bridges, together with the paving, when complete, will cost in the neighborhood of $5,000,000. The remaining portion of the State Highway system is estimated at $15,000 per mile, which, if anything is too low when consideration is given to the fact that most of the road will have to

be surfaced; much of it is over mountains and the drainage structures are expensive.

COST OF SEVEN PER CENT SYSTEM

The 7 per cent system as suggested will, therefore, cost over $25,000,000. To date the Federal Aid for Arizona is less than $5,000,000. We doubt if we can early anticipate more than $6,500,000 additional, which can only be secured if Congress should adopt a five-year road building program with $100,000,000 appropriation every year of the next five years.

This means that at the present we shall be subject to a total expenditure of $25,000,000, included in which would be only approximately $11,000,000 of federal funds.

At the present ratio of 61 to 39 the $11,000,000 of federal funds would require approximately $7,000,000 of state funds, while the 7 per cent program should necessitate nearly $14,000,000 of state funds.

We do not believe that we should assume a greater burden at this time than twice the funds required by Congress. Neither do we believe that it is wise for us to anticipate longer than five years in advance the necessities in main line highways for a state developing as rapidly as Arizona.

MILEAGE IS LACKING

Had we an additional mileage we would like to include all of the road suggested by you and additional mileage as, for instance, a road from Tucson to Sentinel and from Buckeye to Blythe and Parker, also many inter-county highways which are growing in importance.

Yours very truly,

THOMAS MADDOCK,
State Engineer.

Vital Changes Suggested by Federal Engineer

UNITED STATES DEPARTMENT OF AGRICULTURE

Bureau of Public Roads, No. 13

Albuquerque, N. M., January 24, 1922.

Mr. Thomas Maddock,
State Engineer,
State House, Phoenix.

Dear Sir:

This office has been requested to take up with you possible changes in your seven per cent map submitted January 3rd. The changes which are suggested, and regarding which we now request an opinion from you, are as follows:

WOULD ELIMINATE NOGALES-FAIRBANKS

(1) In view of the fact that the connections from Tombstone to Nogales and from Nogales to Tucson seem to be a duplication, and while very desirable in the final analysis, they are not particularly pertinent to the skeleton system at the present time, and it is suggested that they be eliminated from your map.

APPLIED TO THE NORTH

(2) The mileage resulting from such elimination would provide sufficient mileage to close the gap between Holbrook and Lupton, a very necessary connection in view of the fact that the State of New Mexico proposes a connection at Lupton primary in character. In fact, it would appear that this connection will almost be required. Further, this eliminated mileage would furnish a possible route from Grand Canyon connecting with your east and west northern route.

CUTTING OUT FLORENCE

(3) It is further suggested that the route between Phoenix and Tucson, instead of running by Florence, be changed so as to run thru Casa Grande, Sacaton, Chandler

and Mesa. This suggestion is made in view of the fact that, should the San Carlos Dam be constructed—and this is entirely probable—the proposed route would traverse and serve a very rich area. It would connect at Chandler with improvements carried on by Maricopa County, which are of a very high standard. There would be, then, a necessity of stub connection between Casa Grande and Florence. Very naturally, you can see that such a connection would admit of additions or extensions at a later date which would connect with Gila Bend, furnishing the shortest direct route to California.

YUMA-PHOENIX-DUNCAN

(4) After due consideration, it is believed that your southern, east and west route from Yuma via Gila Bend, Phoenix and Globe to Duncan, should be primary in character. Undoubtedly the remainder of the primary mileage should be located along the Topock-Lupton route.

COLORADO RIVER CROSSING

(5) What decision was reached during your visit to San Francisco in respect to a connection from Kingman by way of Boulder Dam and St. George connection in Utah is not of record in this office. While your mileage at this time may be limited to such an extent that serious consideration of this route would not be possible, this office would appreciate your view in respect to the same as an ultimate connection.

Please advise us at your convenience, and greatly oblige

Very truly yours,

E. S. WHEELER,
District Engineer.

Approval of System Secured

Subsequent discussions between the State Engineer and the District Engineer of the Bureau of Public Roads and finally a meeting of the Chief of the Bureau of Public Roads and Highway officials of the eleven western states resulted in a tentative agreement which was later approved, at least in so far as Arizona is concerned. The following correspondence relates to the final submission and approval of the system as approved:

Phoenix, Arizona, July 31, 1922.

Bureau of Public Roads,
325 West Washington St.,
Phoenix, Arizona.

Gentlemen:

We are submitting five copies of map of Arizona showing the 7% system, in accordance with the verbal understanding arrived at between the various state Highway Departments, at the meeting held in San Francisco at the call of Mr. Thomas H. MacDonald, Director of the Bureau of Public Roads, on July 25-26, 1922.

The primary system as shown includes all of the possible primary mileage in the State of Arizona and the secondary includes nearly all of the second mileage. The distances shown, while approximate, are very close to what will result on final construction.

The road from Mesquite to the Utah State Line, made a portion of the State 7% system at the request of the Bureau to provide for a connection with the systems of Utah and Nevada, will serve but little of the population of this State and on this account we believe that we should not be required to construct this road to Federal Aid standards before extending our 7% system, unless the portions of this thru road in Utah, Nevada and California, which States are interested in this connection, have been brought to Federal Aid standards. In the meantime Mohave County is improving this road as a county highway.

At the suggestion of the Bureau of Public Roads, we have placed on our secondary system the connection between Holbrook and Lupton with the understanding that in return for this action on the part of Arizona, New Mexico will place on her 7% system the road from Lordsburg to Franklin.

As requested by the Bureau the road from Nogales to Fairbanks has been eliminated from the 7% system in order to provide the necessary mileage for interstate connections.

We would appreciate the early approval of this system.

Yours very truly,

THOMAS MADDOCK,
State Engineer.

The following leter approving the system was received from the Department of Agriculture, Washington, D. C.

September 1, 1922.

Mr. Thomas Maddock,
State Highway Engineer,
Phoenix, Arizona.

Dear Mr. Maddock:

After careful consideration of the system of Federal aid highways selected and submitted by the State Highway Department of Arizona, pursuant to provisions of Section 6 of the Federal Highway Act, the same has today been approved by me, in accordance with recommendation of the Bureau of Public Roads, which recommendation is based on the certificate of the State Highway Department that according to its records at the time of the passage of the Federal Highway Act, that is, November 9, 1921, the total highway mileage of the State was 21,400 miles, 7 per cent of which would be 1,498 miles. The Bureau of Public Roads states that the routes which the State Highway Department has selected and designated aggregate approximately 1,498 miles, so that the system does not exceed the mileage allowed by law.

The routes embraced in the system of Federal aid highways as approved for Arizona are indicated by the following controlling points:

Yuma, Gila Bend, Phoenix, Comet Peak, Florence, Tucson, Benson, Douglas, New Mexico Line.

Comet Peak, Globe, Safford, Duncan, New Mexico Line.

Topock, Kingman, Ashfork, Flagstaff, Winslow, Holbrook, Lupton, New Mexico Line.

Ashfork, Prescott, Wickenburg, Phoenix.

Tucson, Nogales.

Utah Line, Littlefield, Nevada Line.

Holbrook, St. Johns, Springerville, New Mexico Line.

In connection with the consideration and approval of the system of Federal Aid Highways selected and submitted by the Highway Departments of the several states respectively,

it has been considered advisable to defer until later the determination of the classification which shall be given to each of the routes embraced in the system for each state. The relative importance of the various routes has been carefully considered, but, even so, it is thought desirable for the present to postpone the determination of which of the routes shall be designated as primary or interstate and which shall be designated as secondary or intercounty, as future study may develop additional information which might influence the final classification.

It is recognized also that the final location on which shall be constructed each route, or portion of route, between the controlling points named in the memorandum showing approval by this Department will be a matter for determination later as location surveys are made and other information which should govern develops, and may not necessarily follow the location between these controlling points as shown on the maps submitted by the States.

It is conceded that it may not be practicable for some States to select at this time the whole of the 7 per cent system, and, in such cases, of course, the approval of a mileage less than 7 per centum of that certified by the State Highway Department as the total highway mileage of the State will be subject to later extensions by approval of supplemental routes, increasing the mileage to not exceed the 7 per centum authorized by law.

In view of the foregoing, approval of the system of Federal aid highways as selected and submitted by the State Highway Department of Arizona is with the understanding and subject to the following conditions.

1. That approval at this time is without classification as to primary or interstate and secondary or intercounty, but such classification shall be made within 2 years after the approval of the Federal Highway Act, i. e., on or before November 9, 1923, in order that this Department may prepare, publish, and distribute the map required by section 15 of said Act.

2. That approval of routes on the system of Federal Aid Highways submitted by a State as touching certain specified controlling points is not to be construed as approval for construction on the location shown on the map between such controlling points, but such location for construction shall be subject to later determination in the light of loca-

tion surveys and other pertinent information which may develop.

The location for construction of sections of a route between the controlling points will be considered project by project as project statements are submitted, and each project will be examined in the same way and will be subject to the same requirements as heretofore.

3. That any errors or omissions shall be subject to correction.

4. That the mileage computed as constituting 7 per centum of the total highway mileage of each state is based solely upon the certificate submitted by the State Highway Department of the total highway mileage of such State as shown by the records of the State Highway Department thereof at the time of the passage of the Federal Highway Act.

5. That where the mileage embraced in the system of Federal Aid Highways shown on the map submitted by a State is less than 7 per centum of the total highway mileage of such State, additional routes may subsequently be submitted for consideration and approval within the 7 per cent limit.

Sincerely yours,

HENRY C. WALLACE,
Secretary,

Forest Highways

Besides Federal Aid allotted to Arizona there was also available out of Federal Appropriations up to and including the fiscal year 1923, approximately $715,000 to be expended by the Forest Service on road construction in Arizona. Of this amount $484,500.00 was to be expended on Forest Highways in or adjacent to the National Forests, and the remainder to be spent for the development of the forests themselves. The State Highway Department requested that the entire $484,500.00, as well as subsequent appropriations of a like nature be expended on roads embraced in the 7% system, and lying within the forests, until those roads were completed. However, only about one-half of this money was allotted to this system, this amount being allowed for the road from Prescott to White Spar and the road from Flagstaff to Canon Padre. The following letter shows the program of road construction to be undertaken by the Forest Service in Arizona:

UNITED STATES DEPARTMENT OF AGRICULTURE

Albuquerque, N. Mex., May 31, 1922.

Mr. Thos. Maddock, State Engineer,
Phoenix, Arizona.

Dear Mr. Maddock:

I am glad to inform you that the Secretary of Agriculture on May 22, 1922, approved the Arizona Forest Highway program, to be undertaken with the funds made available by the act of November 9, 1921. The projects approved, the estimated cost and the funds to be used, are as follows:

Project	Mi.	Est. Cost	F. H. F.	Sec. 8	Coop.	Total
*Prescott-White Spar	18.	$ 145,000	$145,000	.....	.....	$ 145,000
Clifton-Springerville	44.	240,000	10,000	230,000	.....	240,000
Camp Verde-Fossil Creek	20.	282,000	50,000	.....	232,000	282,000
Strawberry-Fossil Creek	11.	110,000	77,000	.....	33,000	110,000
Salt River-Pleasant Valley, Sec. 1	18.	109,000	77,000	.....	32,000	109,000
*Flagstaff-Angel	22.	184,000	125,500	.....	.....	125,500
		$1,070,000	$484,500	$230,000	$297,000	$1,011,500

Very sincerely yours,

FRANK C. W. POOLER, District Forester.
By R. E. Marsh, Acting.

In submitting projects to the Bureau of Public Roads for approval the two projects marked "*" have been omitted, as they are to be constructed by the Forest Service without State funds.

This Department believes that the efforts of the State of Arizona in Highway Construction should be centered on the completion of the 7% system to the exclusion of everything else, until the system is completed. While there are many other roads of great importance which need to be improved, the 7% system includes the main arteries of thru traffic, which should provide continuous and uninterrupted service to the large number of people who are constantly using them.

The program at first glance looks very large, but when the fact is taken into consideration that the construction of this system is already nearly complete, it would appear the part of wisdom to see that it is fully completed without being sacrificed for other projects of more or less local or scenic importance.

STATUS SEVEN PER CENT ROADS

In order that any one interested may be apprised of the present status as regards construction of the highways included in the 7% system, the following brief summary is given, the roads being taken in the order in which they appear in the letter of the Secretary of Agriculture approving the System.

The entire System has been surveyed with the exception of a few small sections on which survey parties are now working. In the descriptions the following symbols are used for the sake of brevity.

FA	Federal Aid
BPR	U. S. Bureau of Public Roads
AHD	Arizona State Highway Department.
SE	State Engineer
Co.	County
st.	started
com.	completed
beg.	beginning
surf.	surfaced
Pvt.	pavement

PS. .....Project Statement
PS&E ..... Plans, Specifications and Estimates
PA .....Project Agreement
sub. .....submitted

A number following the letters "FA" indicates the number of the Federal Aid Project, for example, "FA 26" means Arizona Federal Aid Project No. 26. In describing the condition of roads federal aid requirements are taken as the standard, for example: if the word "narrow" occurs, it means that the roadway is too narrow to comply with federal aid requirements, etc.

Yuma-Phoenix

205-1 Miles

Yuma to beg. FA 26 surf. Co. & AHD constructed.. 7.1 miles

FA 26 Sec. B to Blaisdell AHD constructed surf. 1921-22 ..... 6.8 "

To Liqurta Co. and AHD constructed 1914 surf. narrow, sharp curves .....13.2 "

To Wellton FA 26 Sec. D; AHD constructed surf. 1922 ..... 9.9 "

To Aztec FA 55, FA approved construction st. 1922 .....42.6 "

To Maricopa Co. line unimproved, FA 55 Revised PS sub. 1922 ..... 7.0 "

To Piedra, unimproved, FA 69, PS sub. 1922.....22.2 "

To Gila Bend FA 56, approved AHD construction 60% complete 1922 .....14.9 "

To Gillespie Dam FA 53, surf. narrow AHD construction 90% complete 1922 .....23.5 "

Cross Gila River on apron of Gillespie Dam.....

To Hassayampa FA 64, PS sub. 1922 AHD constructed .....11.6 "

Cross Hassayampa River steel bridge AHD constructed 1922 .....

To Buckeye FA 71 PS sub. 1922, grading done AHD constructed 1922, to be paved 9' wide.... 9.4 "

To Agua Fria, FA 46, Sec. B. Co. construction concrete pvt. 16′ wide 1922 ..... 18.4 "

Cross Agua Fria concrete and pile bridge earth fill approaches temporary construction, AHD 1916-22 ..... 1.0 "

To Phoenix FA 46 Sec. A, Co. construction, pvt. 16′ wide, 1921 ..... 15.5 "

Phoenix-Comet Peak

53.0 Miles

To Mesa, FA 30, 2, 8 AHD constructed, pvt..... 16.0 miles

To Eastern Canal, AHD constructed, conc. pvt. FA 47 ..... 4.5 "

FA 65, PS sub. 1922, graded 1922 ..... 4.0 "

To Junction AHD constructed, surf. 1921, good condition ..... 6.9 "

To beg. FA 7, AHD constructed, surf, 1918-1919.... 9.9 "

To Comet Peak, FA 7, AHD constructed surf. 1919-20 ..... 11.7 "

Comet Peak-New Mexico Line

(Via Superior)

180 Miles

To Superior, FA 23, AHD constructed, surf. 1921-22 ..... 16.0 miles

To Miami, FA 16, AHD constructed surf. 1919-1922..... ..... 20.7 "

To Globe, Co. constructed conc. pvt. 1917..... 8.0 "

To Boundary Indian Reservation, AHD constructed, improved 1916 ..... 5.0 "

To Rice, Sections A & B, FA 15, AHD constructed surf. 1921 ..... 18.0 "

To Point 5 mi. west Geronimo, temporary road, surf. 1920 ..... 27.3 "

To Geronimo, Sec. D, FA 15, AHD constructed surf. 1921 ..... 5.0 "

To Mathews Wash, AHD constructed surf. 1921-22 ..... 14.5 "

To Central PS 63 sub. 1922, fair condition ..... 8.0 "

To Safford, FA 43, AHD constructed conc. pvt., construction st. 1922 ..... 6.5 "

To point 2 mi. east of Solomonville PS 67 sub. 1922 ..... 7.5 "

To Junction Co. construction st. 1922 ..... 10.0 "

To Duncan, unimproved narrow desert road existing ..... 30.0 "

To Franklin and State line, part FA 13, AHD constructed surf. 1919-1920 ..... 3.5 "

Comet Peak to New Mexico Line

(Via Tucson)

267.2 Miles

Comet Peak to Florence, Sections A & B, FA 23, AHD constructed surf. 1920-1922 ..... 14.8 miles

Cross Gila River at Florence concrete Bridge, 1450', AHD constructed 1911-18, includes FA 1

To a point 4.0 miles north of Tucson AHD constructed surf. 1922 ..... 64.0 "

To Tucson, FA 9, AHD constructed paving 1920 .... 3.8 "

Thru Tucson paved streets ..... 3.0 "

To beg. FA 18, AHD constructed surf. narrow, good condition ..... 24.7 "

To Benson, FA 18, AHD constructed surf. 1920-1922 ..... 27.4 "

To Junction Tombstone-Fairbank Hwy. Co. constructed surf. 1919-20 ..... 25.6 "

To Tombstone, AHD constructed 1919 ..... 4.0 "

To point 10 mi. south AHD constructed surf. 2" asphaltic concrete 1922 ..... 10.0 "

To Bisbee, AHD constructed surf. 1918 ..... 16.2 "

To Douglas, AHD and Co. constructed concrete

paving, 1920, includes FA 11 ..... 24.6 "
To New Mexico State line, AHD and Co. constructed surf. 1920-1921, includes FA 14 & 38 ..... 49.1 "

Tucson to Nogales

67.2 Miles

FA 29, AHD surf. concrete pvt. 1921 ..... 9.0 miles
To Co. line, Co. constructed surf. 1917 ..... 26.4 "
To point 2 miles north of Nogales, AHD constructed surf. 1917 ..... 29.8 "
To Nogales AHD constructed conc. pvt. 1922 ..... 2.0 "

Ashfork to Phoenix

168.4 Miles

Ashfork to Tusayan Forest Boundary Line, FA 62, PS&E sub. 1922 ..... 23.7 miles
To Prescott, FA 61, and 36, AHD constructed surf. 1922 ..... 26.5 "
To White Spar, Forest Project, no road at present ..... 18.5 "
To Congress Junction, FA 72, PS sub. 1922 unimproved ..... 29.5 "
To Wickenburg, AHD constructed surf. 1922 ..... 16.0 "
Cross Hassayampa River, Steel Bridge, AHD constructed 1921, FA 31
To Hot Springs Jct. FA 59, AHD construction st. 1922 ..... 10.7 "
To FA 70, AHD construction st. 1922 ..... 23.0 "
To Agua Fria River, FA 70, PS sub. 1922, unimproved ..... 3.0 "
Cross Agua Fria River, conc. bridge AHD constructed 1921
To Marinette, FA 70, PS sub. 1922, unimproved .. 1.0 "
To Glendale, FA 48, Co. constructed concrete pvt. 1922 ..... 7.5 "

Project crosses New River, conc. bridge, (under construction) Co.

To City limits of Phoenix, FA 33, AHD constructed concrete pavement 1922..... 9.0 "

Topock to Holbrook

337.6 Miles

Enters Arizona by bridge crossing Colorado River at Topock.

To Boundary Cone, FA 39, AHD constructed surf. 1921-22 .....21.1 miles

To Oatman, AHD constructed surf..... 3.2 "

To Goldroad, FA 5 and 44, AHD constructed surf. 1921 ..... 2.7 "

To Kingman, AHD and Co. constructed 1916 and 1921 .....26.6 "

To Peach Springs, Co. construction, narrow, 1917..52.0 "

To Pica, AHD constructed surf. 1921..... 8.0 "

To Seligman, Co. constructed 1921.....42.1 "

To Ashfork, AHD constructed surf. 1922, includes FA 57 .....24.6 "

To Williams, AHD constructed surf. 1921-1922, includes FA 51 and 37.....20.0 "

To Flagstaff, AHD constructed surf. 1919-1921, includes FA 24 .....37.0 "

To Winslow, unimproved .....67.7 "

Thru Winslow, FA 20, AHD constructed pvt. 1922 1.0 "

To Holbrook, FA 40, AHD constructed surf. 1922..31.6 "

Holbrook to New Mexico Line

(Gallup Route)

82.5 Miles

To Apache County Line, Co. improved, partially surf. 1922 .....20.0 miles

To Lupton, AHD constructed narrow, partially surf. 1922 .....62.5 "

Holbrook to New Mexico Line

(Springerville Route)

116.3 Miles

From Holbrook to FA 42, Co. constructed surf. 1921 ..... 6.6 miles

To Petrified Forest, FA 42, AHD constructed surf. 1922 ..... 10.6 "

To Apache County line, FA 3, AHD constructed surf. 1921 ..... 3.7 "

To Hunt, Co. constructed surf. narrow, 1921..... 18.0 "

To Concho, FA 6, AHD constructed surf. 1921-1922 ..... 12.6 "

To St. Johns, Co. constructed 1919, surf. narrow, sharp curves ..... 17.1 "

FA 60, AHD construction st. surf. 1922..... 12.0 "

To Springerville, FA 68, PS sub. 1922, unimproved ..... 19.5 "

FA 63, PS sub. 1922, unimproved ..... 10.0 "

To New Mexico line, unimproved, fair road..... 6.2 "

Arrowhead Trail

18.8 Miles

Utah line to Nevada line, unimproved..... 18.8 miles

AN ACKNOWLEDGMENT

It is with great pleasure that I can at this time acknowledge the benefits secured to the people of Arizona by the aid and co-operation given to the Arizona Highway Department by the Federal Bureau of Public Roads.

The insistence of the Bureau on a high type of road construction has been invaluable to this Department in meeting some popular opposition to the expenditures necessary to secure permanent types of construction.

Our ability to depend upon the verbal assurances and the fairness of the Bureau's engineers, and their reliance on our engineering and inspection in endeavors to secure the best return for mutual expenditures have permitted the elimination of a great deal of duplication in work, and materially advanced the time of completion of all Federal Aid projects. We especially appreciate the efforts of the engineers in the Bureau to reduce to a minimum the usual red tape encountered in most transactions between the State and the Federal Government.

FEDERAL AID

LIMIT IS SECURED

Two years ago great concern was felt that a large amount of Federal Aid appropriated to Arizona would be lost to the State, because it could not be matched with State money. At that time the total appropriation for Federal Aid allotted to Arizona amounted to $3,771,351.69. Since that time an additional $1,053,281.44 has been appropriated and $702,-188.00 more authorized to be appropriated, on which the State is allowed to submit project statements and to enter into project agreements, making a grand total of $5,526,-821.13 allotted to Arizona.

Not only has all this Federal Aid been applied for, but on a number of projects, it was necessary to request less than the legal limit, in order to divide the Federal Aid over the desired number of projects. The latter action was taken with the understanding that when further Federal aid becomes available, Federal participation will be increased to the legal limit, without having to wait for the long delays incident to examination, and investigations of the project before Federal Aid is approved. This will advance the final completion of our projects some six months, and enable construction work to start on about twice as much road construction this fiscal year.

Several steps are necessary to secure Federal Aid, each step superseding previous ones, in so far as they differ. The first step is to submit a Project Statement, briefly describing the project, and furnishing an estimate of the cost. When this project statement is approved, Federal Aid based on that estimate is set aside and becomes allotted. The next step is to submit plans, specifications and estimates. When these are approved, the Federal Aid is based on that estimate and if different from the project statement estimate, supersedes it.

The next step is the Project Agreement. This is usually in the same amount as the estimate accompanying the plans and specifications, but in some cases is different, and, therefore, supersedes the estimate just previous. In some cases it is necessary or desirable to have Project Agreements modified and based on bids received. When approved each esti-

mate supersedes the previous one, and becomes the basis of determining the amount of money allotted. The next and final step is the payment of vouchers for work done. When the work is completed and final voucher paid, the project is closed and the final voucher supersedes all previous estimates.

STATUS OF PROJECTS

Therefore, in order to determine the status of Federal Aid funds, it is necessary to divide the projects into several classes, depending on their status. The following tables show the status of various Federal Aid projects in Arizona. The first shows completed projects and the amount of Federal Aid, based on the completed work. The second shows Federal Aid allotted on the basis of project agreements, or the last modified project agreement; the third shows Federal Aid allotted on the basis of approved plans, specifications and estimates, and the last shows Federal Aid allotted on the basis of Project statements:

Completed Projects

Federal Aid. No.	Name of Project	Federal Aid
1	Florence Bridge	$ 55,982.23
2	Phoenix-Tempe Highway	46,249.81
3	Holbrook-St. Johns Highway	13,990.46
5	Oatman-Goldroad Highway	33,517.64
6	Holbrook-St. Johns Highway	27,857.75
7	Mesa-Superior Highway	62,910.04
8	Tempe-Mesa Highway	103,209.54
9	Tucson-Florence Highway	58,009.00
10	Agua Fria Bridge	30,138.78
11	Bisbee-Douglas Highway	137,361.77
12	Prescott-Jerome Highway	37,260.00
13	Clifton-Franklin Highway	72,312.68
14	Douglas-Rodeo Highway	40,618.27
15	Globe-Geronimo Highway	87,657.38
16	Superior-Miami Highway	422,349.50
17	Prescott-Jerome Highway	99,539.16
18	Benson-Vail Highway	156,712.01
21	Flagstaff Paving	24,205.97
23	Florence-Superior Highway	112,614.54
24	Flagstaff-Williams Highway	87,249.80
25	Tucson-Nogales Bridges	20,165.77
26	Yuma-Welton Highway	73,922.16

27	Nogales-Fairbank Highway	47,700.38
28	Ray-Superior Highway	29,204.09
29	Tucson-Nogales Highway	128,103.17
30	Phoenix-Tempe Highway	47,245.51
31	Wickenburg Bridge	34,816.38
33	Phoenix-Glendale Highway	124,763.45
37	Williams-Ashfork Highway	30,606.77
38	Douglas-Rodeo Highway	80,301.76
39	Topock-Oatman Highway	78,422.10
44	Oatman-Goldroad Highway	5,557.29
46	Phoenix-Buckeye Highway	502,230.43
47	Mesa-Superior Highway	67,837.03
	Total	$2,980,622.62

Project Agreements

Federal Aid No.	Name of Project	Federal Aid
19	Prescott-Jerome Highway	$ 94,130.21
23	Florence-Superior Highway	116,872.04
36	Prescott-Jerome Highway	48,380.47
40	Winslow-Holbrook Highway	103,732.50
48	Glendale-Marinette Highway	156,524.07
49	Nogales-Fairbanks Highway	62,732.29
51	Williams-Ashfork Highway	19,333.82
54	Kingman-Oatman Highway	25,333.63
57	Ashfork-Seligman Highway	75,435.46
	Total	$ 702,474.49

Plans, Specifications and Estimates

Federal Aid No.	Name of Project	Federal Aid
20	Winslow Paving	$ 24,487.97
42	Holbrook-St. Johns Highway (Navajo County)	44,668.90
53	Gila Bend to Gillespie Dam	111,227.14
55	Welton-Maricopa County Line	185,182.69
56	Gila Bend to Piedra	81,720.55
59	Wickenburg to Hot Springs Jct.	201,742.13
60	St. Johns-Springerville Highway	63,346.51
61	Prescott-Ashfork Highway	124,511.99
62	Prescott-Ashfork Highway	140,690.00
63	Geronimo-Solomonville Highway	170,288.45
43	Geronimo-Solomonville	104,870.78
	Total	$1,252,737.11

Project Statements

Federal Aid No.	Name of Project	Federal Aid
22	Winslow-Coconino County Line	$ 7,979.40
64	Gillespie Dam-Hassayampa River Highway	52,921.00
65	Mesa-Superior	31,361.27
66	Tucson-Nogales Bridges	9,193.93
67	Geronimo-Solomonville Highway	61,635.20
68	St. Johns-Springerville Highway	28,725.12
69	Piedra-Yuma County Line	53,567.25
70	Phoenix-Wickenburg	32,330.65
71	Hassayampa River-Buckeye Highway	51,521.25
72	White Spar-Congress Junction	104,500.00
73	Springerville-New Mexico State Line	15,881.25
	Total	$ 449,616.32

Recapitulation

	Federal Aid
Total Completed Projects	$2,980,622.62
Total Project Agreements	702,474.49
Total Plans, Specifications, Estimates	1,252,737.11
Total Project statements	449,616.32
Grand Total Federal Aid encumbered	$5,385,450.54

It will be seen from the above that a total of $5,385,450.54 has been allotted, out of a total of $5,526,821.13 available. When projects numbered 62, 64, 65, 66, 67, 68, 69, 70, 71, 72 and 73 have been changed to provide for the legal limit of Federal Aid participation, approximately $600,000 additional Federal Aid not yet available will be covered.

Since all Federal Aid funds must be spent on the 7% system, and since the construction of the 7% system is so far advanced, there can be practically no choice about what projects should be submitted, and it is believed advisable to have all the system approved as Federal Aid projects as soon as possible, in order to avoid later delays.

LOCATION OF HIGHWAYS

By C. C. Small
Chief Locating Engineer

The policy adopted by the Arizona Highway Department in the location of highways to get the greatest value for the dollar expended, is common to any engineering project. However, to go into greater detail the following outline of the objectives sought is briefly set forth:

It is believed that but very few who have followed the development in highway improvement and the increased traffic on our main roads comprising the 7% system will care to differ when the statement is made that the time is not far distant when this section of our highways will be paved. With this paving in view it has been the policy of the Department to locate the roads so that the present construction plus the future paving will give the most economical lay-out. To those who may contend that the paving of the 7% system is too distant to warrant such construction it may be said that the saving to traffic and maintenance by elimination of distance and curvature will pay back to the taxpayers the additional money invested, before the road is paved. We then have, when the time arrives for this improvement, a well-settled roadbed with easy grades and curves ready for the paving. An authority has said: "It is well to remember that the only permanent feature of roadwork is repair." However, it is conceded that the section of the road more nearly approaching permanence is the drainage structures and roadbed. In one of the counties of this State we have a bad example of the policy of placing a so-called permanent pavement on a newly widened grade built to receive the same.

While it may not be pertinent to discuss the theory of location, there are many outstanding facts connected therewith which are worthy of attention. It is a fact that the cost of operating an automobile exceeds ten cents per mile. With a traffic of two hundred cars a day, the elimination of one mile in distance would mean a saving of $20.00 per day, or a total saving of $7,300.00 per mile per year. If the State can borrow money at 5% interest, this will represent a capitalized amount of $146,000.00 that the State can afford to

spend to eliminate one mile of distance. Only two miles of the Arizona Highways have cost this much, and if we take an average of the cost per mile of all of the roads built at $15,000.00 we can alter our premises at will and still show the financial advantage of eliminating distance.

Let us take the above example of two hundred cars per day and the saving of a distance of one mile, which we have capitalized at a saving of $146,000.00. For the sake of argument we will concede that about one-half of the cars passing over this route are from without the State, and the taxpayers of Arizona are little interested in saving distance to this traffic. We will further concede that one-half of the Arizona cars are used for pleasure and would travel a certain distance regardless of any detail of road location. This will leave us fifty cars still traveling the main highway. We are then warranted in spending $36,500 to save one mile of distance. This being a fact today, there can be no argument against the elimination of distance when future traffic is concerned.

In addition to the above, the reduction of distance will show a financial return in reduced maintenance cost. In the above example we cancelled 75% of the traffic as not of direct interest to the taxpayers of the State. When we consider maintenance, unfortunately we must consider all the traffic as adversely affecting this item and practically in direct proportion to the volume of traffic. Assuming the cost of maintenance at $300.00 per mile—a figure not excessive at the present time, but insufficient for future traffic requirements—we have, capitalizing this amount at 5%, an addition of $6,000.00 which can be expended to eliminate one mile of distance.

The above features of the locations have received careful attention. However, the alignment requirements of the U. S. Bureau of Public Roads have compelled a standard more exacting than adopted by the State. That the shortest practical route is more economical to construct is obvious in sections requiring but little grading. In sections requiring heavy construction the difference between the shortest practical route with good alignment and the more tortuous longer route is seldom but a small per cent of the cost of the finished project.

Criticisms have frequently been made in the past four years that the roads were not so located as to secure the best interests of all the people. This criticism has largely been brought about, we believe, by some isolated instances where

a small store, postoffice or few ranchers have been left to one side of the relocated highway.

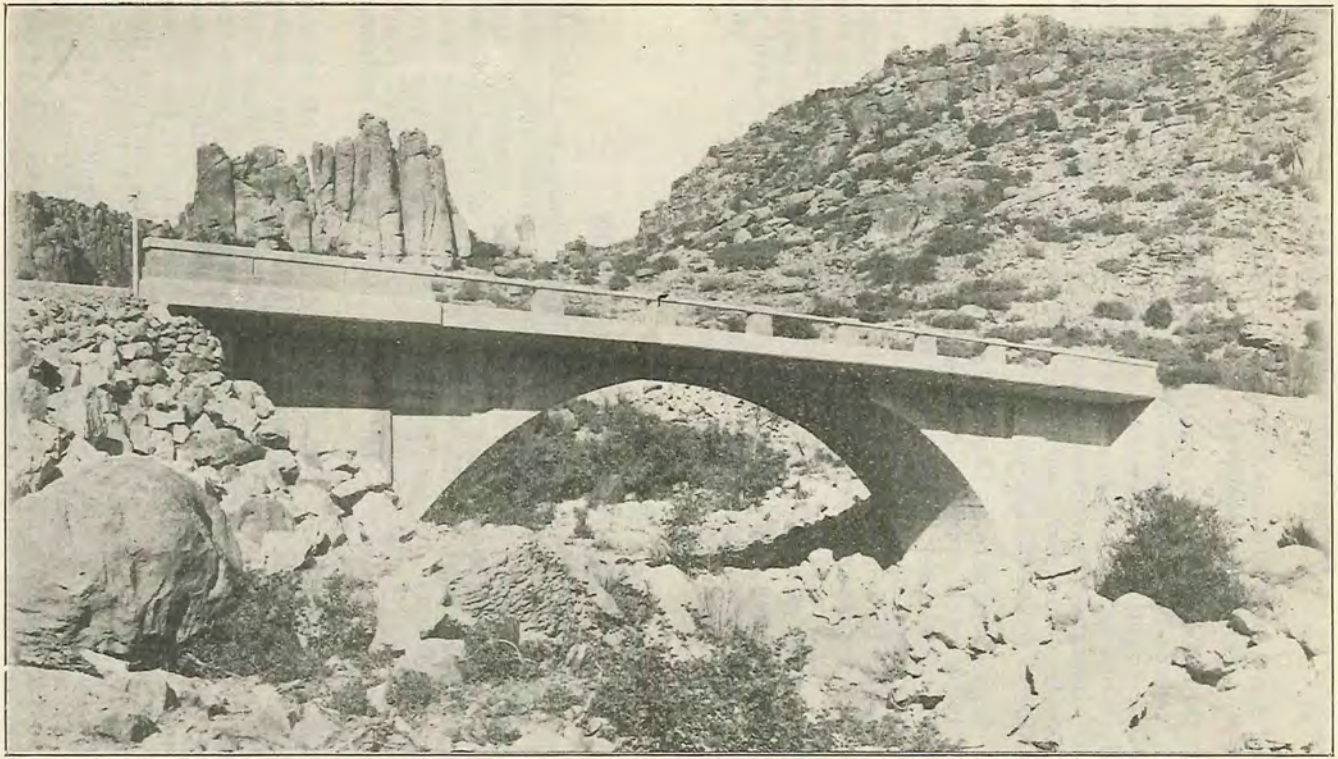
It should be borne in mind, as the figures show, that the 7% System is but one-fourteenth of the road mileage of the State and counties of Arizona, and that this 7% system has been laid out as a trunk line highway. If the main system is properly designed the future State and county highways can be made to co-ordinate with the system into the most economical and practical lay-out.

If five taxpayers of this State have to travel a distance of two miles each going to and returning from a main highway and fifty other taxpayers can save each one mile of travel by reason of the shorter route on this main road, is it not true that the road is well located to serve the best interests of the taxpayers of the State? It is noteworthy that the taxpayer who criticises the road work in his immediate vicinity makes no objections to the more direct routes when traveling in other parts of the State. It may be desirable to place every farm, mine and residence in the State on the main highways, but it is not practical to do so.

PHOENIX-GRAND CANYON

The distance from Phoenix, via Wickenburg, to Ashfork, over present traveled roads is 210 miles. Roads now under construction and others for which funds are available, and which are to be constructed immediately, will reduce this distance approximately fifty miles. The total distance from Phoenix to the Grand Canyon, when these roads are completed, will be approximately 260 miles over good road, which can be easily traveled in one day. Eleven railroad crossings will be eliminated.

The trip will start in the fertile cultivated fields of the Salt River Valley, at an elevation of 1100 feet, thence across the desert and half buried mountains, skirting along and above the Hassayampa thru mining towns and up over the Weaver mountains into People's Valley, then another climb over the Sierra Prietas Mountain, thru the pines of the Prescott forest into Prescott, a full mile above the sea; out thru the Granite Dells and miles of cedar trees to Ashfork, then up two thousand feet to the pine covered Mogollon plateau, then around Bill Williams, Sitgraves and Kendricks peaks, close to the San Francisco peaks, and again thru the cedars and then the pines to the Grand Canyon.



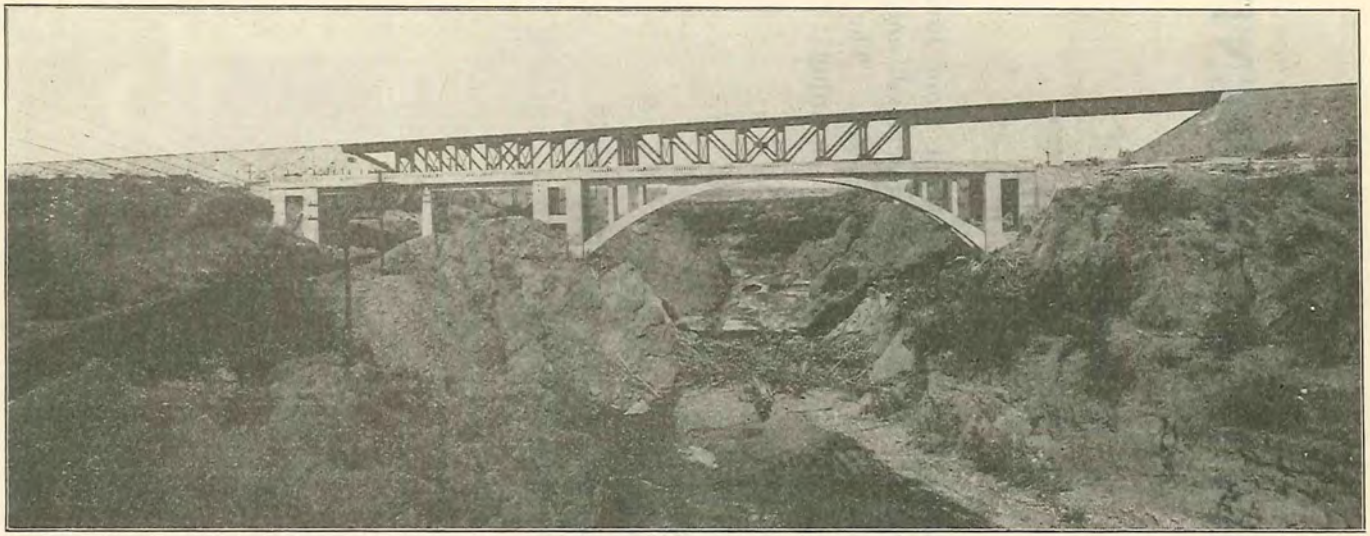
DEVIL'S CANON BRIDGE—SUPERIOR-MIAMI HIGHWAY—SOLID SPANDREL WITH CANTILEVER DECK.

BRIDGE DEPARTMENT

By Merrill Butler
Bridge Engineer

The work of the Bridge Department from January 1, 1921, to December 31, 1922, is briefly described, and recommendations for future activities enumerated. The subject matter is divided into the following sub headings:

1. New Construction
2. Repairs
3. Standards
4. Miscellaneous Duties
5. Office Buildings and Yard
6. Recommendations



CIENEGA CREEK BRIDGE—ON BENSON-VAIL HIGHWAY, NEAR S. P. AND E. P. & S. W. RAILWAY CROSSINGS.

1. NEW CONSTRUCTION

Location	Type of Structure	Length	Actual or Estimated Cost Not Including Engineering	Status of Work	Remarks
Agua Fria at Marinette	5 span reinforced conc. arch	497′	$ 62,459.08	Completed	Mentioned in Report 1919-1920
Cienega Creek	Reinforced conc. arch and girder spans	278′	40,015.54	Completed	Mentioned in Report 1919-1920
Railroad Wash	2 concrete girder spans	66′	10,849.14	Completed	Mentioned in Report 1919-1920
Mescal Wash..	2 concrete girder spans	67′-6″	17,327.50	Completed	Mentioned in Report 1919-1920
Queen Creek-Superior-Miami	Reinforced conc. arch arch and retaining walls	190′	30,118.95	Completed	Mentioned in Report 1919-1920
Devil's Canyon	Reinforced conc. arch	108′	23,780.70	Completed	Mentioned in Report 1919-1920
Pinto Creek.....	Reinforced conc. arch culvert	x122′	10,834.85	Completed	Mentioned in Report 1919-1920
Granite Creek..	2 conc. girder spans	87′-6″	11,887.64	Completed	Mentioned in Report 1919-1920
Wickenburg	3-100′ steel spans	303′	67,319.77	Completed	Mentioned in Report 1919-1920

NEW CONSTRUCTION (*Continued*)

Location	Type of Structure	Length	Actual or Estimated Cost Not Including Engineering	Status of Work	Remarks
5 Bridges on Tucson - Nogales Highway	Reinforced concrete		39,220.08	Completed	Mentioned in Report 1919-1920
Granite Creek Bridge near Whipple Barracks	3 conc. girder spans	145'-6"	23,999.38	Completed	61% cost paid by Federal Government
Concho Bridge	Through concrete girder	32'-6"	9,600.25	Completed	State Funds
Arlington	2—90' pony trusses with existing trestle approach	378'-6"	26,000.00	Under construction	State Funds
New River.....	6—60' concrete girder spans	360'	34,617.50	Under construction	Federal Aid and Maricopa County Bond Money
Willow Creek..	Reinforced conc. arch	110'	11,085.35	Under construction	Federal Aid and Yavapai County Bond Money
Verde River	Reinforced conc. arch	127'	16,770.15	Under construction	Federal Aid and Yavapai County Bond Money
Chino Wash	6 conc. girder spans	205'	12,735.00	Under construction	Federal Aid and Yavapai County Bond Money

NEW CONSTRUCTION (*Continued*)

Location	Type of Structure	Length	Actual or Estimated Cost Not Including Engineering	Status of Work	Remarks
Box Culvert west of Holbrook	16′ x 16′ reinforced conc.		5,526.00	Under construction	61% of cost paid by Federal Government
Patagonia	120′ steel span with concrete slab approaches	173′	15,975.50	Under construction	State and Santa Cruz County Funds
					State Funds
Allantown	130′ steel span with wooden approaches	170′	11,318.11	Under construction	
Lupton	60′ steel span with wooden approaches	80′	6,518.00	Under construction	State Funds
Hell Canyon....	Reinforced concrete arch and girder spans	238′-7″	33,559.00	Contract awarded	Federal Aid and Yavapai County Bond Money
Little Hell Canyon	2 80′ deck trusses	164′-9″	26,390.00	Contract awarded	Federal Aid and Yavapai County Bond Money
13 Bridges on Tucson - Nogales	Reinforced concrete		71,292.00	Project Statement sent to Bureau of Public Roads	
				Contract awarded	State Funds

NEW CONSTRUCTION (*Continued*)

Location	Type of Structure	Length	Actual or Estimated Cost Not Including Engineering	Status of Work	Remarks
Sanders	2—75′ steel spans with wooden approaches	191′-3″	12,000.00	Plans Complete	Federal Aid and Maricopa County Bond Money
San Domingo Wash	Reinforced concrete arch	75′	11,000.00	Contract awarded for steel	To be erected by State forces
Apache Trail....	Steel Trusses		3,300.00		
	GRAND TOTAL.....		$645,500.29		

In addition there have been built, or are under construction, the following structures which are not shown by special drawings, and whose cost is included in the general cost of the various road projects:

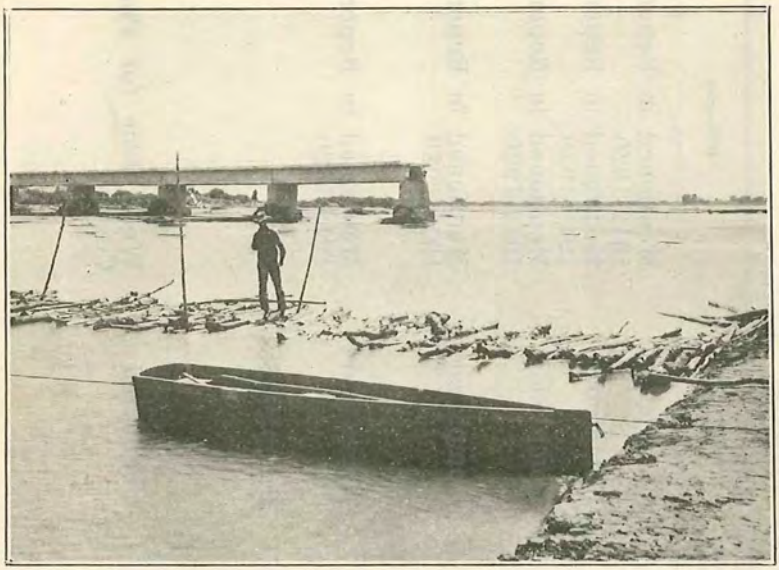
831 Standard pipe culverts

319 Standard concrete box and slab culverts having a total length of 1940 feet

60 Standard concrete brigdes of 20 ft. clear span or over, and having a total length of 2101 feet.

2. REPAIRS AND EXTENSIONS

Location	Type of Structure	Length	Actual or Estimated Cost Not Including Engineering	Status of Work	Remarks
San Carlos Br.	4—126′ steel trusses	406′	$ 37,835.85	Completed	Mentioned in Report 1919-1920
Antelope Hill Extension ...	Pile Trestle extension	855′	20,028.87	Completed	Mentioned in Report 1919-1920
Agua Fria at Cashion	Pile Trestle and other work		65,000.00	Completed	Mentioned in Report 1919-1920
Surfacing for Agua Fria Bridge at Cahsion	Asphalt skin coat on wooden deck		554.72	Completed	Mentioned in Report 1919-1920
Tempe Bridge Repairs	Underpinning pier and other work		76,846.84	Completed	Mentioned in Report 1919-1920
Florence Br. Expansion Joints	Renewing broken expansion joints		684.90	Completed	
Rillito Creek....	Replacing 2—60′ spans washed out in August, 1921		10,295.24	Completed	Work done for Pima County
	GRAND TOTAL.....		$211,246.44		



ANTELOPE BRIDGE WASHED OUT

ANTELOPE BRIDGE—REBUILT WITH 55-FOOT PILES

3. STANDARDS

The Department has added to the number of standards and has modified those already in use as the need became apparent. The old style of reinforced concrete handrail for slab and girder bridges has been discarded and provision has been made for the use of different styles of railing to suit the local conditions. The use of high handrails on short, low spans has been done away with; the low curb rail is used instead, with a considerable improvement in appearance. The low rail and two styles of pipe rails are now standard; reinforced rails are designed as special parts of the structures on which they are to be placed.

Plans for arch culverts made up of elephant shelters received as part of Arizona's allotment of surplus war material have been prepared.

Reinforced concrete box culverts ranging in size from 3x6 to 12x12 have been designed and are now included among the State Standards.

Standard specifications for steel structures have been prepared. The arch culverts, box culverts and steel specifications have been approved by the Bureau of Public Roads.

4. MISCELLANEOUS DUTIES

Various counties in the State have availed themselves of the services of the Department for the preparation of bridge plans and examination of sites and manufacturers' proposals. One 133-foot steel truss bridge, a two-span steel truss bridge 231 feet long, a 90-foot reinforced concrete arch, two wooden trestles, a 40-foot wooden truss and a 60-foot concrete girder have been designed and estimates and specifications furnished.

Lists of reinforcing steel have been prepared for all road and bridge projects. Much of this material has been cut in the Phoenix yard from the stock which is kept on hand at all times. This is a continuation of the policy instituted over two years ago. The results in the matter of cost and lack of delay have been highly gratifying.

Corrugated metal pipe and cement for all road works are ordered from lists prepared by this Department.

A start has been made toward a complete list of all the bridges for which the Highway Department is responsible.

The data is yet incomplete as the work progresses at intervals only and at times when the forces are not busy with new projects.

Instructions to inspectors and engineers have been prepared in order that uniformity may be secured in the field.

Plans have been drawn for the use of individual shelter sections as culverts on secondary roads where funds were limited. Schemes for the utilization of other surplus war material have been worked out for various locations in the State. A shed and house for the caretaker have been designed and are now being constructed on property recently acquired for storage purposes and use of the maintenance crews in Tucson.

5. OFFICE BUILDING AND YARD

The facilities at the Phoenix yard have been gradually augmented. The two-story and basement office building has been completed, and in use for somewhat over a year. This structure is 60 ft. by 100 ft. in plan and houses the general offices of the State Highway Department, Land Department and Water Department. The great amount of shop work now being handled in Phoenix made it necessary to erect another 50x121 ft. building. The blacksmith, paint and carpenter shops are now located in the new structure. A traveling crane has been installed in the machine shop and extended 32 ft. into the yard. Material can be removed from cars on the siding by means of the stiff-leg derrick and then be picked up by the traveling crane. The spur track which has been laid into the yard has effected a great saving in time and money because of ease of loading and unloading supplies. A concrete pavement nine feet wide has been put in on the main driveways leading to the warehouse and shops. Fire protection is secured by means of a four-inch line which connects with the main City line and extends nearly the whole length of the yard. The machine shop has been completely equipped with surplus war material received from the Government. Nearly all classes of machine work except the very heaviest can now be handled in this department. The engine which furnishes power for the stiff-leg derrick also supplies steam for a blast which is used for cleaning trucks and cars preparatory to painting. In order that the value of the residence property on the opposite side of the street may not be depreciated because of the outlook, vines have been planted all along the fence and trees have been set out. It is felt that the appearance of the office

building adds to rather than detracts from the looks of the surroundings.

The costs of the various improvements are as follows:

Office Building	$ 52,045.24
Warehouse	14,499.76
Sheds	9,469.08
Machine Shop	7,542.94
Paint Shop	7,311.04
Grounds and Fence (inc. cost of land)	18,545.49
Spur track	1,575.63
Paving	2,003.56
	$112,992.74

6. RECOMMENDATIONS

TEMPE BRIDGE: This bridge is showing slowly progressing evidences of failure in the superstructure. Numerous cracks have appeared in the floor slabs and beams and in the spandrel arches and columns. The increasing number of these cracks indicates the possibility of an ultimate failure which may be serious in its consequences. Frequent inspections should therefore be made to determine the condition of this bridge. The floor system as originally constructed had no expansion joints. It was continuous from the crown hinge of one arch to the crown hinge of the next. From what appears to be the consequence of this form of construction, the floor slab, floor beams and spandrel arches cracked transversely to the center-line of the bridge at three piers. In various other spans the spandrel columns cracked. This Department cut out portions of the floor and spandrels at the above mentioned three piers and built in expansion joints. This work has proved to be entirely satisfactory and it is recommended that a similar procedure be followed at several other piers. The provision of these roadway expansion joints should have the effect of eliminating thermal stresses in the floor and should therefore lengthen the life of the bridge.

FLORENCE BRIDGE: The Florence Bridge consists of 29 girder spans, each 50 ft. in length. For the most part these girders are continuous over two piers. A recent inspection discloses that numerous cracks are appearing in the beams adjacent to the fixed piers. None of these footings, it should be noted, are founded on unyielding material, but on the contrary are supported by piling driven into the silt of the river bed.

The possibility of settlement in a slight amount therefore exists at every pier, with the consequent possibility of setting up stresses in the superstructure, which are indeterminate, but nevertheless a source of danger. In fact, this condition is really an added cause for uneasiness.

Also the temperature stresses are greater in a structure of this type than in one composed of simple spans. These latter can be estimated and proper reinforcement can be provided, but a slight pier settlement will disarrange the entire stress distribution. It would appear that this condition exists at the Florence Bridge, and that the combination of high temperature and other indeterminate stresses has caused the cracks above mentioned. The bridge does not give any evidence of being in any danger, but frequent and careful inspections should be made. It is further recommended that no continuous structures be built on compressible or yielding foundations.

COTTONWOOD BRIDGE: This structure consists of two 136'-6" arches of Luten design with solid spandrels and cantilever roadways. These spandrel walls have cracked about one-third of the way out from the haunch to the crown. The same condition has been observed on the Canyon Padre and Canyon Diablo Bridges, which are of similar design. The more recent arch bridges with solid spandrels have heavier and more frequent reinforcing and additional expansion joints in the spandrels. No cracks have appeared; thereby indicating the advisability of continuing this practice.

SAN CARLOS BRIDGE: The steelwork of the old portion of the San Carlos bridge across the Gila River is badly in need of painting and should be attended to without much further delay.

A. H. D.---CONTRACTOR

During the past two years approximately half of all of the roads built in Arizona have been constructed by the Arizona Highway Department's own forces.

The counties and cities of Arizona have turned over to this Department from their funds more than $1,000,000, in addition to the State and Federal Aid money included in this work.

More than $1,000,000 was also handled for the counties of the State by this Department to pay for road construction done by various contractors under our direct supervision. Several hundred thousand dollars are still to be received from the same sources.

County funds used for construction of roads by the State Highway Department's forces totaled $1,143,277.59 and were as follows:

Apache County: Adamana-Lupton, $15,000.00.

Cochise County: Fairbank to Depot, $516.42; Huachuca Siding road, $2,792.25; Nogales-Fairbank fencing, $6,621.26. Total, $9,929.93.

Coconino County: Flagstaff to Williams, $69,910.00; Williams to Ashfork, $20,000.00. Total, $89,910.00.

Greenlee County: Clifton-Mule Creek road, $20,000.00.

Maricopa County: $60,830.59.

Mohave County: Oatman-Goldroad, $4,500.00; Topock-Oatman, $81,066.05. Total, $85,566.05.

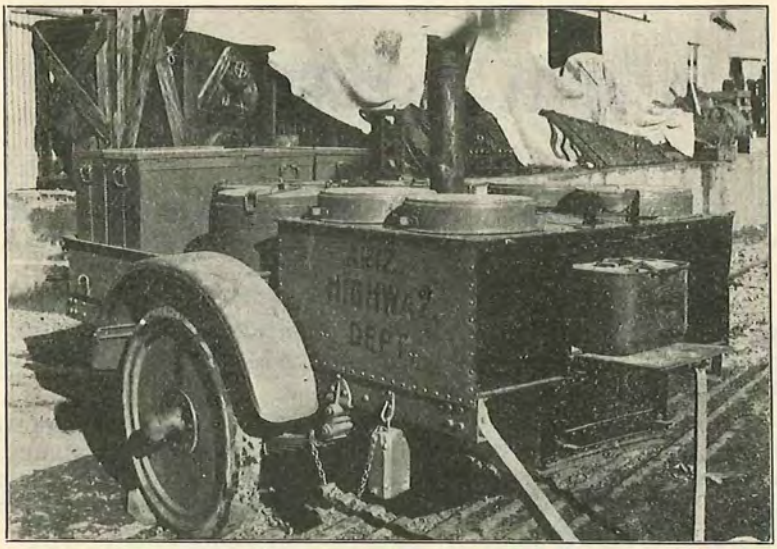
Pima County: Benson-Vail Highway, $137,159.96; Vail-Empire, $163,886.00; Rillito Creek Bridge, $4,660.19. Total, $305,706.15.

Pinal County: Florence-Superior Highway, $150,000.00.

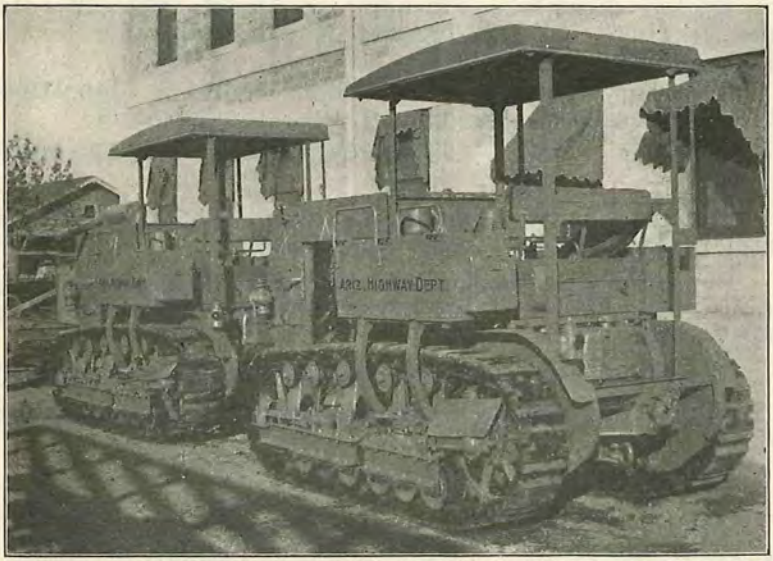
Santa Cruz County: Nogales-Fairbank Highway, $92,-092.57.

Yavapai County: $314,242.30.

A total of $12,724.91 was also expended for the following cities and towns: City of Miami, $11,725.18; town of Benson, $343.76; town of Tombstone, $655.97.



PORTABLE ARMY KITCHEN.



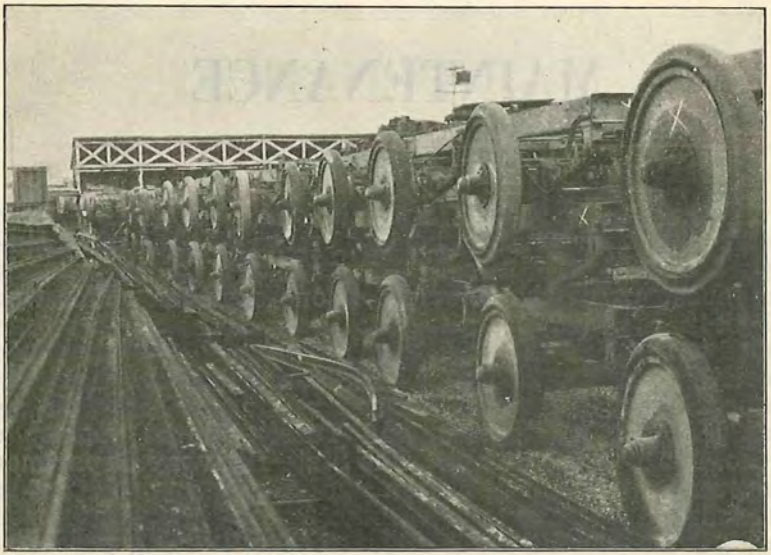
10-TON CATERPILLAR—BEST ROAD BLADING EQUIPMENT

MAINTENANCE

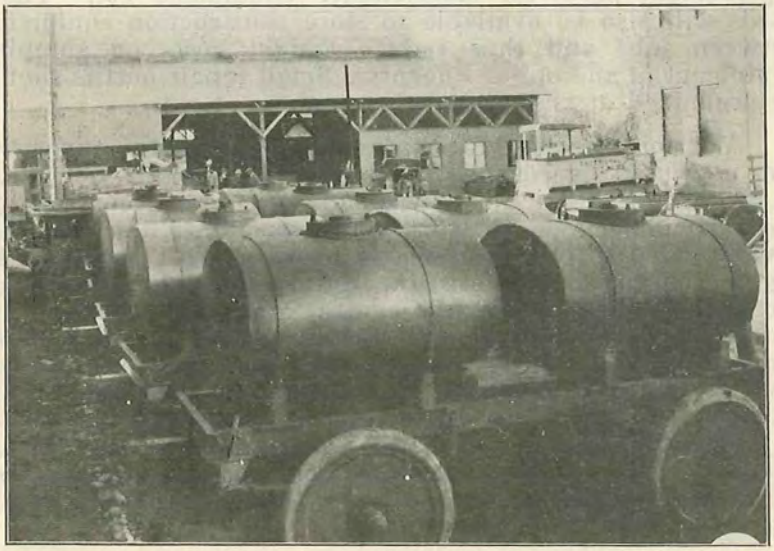
During the last two years the State Highway Department has increased the number of miles of road maintained from 335 to 1013. About two years ago the maintenance was placed under the direction of one engineer. This work has been subdivided during the last year, and three men placed in charge. The highways north of Prescott are in one district; from Yuma thru Phoenix to Florence, Mesa, Superior, Miami, Globe and Duncan in a second district; and from Florence to Nogales, and Tucson to the vicinity of Rodeo, in the third district. The State Highway Department has purchased land at Tucson and is erecting quarters for maintenance men and a warehouse for storage purposes. A lease has been secured at Ashfork and a building purchased for warehouse use. These sites are well located, as several railroads and highways center at these points. The yards will be used to store engineering equipment when not in use, replacement parts for maintenance equipment, etc. These yards will also be available to store construction equipment between jobs and thus reduce freight costs on shipping equipment in and out of Phoenix. Small repair outfits should be organized at these points.

We note that several States are adopting the same system now used by Arizona in its highway organization; that is, abolishing district or divisional offices and centralizing the particular classes of work under specialists, the only subdivisions being for maintenance work. This permits the highway location, bridge work, testing materials, purchasing, etc., to be handled from the central office and enables construction forces familiar with certain classes of work to be moved anywhere in the State on the same kind of construction. It is quite probable that additional subdivisions will have to be made in the supervision of maintenance, in order to increase efficiency. It is the intention in the near future to add to the Phoenix, Ashfork and Tucson headquarters, additional stations at Holbrook and Globe as additional highways are cared for by the State.

We have had to purchase much maintenance equipment in addition to that secured from the Federal Government.



TRAILERS—BEHIND TRUCKS DOUBLE LOADS ON GOOD ROADS.



WATER TANK TRAILERS—TRANSPORT WATER FOR DESERT

There are 56 trucks working on maintenance. Within a short time it will be necessary to have approximately 100 trucks in operation, which should be supplemented by approximately 25 or 30 being repaired. The State has standardized on one type of truck received from the Federal Government, as enough of this particular make has been assigned to Arizona to provide for our maintenance work. The specializing on one make of equipment will greatly reduce the spare parts necessary for the State Highway Department to keep in stock.

NORTHERN DISTRICT

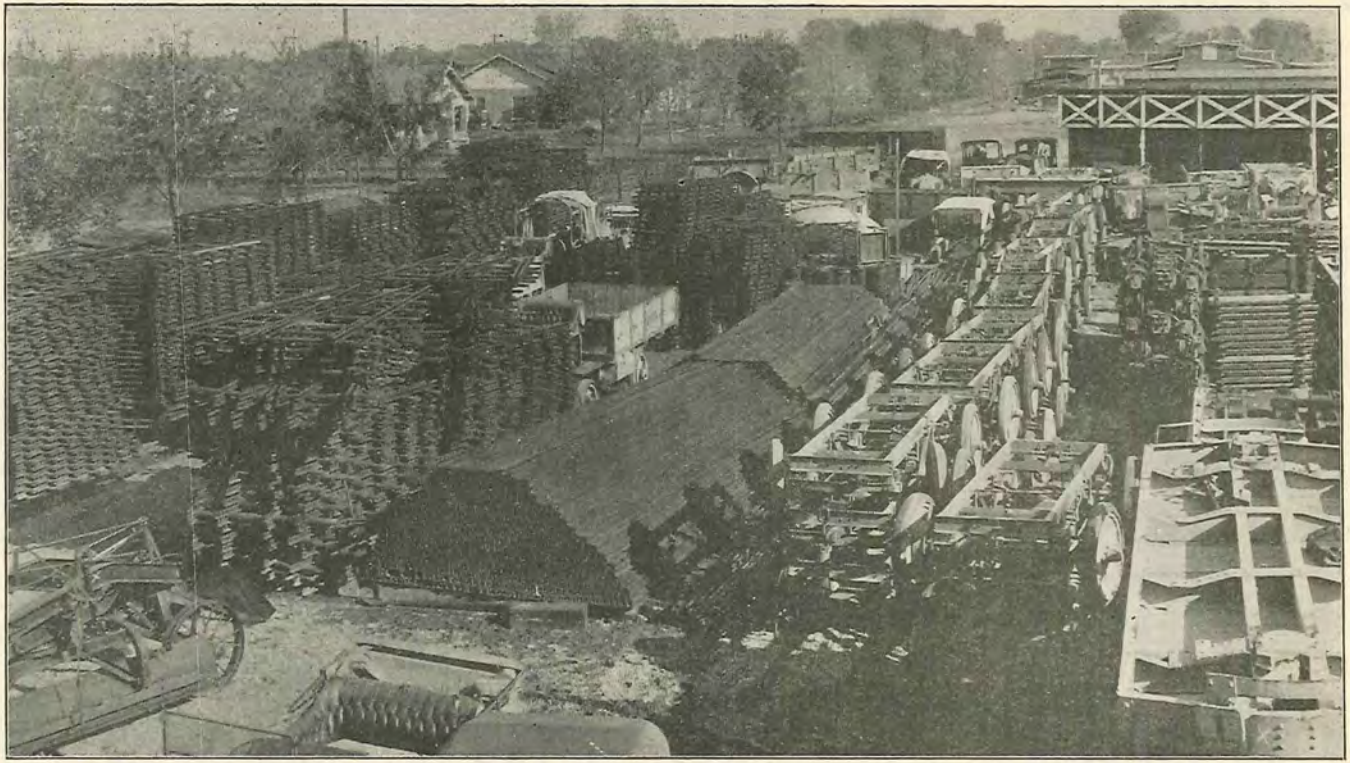
By Shepard Hiscox
Maintenance Engineer

The Northern Maintenance District comprises the Old Trails, from Lupton, on the New Mexico border, to Topock, on the Colorado River; the Holbrook-Springerville Highway, thru the Petrified Forest; the Prescott-Jerome, the Prescott-Ash Fork, and the Wickenburg-Congress Junction Highways.

There are at present sixteen foremen, each taking care of an average of twenty miles of road. Construction foremen are caring for three uncompleted projects. Until recently we have been handicapped by lack of trucks, but as soon as equipment assigned is overhauled, this district will be amply supplied.

The problem has been to find material for surfacing that will stand the volume of traffic upon this most popular route. The most satisfactory is decomposed granite, and the Dells section of the Prescott-Jerome Highway is the easiest to maintain because it is of this material. Volcanic cinders have been much used and are generally satisfactory, but quality varies in each pit and in some cases where they have been burned too clean, a mixture of as much as 50% adobe or other clay has been added to get a bind. Caliche with cinders makes a good surface, though it does not wear well, but caliche alone, especially during dry periods, goes to fines and blows off, and for this reason is avoided. Gravel as found on the Hunt-Concho section, pea size, has given excellent wear and is almost as good as the granite.

Careful preparation and maintenance of subgrade during construction is very essential. When the weather condi-



EAST A. H. D. YARD—SHOWING (3) MILES OF 60 CM RAILROAD AND 25 LB. RAILS FOR CATTLE GUARDS.

tions bring moisture and the surfacing can be put on wet and rolled, results are generally excellent. Maintenance should be commenced upon completion of construction, as ruts and wear holes are hard to eliminate.

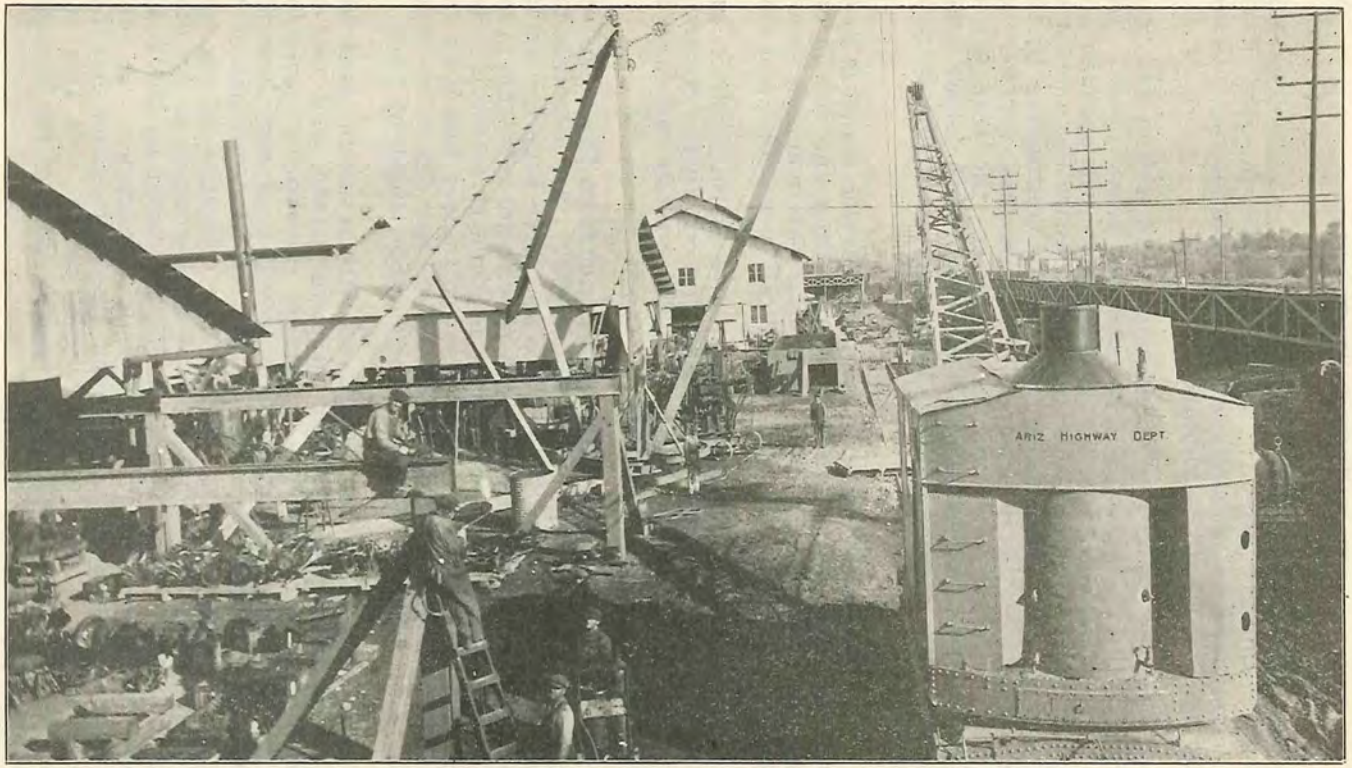
Equipment is now complete upon each section and comprises a truck, a blade and two Adams heavy drags. The Holt 55 Caterpillars are being used upon two sections and are almost as fast as a truck and handle twice the amount of equipment. We have taken over from contractors in the eastern part of the state several land levelers, which cover 20 feet in length, and this length lessens the tendency to follow the small inequalities on the road, as the short drags do. On new surfacing these have been particularly satisfactory.

We are now at work on a special leveler which is to be forty feet long. It will scarify, blade, drag and roll in one operation. Pulled by a 55 caterpillar this machine should take out all the small bumps and fill all wear holes and ruts.

There are two 12-foot snow plows in this district, one at Bellmont on the Old Trails, and one on Mingus Mountain on the Prescott-Jerome Highway. These plows may also be used to level up new capping.

The growth of the Northern District from five to sixteen foremen has been made since June, 1922. All men selected have been tried out in State camps and have been chosen for their fitness. Their helpers are men who are residents in the locality of the work. Preference is given to ex-service men and taxpayers. A very small labor turn-over has been the result of this policy. The scale of $5.00 per day is too small to hold the best men for any considerable length of time.

The constant increase of travel with resultant wear will be the most serious problem in maintenance, and can be counteracted in a measure by proper selection of surfacing material, by the application of improved machinery, and the shortening of the length of section under a foreman from twenty to fifteen miles. Also by the education of car and truck drivers to a reasonable use of the highways, in avoiding ruts and wear holes. Signs should be placed on the roads requesting motor drivers to assist in maintenance. A courteous appeal to the average person, reminding them that they are using **their** roads, paid for by **their** money, will, I am certain, help, in some measure, to remedy some of the thoughtless abuses.



LOCOMOTIVE CRANE AND STIFF LEG DERRICK.

Topock-Oatman (Boundary Cone West)
H. R. Holbrook, Foreman

Since completion of construction on this section, no rain with the exception of light showers has fallen. The material used for capping was gravel and considerable difficulty with ruts and wear holes has been experienced. Continual dragging and blading has kept this section up and only a hard rain will make it set up. Material is being hauled from the California side of the Colorado River to a distance of four miles. It is a conglomerate of sand and unwashed gravel and is by far the best that has been found to compact dry. Culverts and head walls are completed and all dips have been filled with rock and surfaced.

Topock-Oatman: Kingman-Oatman
J. E. Bruce, Foreman

The Oatman mountain has been temporarily surfaced and is in good condition. Material used was caliche and shale and with recent rains has set up like paving. The repair between Oatman and Old Trails, done for Mohave county, washed out three times last season, due to lack of drainage. It is but a temporary location. A four-truck camp took care of all washouts promptly and no delay was caused to traffic.

Peach Springs-Seligman (Peach Springs to Venero)
Joe Garrehy, Foreman

Lack of culverts and dip walls made some difficulty in travel during summer rains. With the exception of what capping has been hauled by one maintenance truck, no surfacing has been done on this section. The break down of a truck during the summer rains set the work back on this section, but it has been almost caught up. The Peach Springs hill had several small washouts last summer, but the construction being in limestone no serious damage was done. This is one of the fastest pieces of road on the Old Trails, a Cadillac having driven the 38 miles in 38 minutes.

Peach Springs-Seligman (Venero to Seligman)
Stewart McCormick, Foreman

A 55 caterpillar is handling a 12-ft. blade, on this valley section. In addition to the big blade, it also pulls two drags. None of this road has been surfaced, but it is in good condition and very fast. It should have a few dip walls and culverts.

TRUCK RECEIVING YARD

Ash Fork-Seligman

Pete Travers, Foreman

This entire section has been recently surfaced, with cinders on the east end, and caliche on the west. Oversize rock has been a difficulty, but has added to the wearing quality of the road, and now that the rains have set it up it drains well and will be a good winter road. Experiments with material from different pits have demonstrated the best, and all patching is being done with proven materials. This new section has stood traffic well and will be easy to maintain. A foreman's camp will be established at Pinevita, in the middle of the section, as soon as a portable house is received.

Ash Fork-Williams

I. D. Massey, Foreman

With the exception of one bridge now under construction, this project is complete. It is possible for the average car to make the Ash Fork hill in high gear ,and cars have made the trip from Ash Fork to Williams, 18 miles, including a 2100-foot rise in elevation, in thirty minutes. There is a stretch of about three miles that will require surfacing, and a satisfactory pit of white cinders is within a short distance. Snow lies on the road in spots due to shading of big timber on the south side of the road.

West of Williams for a distance of four miles the surfacing is red cinders that have been burned clean. Scarifying and shaping up this short distance will make it excellent without hauling much additional material.

Williams-Flagstaff

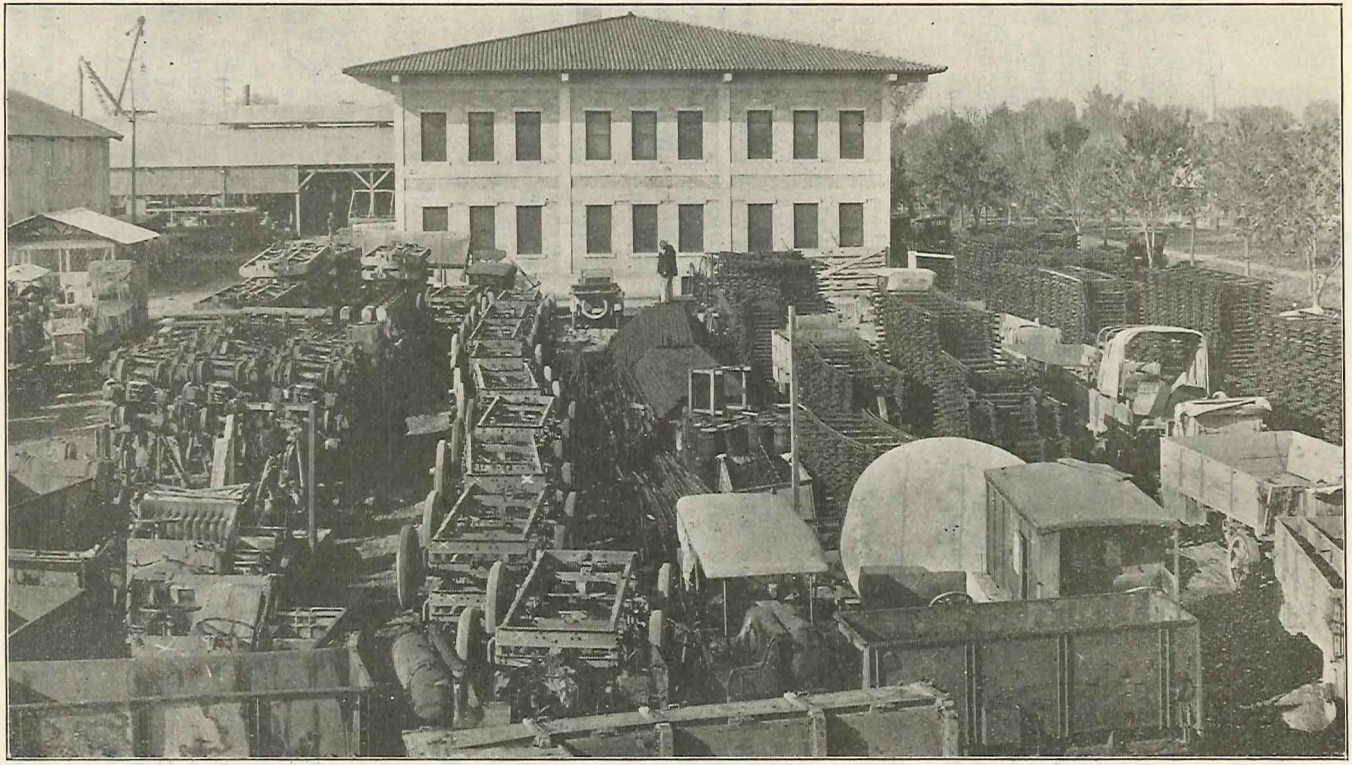
(Williams to Branigan Flat) Harry Yarnell, Foreman.

(Branigan Flat to Flagstaff) Sam Miller, Foreman.

This is compartively an old road and bears the heaviest travel due to the Grand Canyon road, which leaves it at Maine. Three hundred cars per day have been reported during the peak season in June and July.

Heavy log hauling over this road during the time the frost was coming out of the ground, cut the road badly for two miles west of Riordan, and an extra gang was put on this summer to repair the damage. The surfacing material is volcanic cinders and has been passed for final estimate by the Federal Inspector.

Fourteen inches of snow on October 25th was the earliest snow fall in years, but was handled with blades and soon



LIGHT RAILROAD EQUIPMENT

dried out so that travel was not delayed. A snow plow on a 55 Caterpillar is stationed at Bellmont and will handle any snow fall that may come.

The paving thru Flagstaff is completed and gives a metropolitan touch to this famous summer resort and educational center.

Holbrook-Winslow

(Winslow to Havre) R. James, Foreman.

(Havre to Holbrook) John Dewitt, Foreman.

This project has recently been completed with the exception of a few headwalls and dips. The difficulty in obtaining suitable capping within a reasonable haul has delayed completion. The material used is strong on sand but recent rains have demonstrated that it binds well and the fine gravel in it will insure the wearing qualities. There is little, if any, oversize rock on these two sections ,and the road will maintain easily. Two foreman's camps will be established within the month.

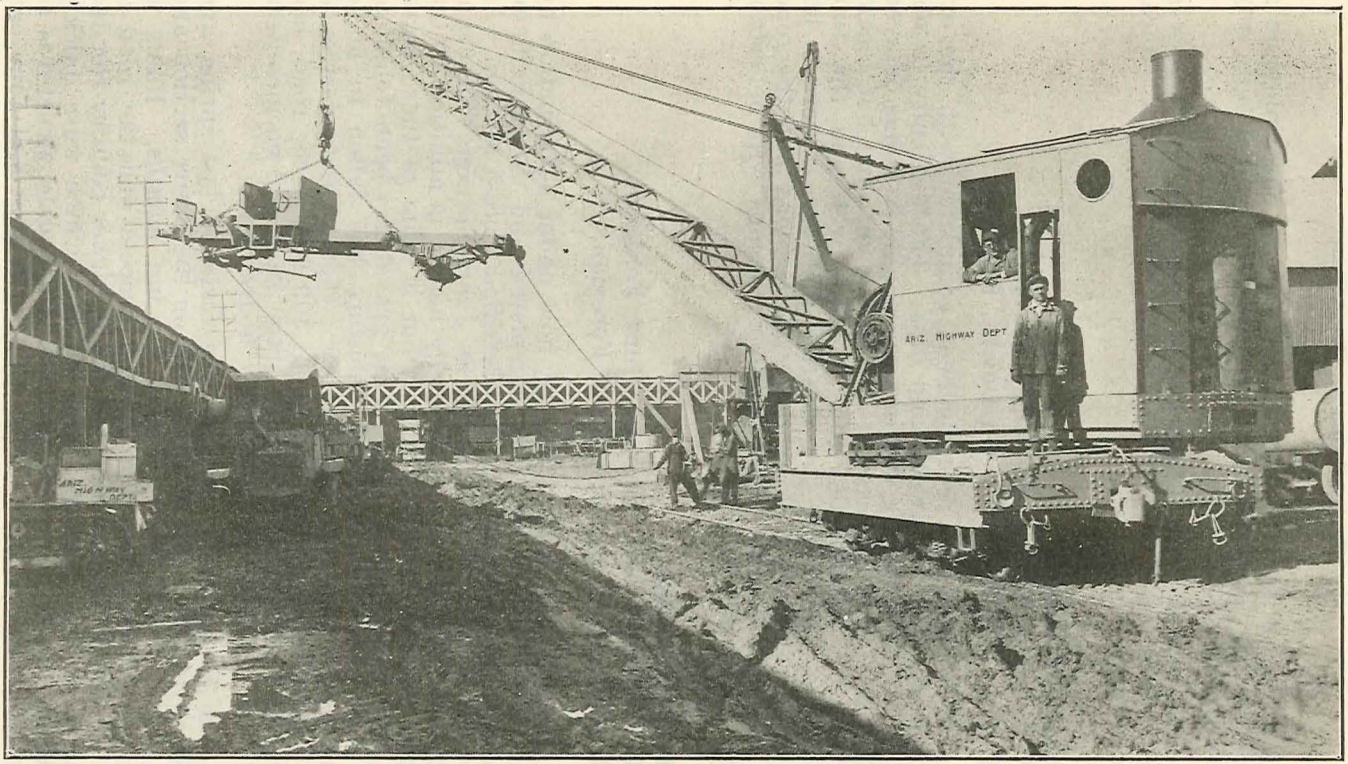
Holbrook-St. Johns

(Petrofied Forest) Ambrose Hunt, Foreman.

(Hunt-Concho) Sanford Hunt, Foreman.

Federal Aid Project No. 42, now under construction by local contractors, is partially completed and is being maintained by the foreman on the Petrified Forest section. As this road is the only inlet to the St. Johns-Springerville county, the truck traffic is exceptionally heavy, in addition to the regular amount of tourist travel, but in spite of these facts, the road has stood up well. Fine gravel has been found at the road side and sufficient moisture has fallen to make maintenance easy and satisfactory. Cloud bursts destroyed two culverts and washed out about 400 feet of the road, last July, but traffic was assisted by state truck and no inconvenience was suffered beyond a few hours' delay.

The Hunt-Concho section was surfaced last spring and accepted in July. No moisture fell on the entire section and the gravel rutted badly during the hot months. Rains in October accomplished the binding process and the road is now excellent. Rains which fell in the higher country flooded the gulches, and damaged two culverts, which were quickly repaired. State foremen repaired two county structures to keep the roads open, building wing walls that had gone out.



15-TON LOCOMOTIVE HOIST

The bridge at Concho is entirely completed and the project to St. Johns is under construction.

Adamana-Lupton

T. A. Greene, Foreman.

With the exception of the large bridges over the Rio Puerco, the subgrade from Lupton to Navajo is finished and being maintained by Engineer Greene.

Prescott-Ash Fork

W. W. Oliver, Construction Foreman.

The subgrade on Federal Aid Project No. 61 is completed with the exception of some dip and head walls. This road goes thru some very heavy adobe, but by constant dragging has satisfactorily handled traffic from the Old Trails Highway to Prescott during construction. Travel is compacting the subgrade and the attention given the road by Construction Foreman Oliver has kept in good condition what would otherwise have been an almost impassable new road.

Prescott-Jerome

(Dells Section) Wm. Bianconi, Foreman

(Jerome Section) Lloyd Rabb, Foreman.

From the large Granite Creek Bridge on Federal Aid Project No. 36, east the Highway is being maintained by state forces. The entrance into Prescott back of Fort Whipple has not yet been completed by the contractors. The Dells section is true granite and was capped last spring with this decomposed material. A new road completed a year ago has demonstrated conclusively the superiority of this class of material.

A gang of 15 men have worked all summer upon the Yaeger Canyon side and capping that is satisfactory has been found, that wears well even when wet. The Lonesome Valley is adobe and was a blade road 44 feet wide. Gravel capping 16 feet wide has been put on the worst eight miles and tire chains are no longer necessary.

On the Jerome side of the mountain surfacing material is hard to get and will have to be obtained by crushing from mine dumps. Some of the road bed is badly worn, especially near the town, and the heavy traffic necessitates constant replacement of capping. However, this Highway is the finest in Northern Arizona.

OLD AND NEW ARMY RUBBER—IT TAKES A LOT OF RUBBER TO WEAR OUT THE ROADS

SOME SHOVELS IN ADMINISTRATION BUILDING BASEMENT

Wickenburg-Congress Junction

Happy Salyer, Foreman.

This link of 17 miles will be the main north and south highway from Phoenix to the north. The material is naturally good and the location following high ridges eliminates drainage difficulties. This section is a forceful demonstration of how a road may be perfected by constant supervision during construction, and by continual dragging during and after rains. The soil conditions lend themselves to satisfactory maintenance by reason of the total absence of adobe.

CENTRAL DISTRICT

710.6 Miles

W. C. Goetz, Maintenance Engineer

The Central Maintenance District extends from the New Mexico border in the Big Lue Mountains, along the Clifton-Mule Creek road to Clifton, thence over the Black Hills thru Solomonville, Safford, Fort Thomas and Rice to Globe. Four miles west of Globe one route leads by way of Roosevelt Lake to the Dam, and then over the Apache Trail to a junction with the Mesa-Superior-Florence Highway, thirty-one miles east of Phoenix. The other route is by way of Miami over the Superior-Miami Highway, thru Superior to a junction with the Mesa-Florence Highway, twenty miles southeast of the Apache Trail Junction, then by way of that junction thru Mesa and Tempe to Phoenix.

From the Superior Junction the district extends thru Florence to a point twenty miles south thereof on the Tucson-Florence Highway, joining there with the Southern District.

From Phoenix a branch leads northwest thru Glendale, Marinette and Wickenburg to Congress Junction, where it connects with the Northern District.

From Phoenix west the route is by way of Buckeye, over the Gillespie Dam to Gila, on the Southern Pacific Railroad; thence along this railroad thru Sentinel, Wellton and Dome to Yuma, on the California border. In addition to this there is a nineteen-mile section from Parker toward Bouse.

In the Central District sixteen crews, ranging from two to five men each, maintain some 430 miles of road. Con-

HORSE AND MULE SHOES—MUCH GOOD LUCK FROM THE ARMY

EXTRA TRUCK SPRINGS

struction crews are building and temporarily looking after the maintenance on all but fifty miles of the remaining 280.6 miles of road in the district. Included in the 430 miles covered by maintenance crews are 115 miles of typical mountain road of heavy construction, and 62 miles of pavement. Also 30 miles of road within the proposed San Carlos Reservoir location, which must be kept passable for traffic coming west from Greenlee and Graham County points. These crews are equipped with trucks, graders, drags, plows, screens for surfacing materials and the necessary smaller tools. Those on mountain sections have wheelbarrows, stone boats and dump carts where needed for the removal of slides, loose or dangerous rock overhead and the cleaning of ditches, while those on sparsely populated sections are furnished with a portable mess and bunk house on wheels, and water tanks on truck trailers. The crews on pavements have portable asphalt kettles and such other equipment as may be needed to properly maintain their particular section of highway.

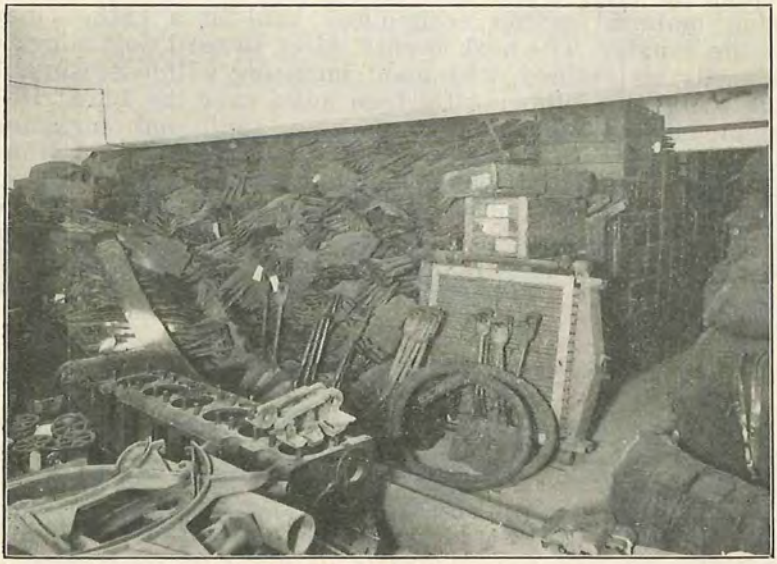
EASTERN SECTIONS

Beginning at the eastern end, the problem on the 19 miles of Mule Creek road, in charge of S. W. Dunagan, is keeping the ditches free from slides, and finding suitable surfacing material within economical haul in a rather inaccessible country. The next twenty miles, toward Solomonville, are easily maintained, with good surfacing within reasonable haul, while the following thirteen miles over the Black Hills are in malapai formation, requiring additional surfacing, which can only be obtained by a long uphill haul, but which will be very necessary when traffic over this road increases. From Clifton to this point, 21.5 miles, O. E. Williams is in charge of maintenance. From here to the San Jose junction near Solomonville, about seventeen miles, the road is mostly unimproved, with construction work in progress by Graham County.

SAN JOSE JUNCTION-MATHEWS

Between San Jose Junction and Mathews, thru Solomonville, Safford, Thatcher and Pima, twenty-two miles of pavement are under construction. From Mathews west 19.5 miles thru Fort Thomas and Geronimo is an improved gravel-surfaced road, requiring in a few places additional binder in the surfacing, and some culverts in place of fords used as irrigating ditches.

CARLOAD OF NAILS FOR BRIDGES AND BUILDINGS



SOME TEN THOUSAND SHOVELS.

The next thirty-two miles, over the Gila River and San Carlos River bridges to Rice, are within the site of the proposed San Carlos Reservoir, thru poor material, with numerous old wooden bridges and culverts, and costly in upkeep. With the aid of the Indian Service this section has been kept passable, but will require constant and vigilant care, especially in keeping the bridges safe. The steel bridges over the Gila and San Carlos Rivers should have new floors this winter, and also require thorough painting. The Rice to Globe section, twenty-two miles, is a first-class gravel road, with a little sanding needed at the Globe end, and additional protection given at three points where floods in the Gilson Wash strike the road.

MATHEWS-GLOBE

The thirty-five miles from Mathews to the Gila River are in charge of W. O. Tuttle, while C. F. Scanlon is foreman on the thirty-nine miles from the Gila River to Globe.

GLOBE-APACHE TRAIL

The Globe-Roosevelt Dam-Apache Trail section is not of standard width, curvature, or grades, and requires heavy maintenance because of much side-hill construction, lack of proper surfacing in some places, and insufficient drainage structures on the Globe-Roosevelt end, which was built several years ago.

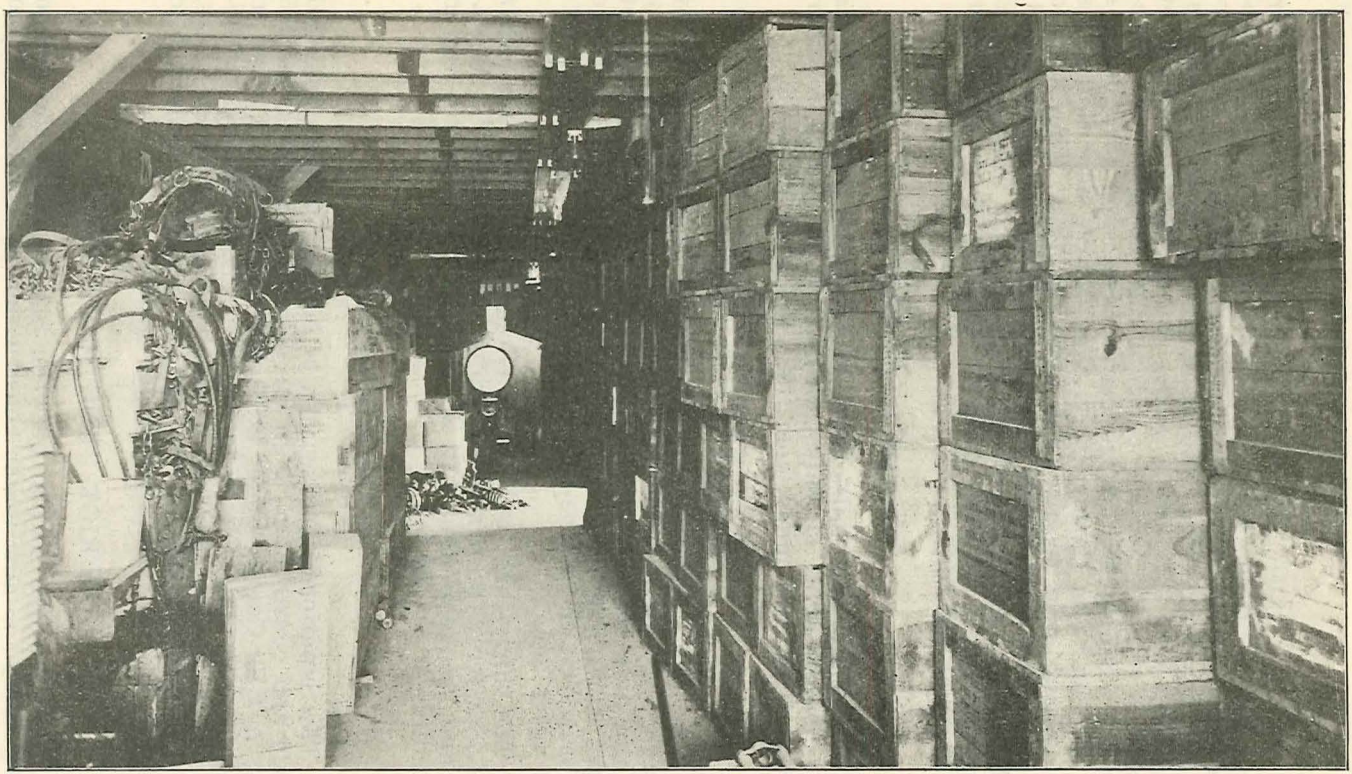
The thirty-three miles from Globe to the Dam are under J. M. Sanders; the next thirty miles west under R. L. Mitchell, and the remaining fifteen miles to the Junction are in care of J. J. Armstrong.

SUPERIOR-MIAMI

The Superior-Miami section, of bold conception, splendid design and construction, is in the care of two crews, the 9.5 miles in Gila County under E. B. Pierce, and the 11 miles in Pinal County under N. M. Lopez, Sr., whose principal activities are in the removal of probably dangerous rock slides, and the maintenance of the surface, which is subjected to a very heavy truck and passenger traffic.

SUPERIOR JUNCTION ROADS

The five-mile section between Superior and the Queen Creek bridge is now under construction by contract. From



ARMY HARNESS

Queen Creek to the Superior Junction, 11 miles, and from this junction 10 miles toward Florence and 10 miles toward Phoenix are in charge of S. L. Stiles as foreman, while J. J. Armstrong is in charge at the Roosevelt Dam Junction, working 10 miles toward Superior Junction, 15 miles toward Roosevelt Dam and 10 miles toward Phoenix to the beginning of the concrete pavement. A contract has just been let for paving with two inches of asphalt the first five miles from the Superior Junction toward Phoenix.

From a point four miles east of Mesa concrete and asphalt pavements extend thru Mesa, Tempe, Phoenix and Glendale to Marinette. This 29-mile section is in charge of Frank Musa.

BUCKEYE SECTION

The 33 miles of concrete from Phoenix to Buckeye, and the Agua Fria River crossing are under the care of L. W. Statler.

These crews of two men each have their sections in good condition and should have no difficulty keeping them so, with occasional extra help on the shoulder work. The dirt or gravel shoulders will ultimately require an excessive upkeep expenditure which could no doubt be most economically solved by slightly increasing the width of pavement, and decreasing the width of shoulder, thereby tempting traffic to stay on the pavement and off the shoulders.

FLORENCE CONNECTIONS

From 10 miles south of Superior Junction to Florence, six miles of gravel surface, the principal work should be the maintenance of a smooth surface, also on the 20 miles from Florence south. The construction of curtain walls on fords on this 26-mile section, under B. F. Abott, should be done at an early date.

WICKENBURG-CONGRESS JUNCTION

The Wickenburg-Congress Junction section of 15.5 miles under C. Weldon, requires curtain walls on fords, and additional surfacing on some stretches. Construction crews are now working between Wickenburg and Hot Springs Junction toward Marinette, and are keeping this 60-mile section in repair.

JIB CRANE AND BRIDGE CAISSON "FORGES."

PARKER-BOUSE

The Parker-Bouse section of 19 miles, with Jabez Durfee as foreman, will be thoroughly surfaced by the end of this year, and should be easily maintained in good condition by judicious blading, although the first 10 miles are thru difficult material.

BUCKEYE-WEST

From Buckeye west by way of Hassayampa to the Gillespie Dam, a distance of 21 miles, the road is now under construction, while the 23.5 miles from this dam to Gila Bend are about completed and a maintenance crew for this is being organized. From Gila Bend west 14.9 miles to Piedra are now under contract construction, likewise the 42.6-mile section between Aztec and Wellton, leaving only the 29.2 miles between Piedra and Aztec on which construction work is not in progress. The construction crews on these sections are keeping the road open for traffic.

WELLTON-YUMA

The Wellton to Yuma section of 39 miles is in charge of Maintenance Foreman Giles E. Wilson. This section presents chiefly a problem in good surfacing material, and should be constantly maintained with the best material available, even though the same requires long hauls. The narrow portion of this road was built by Yuma County.

HOUSING FOR CREWS

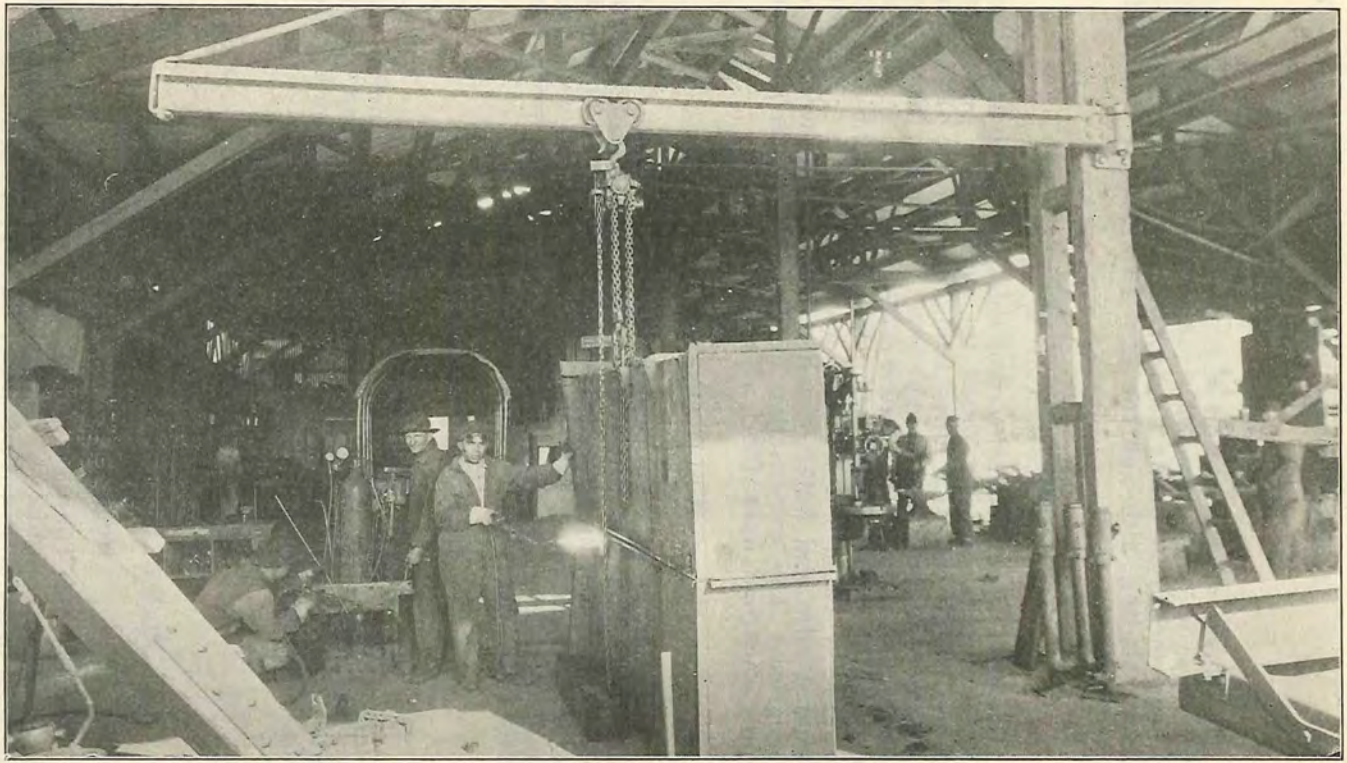
On the Clifton-Mule Creek section and the Clifton-Solomonville section, and also at the Superior Junction and the Roosevelt Dam Junction, the Department has erected suitable frame houses and sheds for the maintenance crews by utilizing old buildings from construction camps.

SOUTHERN DISTRICT

By I. P. Fraizer, Maintenance Engineer

Nogales-Tucson Highway

The Nogales-Tucson Highway, a total length of 68 miles, is in excellent condition. Of this 68 miles, the state maintains 8.85 miles of 18-fot concrete, three-foot shoulders.



OXY ACETYLENE WELDING—MAKING "DUMPS" OUT OF STANDARD TRUCK BODIES.

Expansion joints and minor defects on this pavement have, during the past summer, been filled with asphalt, and the shoulders filled to grade with surfacing material, under the foremanship of J. A. Duggie and crew of four men. The portion between Nogales and mile post No. 39 (from Nogales), is under the foremanship of C. R. Holcomb. He has been in charge of this highway for six years, and is second in years of service with the maintenance department.

This portion of the Nogales-Tucson Highway is in good condition, but numerous ravines and dry wash crossings are a source of trouble during flood periods, due to washouts and deposits of sand, rock and boulders. These crossings are gradually being spanned by culverts and bridges. During the past year two 86-foot bridges, two 24-foot bridges, and two 6x8-foot box culverts have been constructed.

The heavy traffic of approximately 1100 cars daily immediately out of Nogales made it necessary that a roadbed of permanent nature be constructed. Funds were available for 2½ miles of pavement, and this has just been completed.

The thru traffic average of 454 cars daily causes serious wear on the clay-gravel portion of the roadbeds. During the dry periods of the year it is necessary to run the grader and drag over it every four days for good results.

Tucson-Florence Highway

For six and one-half years this 67.6 miles has been under the maintenance foremanship of W. C. Gates, who is first in years of maintenance service, having taken charge shortly after the first construction work was completed. At present this highway is being reconstructed and the greater portion, about 47 miles, is being looked after by the construction crews.

That section between Tucson and Rillito Creek bridge is concrete pavement. The maintenance crew has just completed the repair and graveling of the shoulders for the entire distance. Upon completion of this highway, it is my belief that, in addition to Mr. Gates' crew, a crew should be located in the neighborhood of the Brady Wash.

Tucson-Benson Highway

This stretch, 52.8 miles in length, is one of the fastest highways in the State and is surfaced with clay, gravel and caliche.

Between Tucson and Vail Station, 21 miles are under the supervision of James A. Duggie, a foreman of four years' experience. Numerous sharp curves have been flattened and a greater portion of the highway has been reconstructed and ditched, by the foreman and a crew of four men. This highway is in a better condition than it has ever been. I would recommend that when funds are available, this highway be relocated between Tucson and Vail and constructed along the lines of modern highway construction, eliminating practically all curves now existing between these two towns.

William Short, an experienced foreman, is in charge of the maintenance of the balance of the Tucson-Benson highway, or between Vail and Benson, 30.8 miles, of which 10 miles is in Cochise County. This is a modern clay-gravel surfaced highway, recently constructed, and no serious or out of the ordinary maintenance work has been found necessary. At present it is smooth as a floor and traffic rolls as fast as desired.

Benson-(Tombstone-Nogales Junction)

Length 22.6 miles. This road was taken over this year by the State Highway Department from the Cochise County Board of Supervisors, and extends from Benson to its junction with the Tombstone-Nogales Highway. It is under supervision of Rollo M. Johnson, who has been with the maintenance department three years. To put this highway in better shape, adobe or clay is being added to the numerous sandy stretches, edging or harrowing off the tops of bumps, on portions where the original surfacing material was dumped, rather than equally distributed. General maintenance must not be neglected. I would recommend that a portion south of St. David and north of Curtis Flats be relocated, also close attention be given the river approach at St. David bridge across the San Pedro River.

Mr. Johnson is doing very good work on this road, and within a few weeks it should compare favorably with adjacent stretches.

Tombstone-Nogales

This highway, 74.3 miles in length, has been completed from Tombstone to Patagonia, a distance of 52.3 miles, and is under State maintenance between these two points.

The 25 miles in Cochise County was turned over to the maintenance department last September by the construction

forces. Frank Sanders, the foreman, has been with the department four years, and has had experience in several parts of the State.

William Bowers, who was a gang foreman with the construction crew which built this highway, is foreman between the Cochise County line and Patagonia. This highway thruout is constructed along modern lines and is in excellent condition and repair. With possibly the exception of a few miles in Cochise County, which should be sanded, where the caliche surface during wet weather is inclined to become samewhat slick, only general maintenance is necessary.

Tombstone-Bisbee

Ten miles of this highway, which is 26.2 miles long, has just been paved with asphalt, commencing at the west town limits of Tombstone and extending towards Bisbee. This relieves a very difficult problem, for the ten miles at least, created by the winds, which blow thruout the length of this highway with such force that gravel or surfacing material, of the nature available in the district, is rapidly removed. Since this roadbed is surfaced with rock caliche material, I would recommend that paving or surfacing as above mentioned be continued to the north foot of the mountain just northwest of Bisbee. I would also recommend that the shoulders be enlarged and ditches in cuts be opened on the portion just paved.

C. R. Hannon, the foreman on the Bisbee or mountain end of this highway, has been on this project for more than six years. Due to the irregular and obscured alignment, heavy grades and character of roadbed for which this mountain highway is noted, I would recommend that a team and light spring wagon be continued on this hill, rather than replacing with a truck crew. Thruout, the highway is at present in an excellent condition.

Bisbee-Douglas

This highway is 24.6 miles in length. Until this year the State maintained but 8.4 miles, the portion which the State built. This is a concrete highway 18 feet wide, 3-foot shoulders, and connects two of the largest cities in the State. The maintenance crew is in charge of Joe Holden, another old-timer with the State Highway Department, he having been in State service about six years. This crew is at present filling cracks on the portion constructed by the Cochise

County Highway Commission and recently taken over by the State Highway Department. These cracks are due to insufficient settling of embankment prior to laying the paving, and the carrying of excess loads by trucks during the war period. It is estimated that fifty tons of asphalt will be necessary to properly care for these defects. Thruout, the highway is in excellent condition for travel, and when the cracks are filled will be in good shape for its own preservation. I would recommend that the shoulders be widened to four feet and ditches be cut at different places between Forest Ranch and Forest Station, to prevent rushing surface water from cutting channels along the edge of the embankments.

Douglas-State Line (Near Rodeo)

Length 48.3 miles. At present the construction of concrete fords to replace earthen, gravel, rock filling, is in progress. This work is under Engineer Thompson and Foreman Russell Noyes. On completion of this work I would recommend that the crew be transferred to the Benson-Tombstone Highway, and build concrete fords on all fords not so constructed. The maintenance work of the Douglas end, from the red hill east of Bernardino to Douglas, is in charge of Joe Holden, heretofore mentioned, and who, upon completion of the work now in progress between Douglas and Bisbee, can look after both projects. The eastern portion, from the red hill east of Bernardino to the New Mexico State line, is under the foremanship of Joe Terrell, who for the past year has demonstrated his ability very satisfactorily. I have no further recommendations other than the completion of the concrete fords and general maintenance. At present this road is in excellent condition.

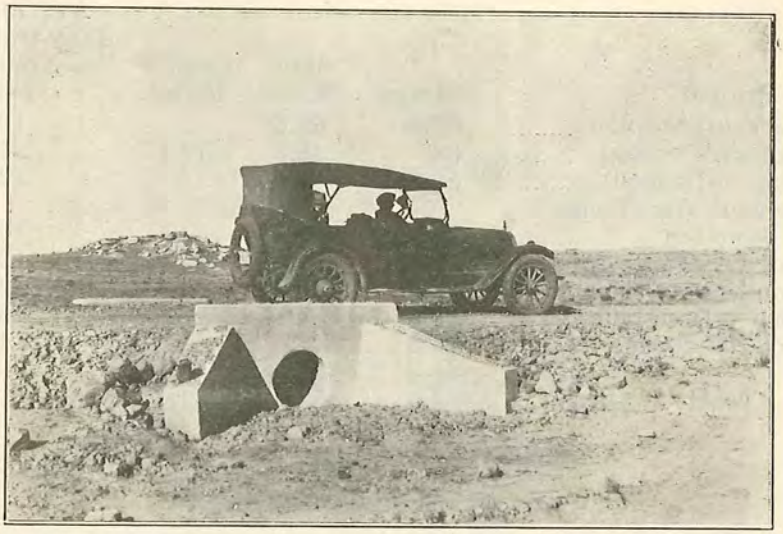
Mileage and Traffic

The total mileage of the roads included in the southern maintenance district is 384.5 miles. The mileage of the several sections is shown in the table below:

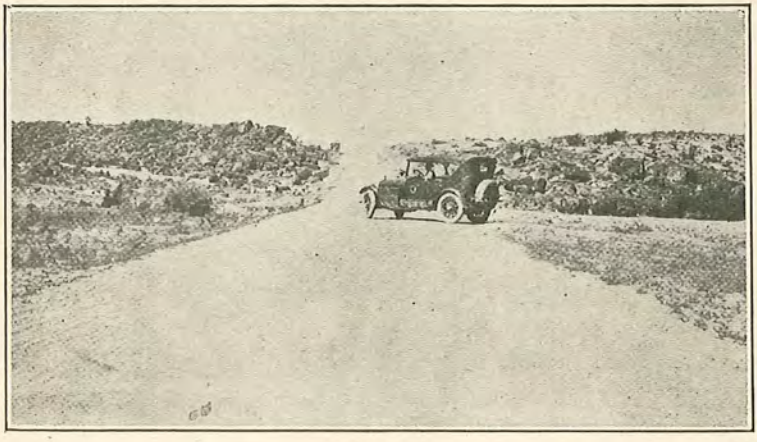
It will be noted that only 31.1 miles are maintained by the counties, the remainder being under the State Highway Department maintenance. It is interesting to note the average thru traffic on these several highways, as shown in the table given herewith:

Project	Mileage	State Maint.	County Maint.	Av. thru daily traffic. No. of cars
Tucson-Florence	67.6	67.6	.....	100
Nogales-Tucson	68.	48.9	19.1	351
Tucson-Benson	52.9	52.9	.....	122
Benson-Nog.-Tomb. Junction	22.6	22.6	.....	107
Nogales-Tombstone	74.3	52.3	22.0	123
Tombstone-Bisbee	26.2	26.2	.....	99
Bisbee-Douglas	24.6	24.6	.....	251
Douglas-Rodeo	48.3	48.3	.....	116
Total	384.5	353.4	31.1	

The condition of the Highways in Arizona as regards maintenance, is illustrated by the fact that during the State Fair in 1922, in a road race from Douglas to Phoenix, a distance of 268 miles, the average speed made by the winning car was 50 miles per hour, and this while 50 miles of roadway were incomplete, and had not been turned open to traffic.



STANDARD CULVERT—HOLBROOK-ST. JOHNS HIGHWAY



MOHAVE COUNTY HAS MUCH NATURAL GOOD ROAD MATERIAL

ROADS BY COUNTIES

Apache County

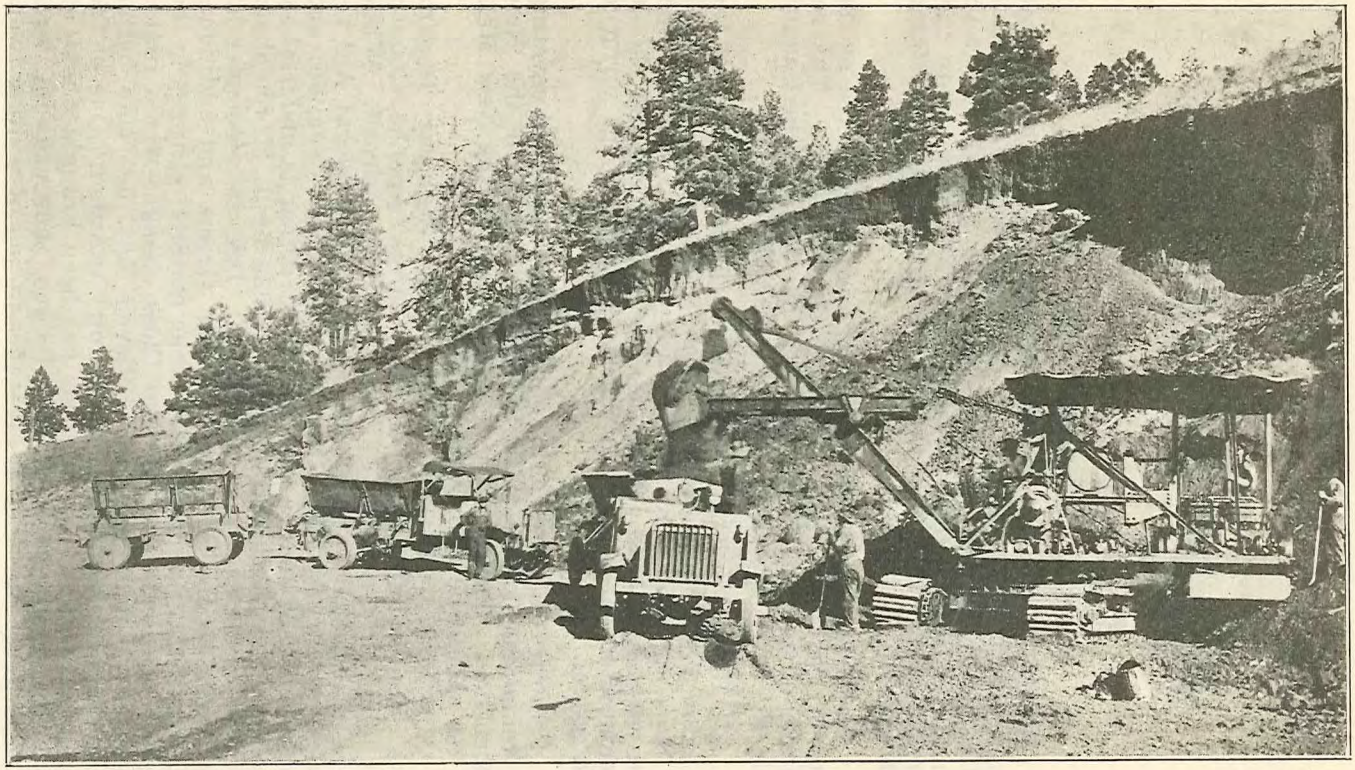
HOLBROOK-ST. JOHNS. Beginning at the Navajo County line, the first 18 miles were constructed by the State in 1914-15. The roadway is surfaced with gravel. The next 13 miles constitute Federal Aid Project No. 6, and were constructed by the State in 1921-22. The roadway is surfaced with gravel.

A concrete bridge of 30 feet span was constructed by the State in 1922 at Concho, crossing Concho Creek. The remainder of the road to St. Johns was built by Apache County. It should be reconstructed to State standard in 1923.

ST. JOHNS-SPRINGERVILLE. Federal Aid Project No. 60, extending from St. Johns 13.5 miles toward Springerville, has been approved and contract for the construction of this road was let in 1922. Work is now in progress and should be completed early in 1923. The roadway is to be surfaced with gravel.

Federal Aid Project No. 68 has been submitted covering the remaining 19 miles to Springerville, toward the New Mexico line. The road from Springerville to the New Mexico line should be improved in 1923.

ADAMANA-LUPTON. The State Highway Department is now improving the road across Apache County, paralleling in a general way the Santa Fe railroad. While the work being done does not comply with Federal Aid requirements, it is being done on a permanent location, and will be utilized when permanent construction is undertaken. This survey was originally made in 1920 by J. M. Shepherd under instructions from this office. Due to recommendations made by Mr. Shepherd and Mr. Green, and additional investigation, it was decided to make material changes in the original location. The result of these changes was a reduction of seven miles and it is believed that the route better serves the local interests of the country traveled. One of the advantages to the local interests has been brought about by two bridge crossings of the Rio Puerco, thus enabling local traffic to cross the river at all stages in lieu of waiting twen-



CINDER PIT ON OLD TRAILS HIGHWAY

ty-four hours for the river to subside, a frequent occurrence in the past. The bridges have been designed and contracts let for their construction. The work is being financed with State Road Funds and $15,000 from Apache County Bond funds.

Cochise County

BENSON-VAIL HIGHWAY, Federal Aid Project 18, Sections D and E.

Section D of this project consists of 3.99 miles of surfaced highway, extending from the Pima County line toward Benson. This section was constructed during the years 1919 and 1920 by Goodman & Merrill under contract with the State Highway Department.

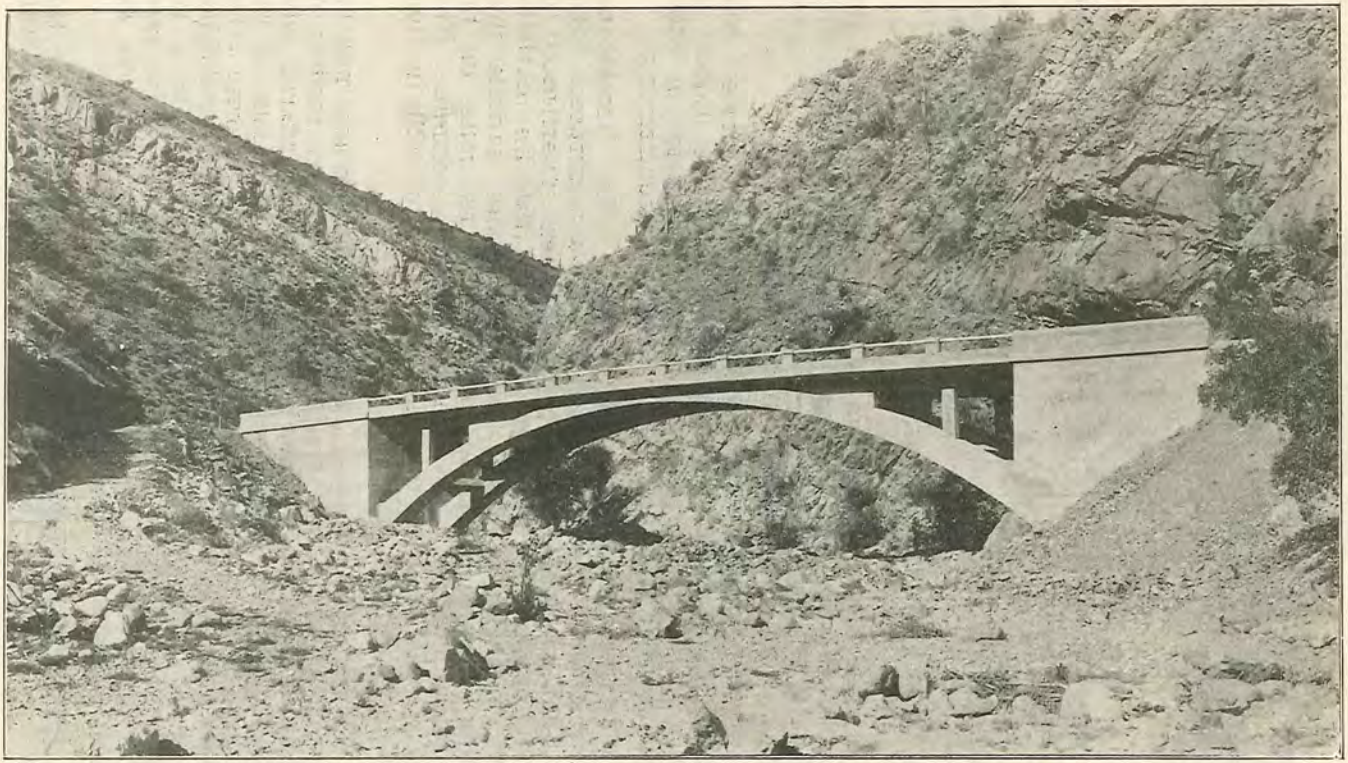
Section E was constructed by Contractors Eckerman and Chambers during 1921 and 1922. The work on this section was delayed because of right-of-way difficulties. This section is 6.01 miles in length and is surfaced.

BENSON-TOMBSTONE HIGHWAY. This project consists of 25.6 miles of road constructed by Cochise County in 1919 and 1920. This road is being reconstructed by State forces in order to comply with Federal Aid requirements.

TOMBSTONE-BISBEE HIGHWAY. The Tombstone-Bisbee Hifhway was completed in 1918 as a surfaced highway, but considerable difficulty has been experienced in maintaining this highway due to the fact that fine particles in the surfacing blow away, leaving the coarse particles protruding. Contract was let for surfacing ten miles on the Tombstone end, with two inches of asphaltic concrete. This work was done during the summer and fall of 1922 by Contractors White and Miller.

This type of surfacing appears satisfactory and may be the solution of the surfacing problem of a large number of highways in Arizona which were previously surfaced with gravel, caliche or other similar material. The cost of the surfacing was approximately $11,000 per mile, whereas other standard pavements would have cost from $25,000 to $35,000 per mile. This cost also compares favorably with a resurfacing of gravel or caliche, which would amount to from $5,000 to $10,000 per mile. This surfacing should be extended to Bisbee as soon as funds become available.

BISBEE-DOUGLAS HIGHWAY. A description of this road is contained in the Fourth Biennial Report of the State



UPPER QUEEN CREEK—SUPERIOR-MIAMI HIGHWAY. TWO RIBBER RE-INFORCED CONCRETE ARCH.

Engineer. The entire distance is paved with concrete 18 feet wide.

Portions of the roadway between Bisbee and Forest Ranch and between Douglas and Forest Station are being repaired, owing to large cracks having developed. Federal Aid Project No. 11, extending from Forest Ranch to Forest Station, and constructed by the State Highway Department, is included in this highway.

DOUGLAS-RODEO HIGHWAY, Federal Aid Projects 14 and 38. The highway from Douglas to Bernardino was constructed during 1919 and 1920. Contract was let to Dan La Roe in October, 1920, for improving the highway from Bernardino to the New Mexico line near Rodeo. This work was completed during the year 1921, except a small etretch at Apache, where right-of-way difficulties held up the completion of the project until the fall of 1922. The entire project is surfaced, and has been accepted by the Bureau of Public Roads.

FAIRBANK-TOMBSTONE HIGHWAY. This project consists of 8.5 miles of surfaced highway, extending from the bridge at Fairbank to Tombstone. It was constructed during the year 1919 by State forces.

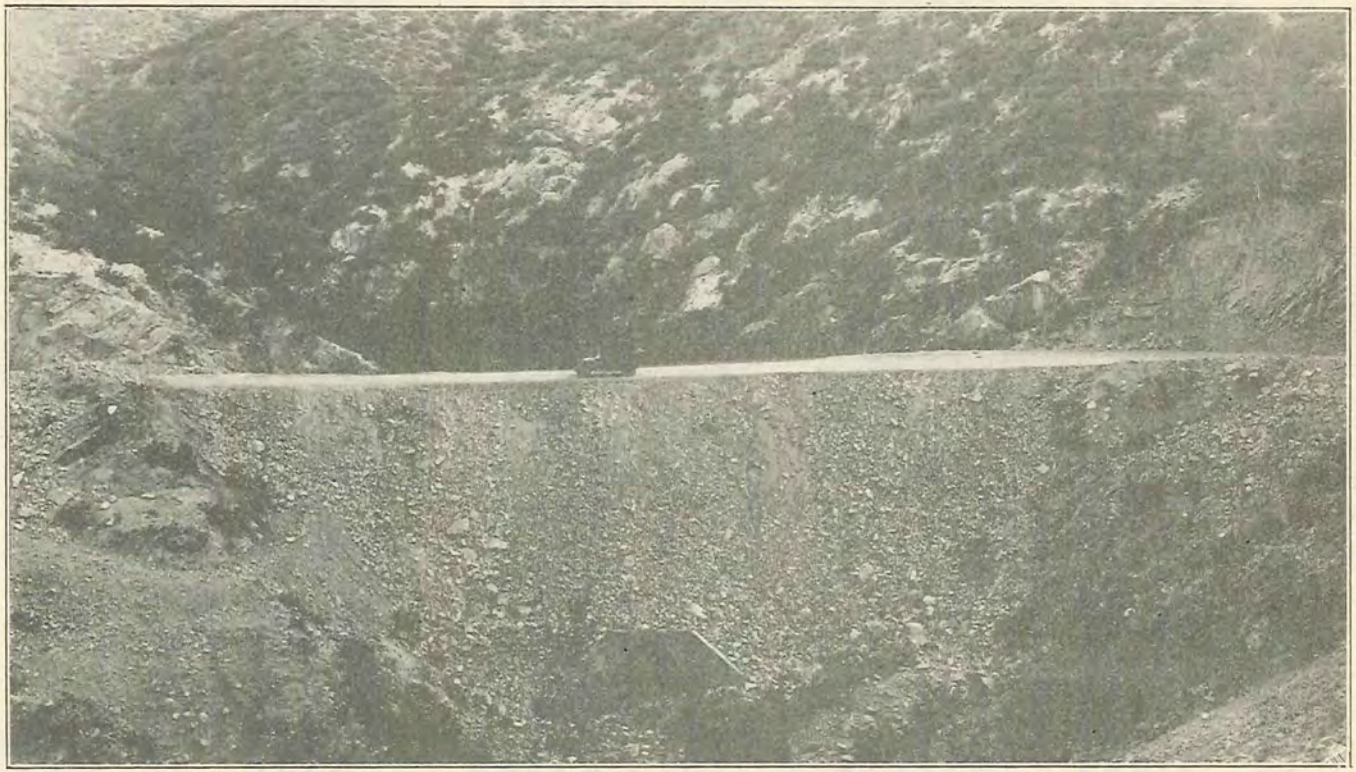
SANTA CRUZ COUNTY LINE TO FAIRBANK, Federal Aid Project No. 49. This project consists of 16 miles of surfaced highway, and was constructed by the State Highway Department during the year 1922. At Fairbank the San Pedro river is crossed by a concrete bridge previously constructed.

Coconino County

WILLIAMS-ASH FORK. Beginning at the county line, west of Williams, the first 4.8 miles constitute Federal Aid Project No. 51. This road was constructed by State forces in 1921 and 1922, and was financed with State Road funds, Coconino County bond funds and Federal Aid.

Due to delays in securing Federal Aid, grading work was done prior to Federal Aid approval and only the surfacing participated in Federal Aid.

The next 2.82 miles constitute Federal Aid Project No. 37, and are known as Ashfork Hill. This road was constructed in 1921, and was surfaced with cinders. The construction of this project eliminated a road that was formerly



PINTO CREEK CULVERT IN 53-FOOT EMBANKMENT—SUPERIOR-MIAMI ROAD

impassable a considerable portion of the year on account of mud and excessive grades.

The remaining 8.7 miles to William swere constructed by State forces in 1921. All but 2½ miles are surfaced. The work was financed with funds appropriated in the Omnibus Bill and State Road fund.

FLAGSTAFF-WILLIAMS. From Williams the first 18 miles of road toward Flagstaff were constructed by State forces in 1915, '16 and '17. The roadway is surfaced with cinders and gravel. The remaining 15 miles to Flagstaff include Federal Aid Project 24. This project was constructed by State forces in 1920 and 1921. The roadway is surfaced with cinders.

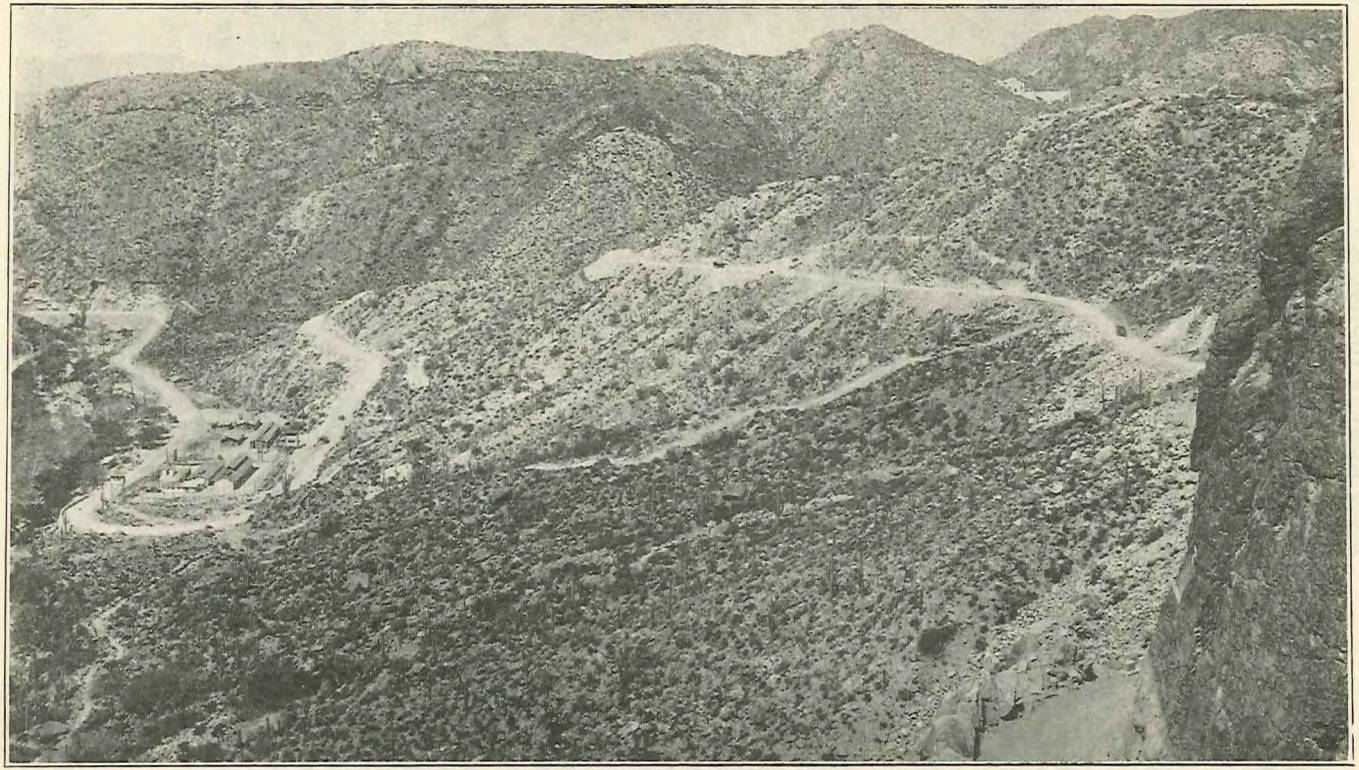
FLAGSTAFF PAVING. The Old Trails Highway thru the town of Flagstaff was paved by the State Highway Department in 1920, '21 and '22. Beginning at the eastern City Limits, approximately one mile was constructed as Federal Aid Project No. 21. The City Limits of Flagstaff were subsequently extended to the west about one-half mile, and the paving then continued to the new City Limits. The work was paid for with funds raised by the Town of Flagstaff, State funds and Federal Aid.

FLAGSTAFF-WINSLOW. Very little permanent work has been done on the Flagstaff-Winslow Highway in Coconino County with the exception of bridges across Canyon Diablo and Canyon Padre.

Arrangements have been made whereby the Forest Service will construct the road from Flagstaff to the eastern boundary of the Coconino National Forest, near Angel. The Highway Department has submitted a project statement to the Bureau of Public Roads covering the road from the Navajo County line to the Canyon Diablo bridge. This road will follow closely the Santa Fe Railroad, as considerable distance can be saved and better alignment secured. The road will necessarily cross the Santa Fe Railroad, but this crossing can be made under one of the Santa Fe bridges. A survey has been made of the entire route, resulting in a shortening of the road approximately eight miles.

Gila County

SUPERIOR-MIAMI, Federal Aid Project No. 16, was completed and accepted by the Bureau of Public Roads, in September, 1922, and final Federal Aid voucher has been



SUPERIOR-MIAMI "LOOP"—TAKEN FROM ABOVE TUNNEL

paid. The work was described in the Fourth Biennial Report of the State Engineer, and will not, therefore, be described in detail here. This road has the heaviest highway construction in Arizona, if not in the United States.

Features of the road are the Queen Creek section, thru extremely rugged country. In this section a tunnel 257 feet long was necessary.

Devil's Canyon is another stretch of heavy construction thru rugged country.

Pinto Creek is also heavy construction. The creek is crossed with a fill having a maximum height of 53 feet. An arch culvert having a span of 14 feet and a height of 9 feet carries the creek thru this fill. The culvert is 122 feet long. The fill is 163 feet wide at the bottom.

Approximately three miles on the Miami end of the project had previously been constructed by Gila County, but as the roadway was narrow, and in other respects did not comply with Federal Aid requirements, it was widened and otherwise reconstructed in 1922.

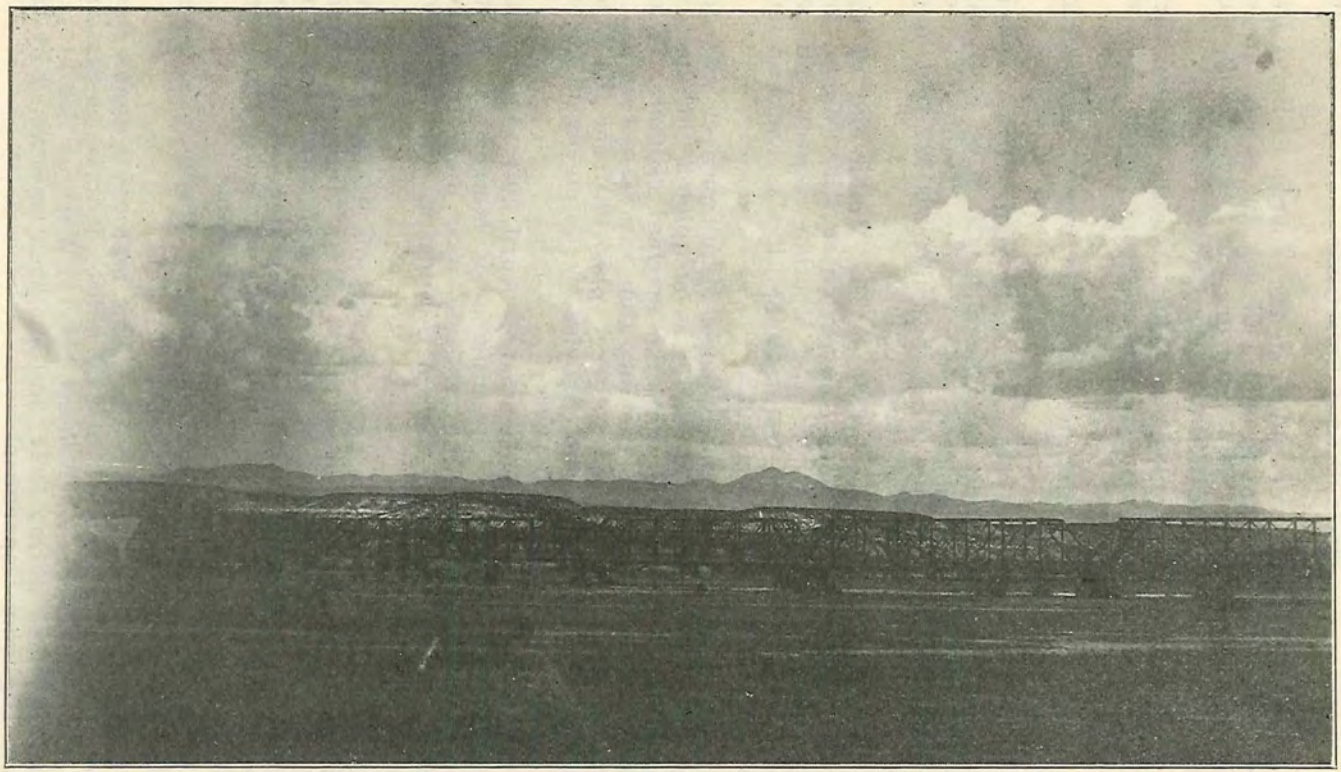
The entire cost of the Superior-Miami project was approximately $1,015,000.00, and was completed for approximately $225,000.00 less than the original estimate. This saving was partly due to the fact that the State received a large amount of TNT and other explosives from the War Department, as well as some articles of equipment, at a cost of freight and loading charges.

The road was formerly opened April 29th, 1922, with ceremonies arranged by the citizens of Miami. A monument was erected along the roadside, near the county line, and was presented to the State of Arizona by the citizens of Miami.

At the request of the City Council of Miami, the State Highway Department improved the State Highway within the city limits of Miami by grading, surfacing, etc. The work was in charge of Harry Hagen, who has just completed the Miami end of the Superior-Miami project. The work was done at the expense of the City of Miami.

The road from Miami to Globe, a distance of seven miles, was paved by Gila County in 1917.

GLOBE-RICE HIGHWAY. This highway extends from Globe to Rice, a distance tof 23.0 miles. It includes Sections A and B of Federal Aid Project No. 15. Work on this project was completed during 1921, and has been maintained by the State Highway Department.



SAN CARLOS GILA RIVER BRIDGE—GRAHAM COUNTY

Graham County

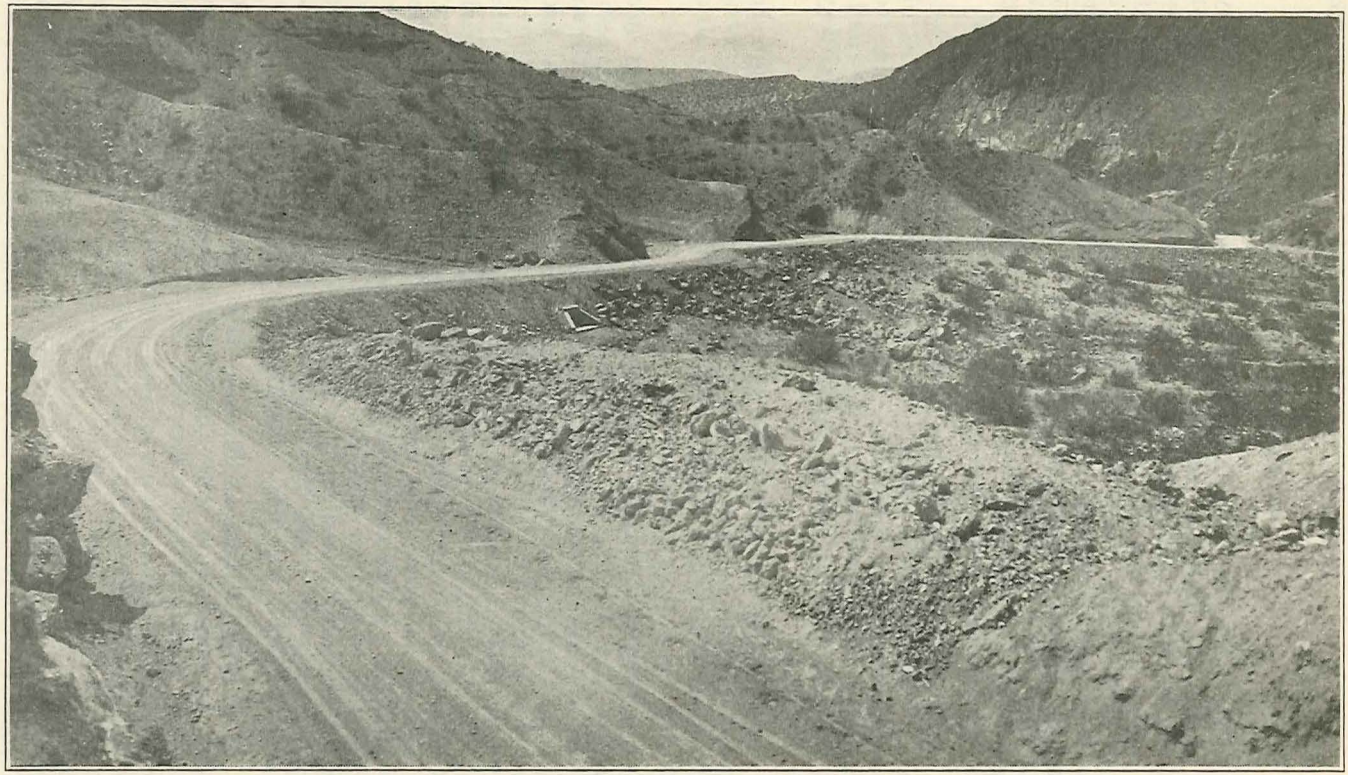
RICE-BYLAS. Practically all of this section of roadway lies within the limits of the San Carlos reservoir site, and for that reason was constructed as a temporary road. The present bridge across the San Carlos river near Rice, and also the bridge across the Gila river near Bylas, will have to be moved to new locations, when the San Carlos dam is constructed. These roads and bridges were originally built by the Federal Government in 1913. The Gila River bridge was lengthened 504 feet by the Arizona Highway Department, and considerable work done on this road in 1920 and 1921.

BYLAS TO GERONIMO, Federal Aid Project 15, Section D. This project consists of approximately five miles of standard highway, extending from a point near Bylas to Geronimo. Construction was completed in 1921. The roadway was built and is being maintained by the State Highway Department.

GERONIMO-MATHEWS WASH. From Geronimo to Mathews Wash, a distance of 14.5 miles, the road was reconstructed in 1921 and 1922. The roadway is surfaced and drainage structures installed.

MATHEWS WASH TO SOLOMONVILLE, Federal Aid Projects Nos. 43, 63, 67. Project statements have been submitted, calling for paving the entire distance from Mathews Wash to a point two miles east of Solomonville. Federal Aid has been approved on the projects extending from Mathews Wash to Central, and from Central to Safford. Contract has been let for doing the grading work from Mathews Wash to Central, this work being deemed advisable in advance of the paving, in order that new fills will have time to settle. Contract for paving six miles from Central to Safford was let in October, 1922, to the Lee Moor Contracting Company, and work is now in progress. The roadway will be relocated in order to avoid numerous crossings of the Arizona Eastern Railroad. Eight railroad crossings can be eliminated.

SOLOMONVILLE-DUNCAN HIGHWAY. Length 10 miles. In connection with the County Engineer of Graham County a survey of ten miles was made from a point on the Solomonville-Clifton Highway to a point on the Solomonville-Duncan Road. The construction was carried out under the Graham County bond issue. This change of line does not reduce the distance over the present traveled road, but it does, by the consolidation of the two routes for a distance of 10 miles from Solomoncille east, eliminate, from the two, ten



APPROACHING CLIFTON ON CLIFTON-DUNCAN ROAD

miles of distance with the subsequent maintenance. The new route will also reduce the maintenance charges by avoiding numerous washes across the present road.

Greenlee County

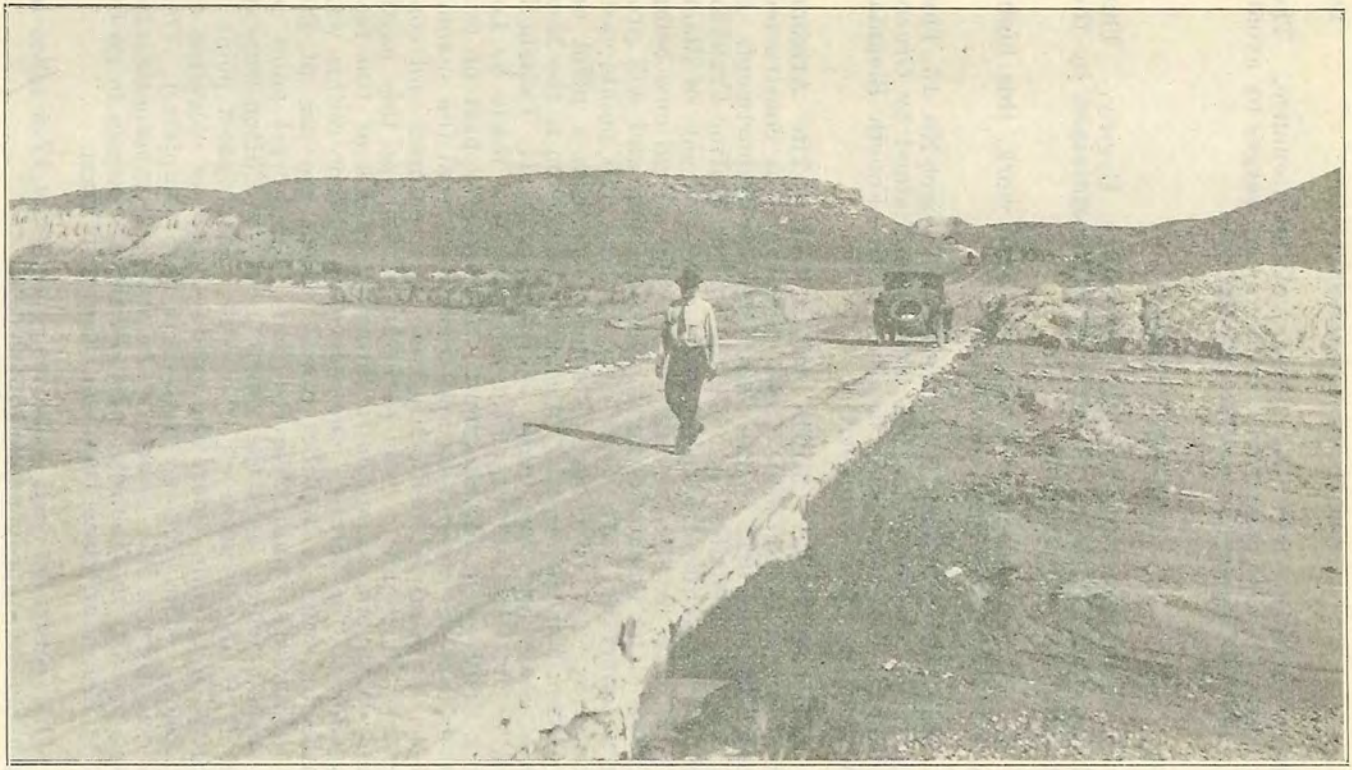
CLIFTON-SOLOMONVILLE, Greenlee County. This highway was completed in 1920, and is maintained by the State Highway Department.

On the completion of Graham County work, this highway will be in first-class condition.

CLIFTON-FRANKLIN, Federal Aid Project No. 13. This project was completed in 1921, and is maintained by Greenlee County. A description is given in the Fourth Biennial Report of the State Engineer.

CLIFTON-MULE CREEK HIGHWAY. The Arizona section of the Clifton-Mule Creek Highway was constructed during 1921 and 1922 by the State Highway Department. It begins about 10 miles from Clifton on the Clifton-Franklin Highway, branching from that road on the east side of Black Jack Canyon. At the state line it will join a road now being constructed by Grant County in New Mexico, and will provide a connection with Silver City, Deming and points east. During the year 1920 the reconnoissance from a point on the Clifton-Duncan road 10 miles south of Clifton to the New Mexico State line was made by Engineer F. G. Twitchell. Early in 1921 the survey of this highway was made by Locating Engineer J. M. Shepherd. The greater part of this route is thru the mountains and four miles from the summit east a supported six per cent grade was required and considerable development was necessary to secure this maximum. With one exception, a minimum radius of 100 feet was adopted for curves. One curve of 60-foot radius was located to avoid a 400-foot tunnel which the use of the 100-foot radius would have required. The lowest point on the survey, which is at the junction of the Clifton-Duncan road, is at an elevation of 3850 feet. The highest point is at Black Jack Gap, where the grade attains an elevation of 6304 feet. (The Arizona portion is now complete.) This road will form a link in one of the shortest transcontinental routes crossing the country, and will enable tourists to go by way of Elephant Butte Dam and Roosevelt Dam.

The section of road just constructed was 17:5 miles in length and cost approximately $151,000.00.



CONCRETE DIP—PETRIFIED FOREST—NAVAJO COUNTY

Maricopa County

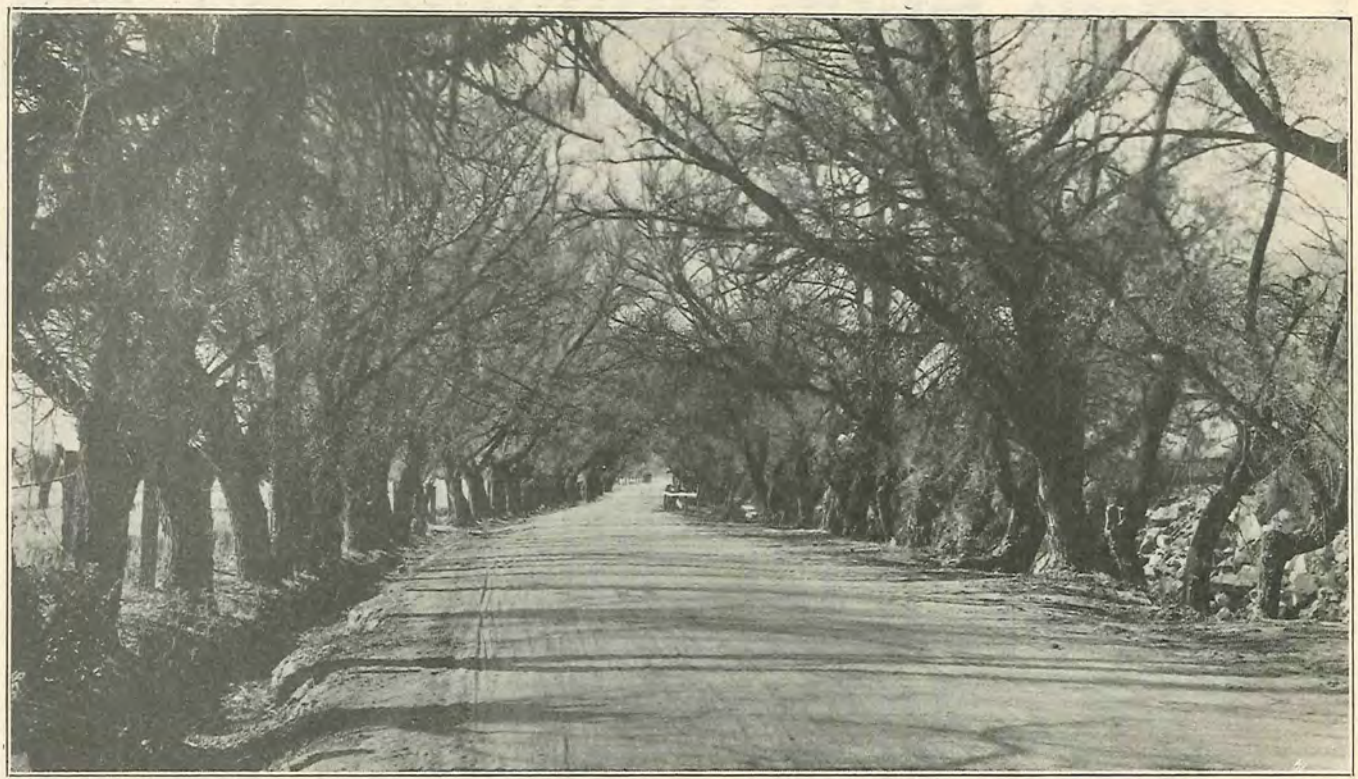
YUMA-MARICOPA COUNTY LINE TO PIEDRA. Project statement No. 69 has been submitted covering the road from the Yuma-Maricopa County line, near Stanwix, to Piedra, a distance of 22.14 miles, at an estimated cost of about $250,000. Funds available from the Maricopa County bond issue, and not needed in the original Maricopa County program, are to be used in this construction, arrangements to this effect having been made with the Maricopa County Highway Commission and the Board of Supervisors.

PIEDRA TO GILA BEND. Federal Aid Project No. 56 consists of 14.9 miles paralleling the Southern Pacific Railroad track, from Piedra to Gila Bend. Bids were received and contract awarded to S. B. Shumway in October, 1922. The work has been sublet by Mr. Shumway to Robert Mackay, and construction work is now in progress. The contract provides for the work to be completed within 140 days. The cost of the project will be approximately $80,000. The contract is approximately 60 per cent complete.

GILA BEND TO GILLESPIE DAM. Federal Aid Project No. 53 consists of 23.5 miles of road. It parallels in a general way the canal of the Gila Water Company. Federal Aid was approved and construction started in April, 1922. The project was difficult to construct owing to the extremely hot weather in that locality, the light silty soil and scarcity of suitable surfacing material. The roadway was constructed with surfacing 13.5 feet wide, the material for which was secured from pits along the road. The surfacing material is not the best in quality, but was all that could be secured at a reasonable cost. Owing to the infrequent and light rainfall in this locality, the new grade and the surfacing were flooded with water pumped from the Gila Water Company's canal, in order to solidify the roads so they could be used by heavy trucks.

A narrow surfacing on this stretch was approved by the Bureau of Public Roads, with the understanding that it would later be widened to a full 24-foot roadway. The project should be completed by the end of 1922. The cost will be approximately $180,000.

GILLESPIE DAM-HASSAYAMPA RIVER. Federal Aid Project No. 64 has been submitted for this project, consisting of 10.66 miles, extending from the Gillespie Dam to the Hassayampa River. Owing to the flooding of the road caused by the construction of the Gillespie Dam, a rather



NOGALES-TUCSON HIGHWAY, "THE WILLOWS"

difficult problem in the way of location, as well as construction, presents itself on this project. Also the present road from the Hassayampa River to Arlington is poorly located for road construction purposes. It is planned to locate this road on higher ground, crossing the mesa on a direct line from the Hassayampa River to Arlington. This will not only provide a better location, but will reduce the distance nearly a mile. A fill will be made across the low, soft ground north of the Gillespie Dam and a long level concrete dip provided to carry the infrequent floods of the Centennial Wash. The estimated cost of the project is about $130,000.

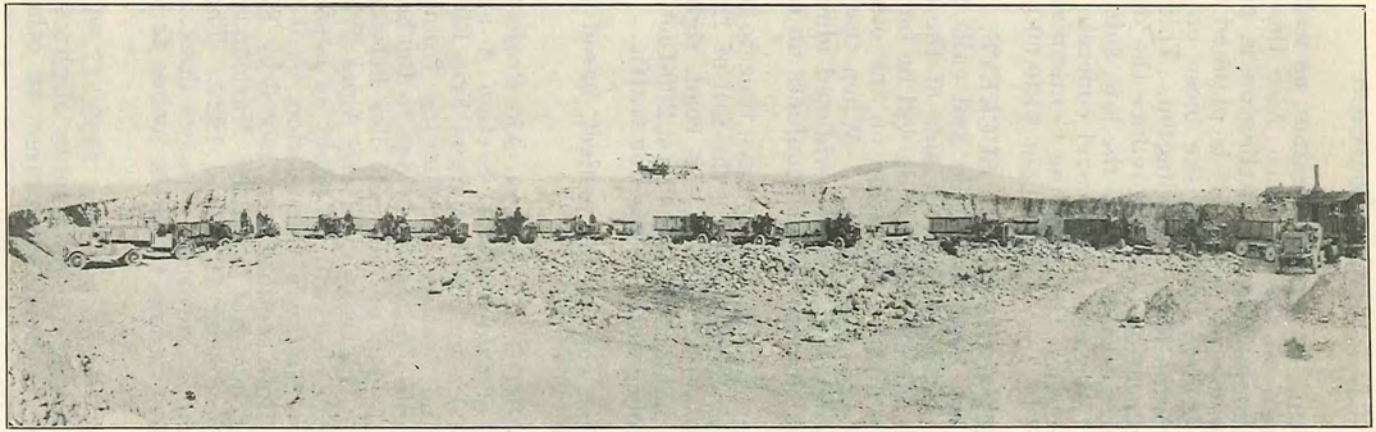
HASSAYAMPA RIVER TO BUCKEYE. Federal Aid Project No. 71 has been submitted and calls for pavement nine feet wide, constructed on one side of the center line of the roadway. Shoulders 6 feet wide will be built on one side of the pavement, and 15 feet wide on the other, making a total width of roadway of 30 feet. When traffic conditions justify, the pavement will then be widened nine feet, making an 18-foot pavement with 6-foot shoulders on each side.

In order that the fills might have time to settle, grading work was done by State forces in the fall of 1922. As there are several right-angle turns in this road, right of way has been secured to make these turns on a 200-foot radius, which will provide much greater safety for traffic.

The estimated cost of the project, based on a nine-foot roadway, is about $200,000.

BUCKEYE-PHOENIX, Federal Aid Project No. 46. This project consists of two sections, Section A extending from the city limits of Phoenix to the Agua Fria River, a distance of 13.4 miles, and Section B extending from the west approach of the Agua Fria River Bridge to Buckeye, a distance of 18.8 miles. A gap of one mile lies between Sections A and B, this being the crossing of the Agua Fria River. It is at present unpaved, but will no doubt be constructed by the Maricopa County Highway Commission, as it is included in their program. Both sections were paved by Twohy Brothers Company, under contract with the Maricopa County Highway Commission, during 1921 and 1922. The pavement is 16 feet wide, and is uniformly 6 inches thick, excepting that the outer two feet tapers from six inches to nine inches at the edges.

The cost of the project was $892,517.86, the full cost being paid by the Maricopa County Highway Commission, the Federal Aid received being used on other projects, in



GRAVEL PIT—PRESCOTT-JEROME HIGHWAY, SHOWING STEAM SHOVEL, TRUCKS AND TRAILERS.

conformity with an agreement between the State Highway Department and the Maricopa County Highway Commission.

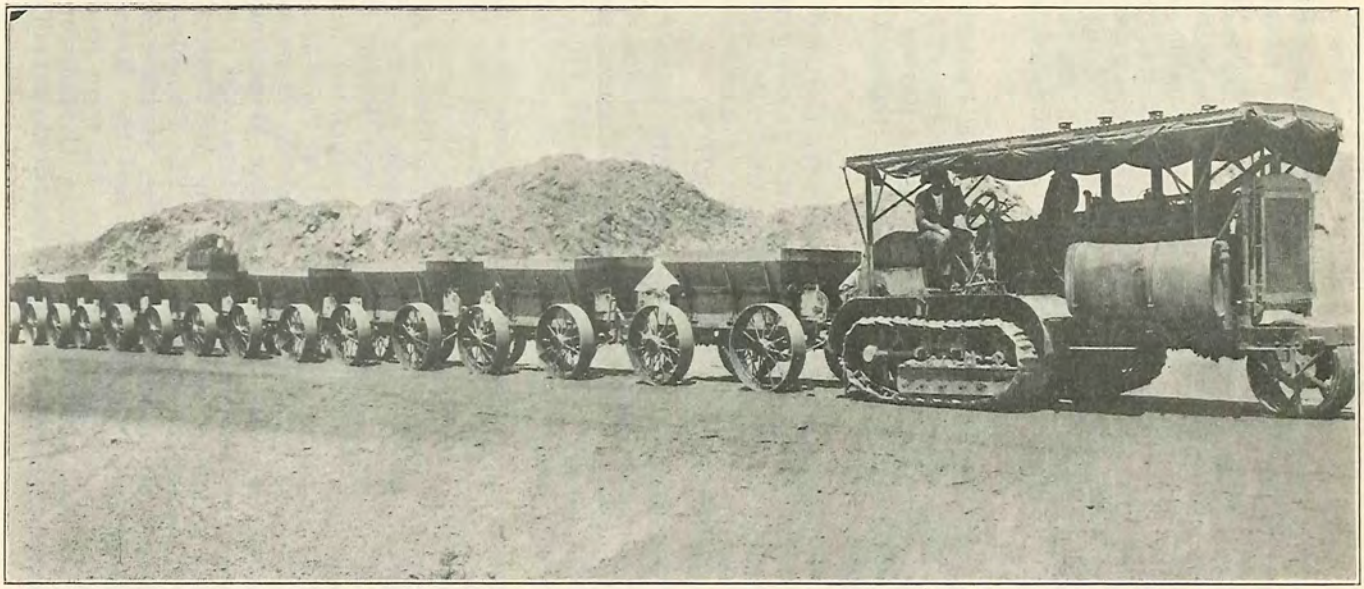
PHOENIX-MESA. Beginning at the city limits of Phoenix,, three miles between Phoenix and Tempe were paved during the fall of 1921. The pavement is asphaltic concrete 18 feet wide and 6 inches thick. The work was done by Contractors White and Miller. These three miles are known as Federal Aid Project No. 30. The east end of the project joins Federal Aid Project No. 2, which extends the remaining four miles to Tempe. This project was constructed by State forces in 1919.

Project No. 2 connects at Tempe with Project No. 8, extending 6.8 miles to Mesa, where it joins the city paving. A gap of approximately one-half mile in the paving thru the east half of Mesa was paved by the State Highway Department in 1922.

From the east city limits of Mesa to the Eastern Canal, a distance of four miles, the roadway was paved during the summer of 1922 by Twohy Brothers, contractors, under contract with the Maricopa County Highway Commission. This four miles constitutes F. A. Project No. 47.

APACHE TRAIL. The Omnibus Bill passed by the Legislature in 1921 appropriated $75,000 for the improvement of the Apache Trail in Maricopa County, providing that $250,000 would be raised for this work from sources other than State taxation.

In order to raise this $250,000 arrangements were made between the State Highway Department and the Maricopa County Highway Commission, providing that certain roads in the Maricopa County program be made Federal Aid Projects, that the County Highway Commission pay the full cost of certain roads within their program, and that of the Federal Aid received $275,000 should be expended within the Maricopa County program and $250,000 on the Apache Trail and the balance spent by the State Highway Department on other State roads. The State Highway Department constructed the Phoenix-Glendale road, Federal Aid Project No. 33, and the Phoenix-Tempe road, Federal Aid Project No. 30, at a cost of approximately $275,000. The Phoenix-Buckeye road, Federal Aid Project No. 46; the Glendale-Marinette Road, Federal Aid Project No. 48, and the Mesa-Eastern Canal Road, Federal Aid Project No. 47, were paid for in full by the Maricopa County Highway Commission. This provided sufficient funds for improving the Apache Trail, etc.



CATERPILLARS PULL IN SAND WHERE TRUCKS AND EVEN MULES FAIL—YUMA COUNTY

Construction work was, therefore, started in May, 1922, and the road will be in good shape by the end of the year. Two bridges have been ordered, but will not be delivered until the early part of 1923. On account of the proposed construction of a reservoir at Mormon Flats, and another reservoir near Horse Mesa, due to which the old road will be submerged, only temporary work was done on those sections, which will be later completed on the new locations.

In rehabilitating the Apache Trail, no efforts were made to comply with Federal Aid requirements, as they would necessitate maximum grades of six per cent instead of the existing ten per cent, longer radius curves and wider roadway, which would mean practically a relocation and reconstruction of the entire road. As the road is primarily a scenic route, such work was not considered necessary.

Minor changes only were made in the location and these where the location could be improved at no additional cost.

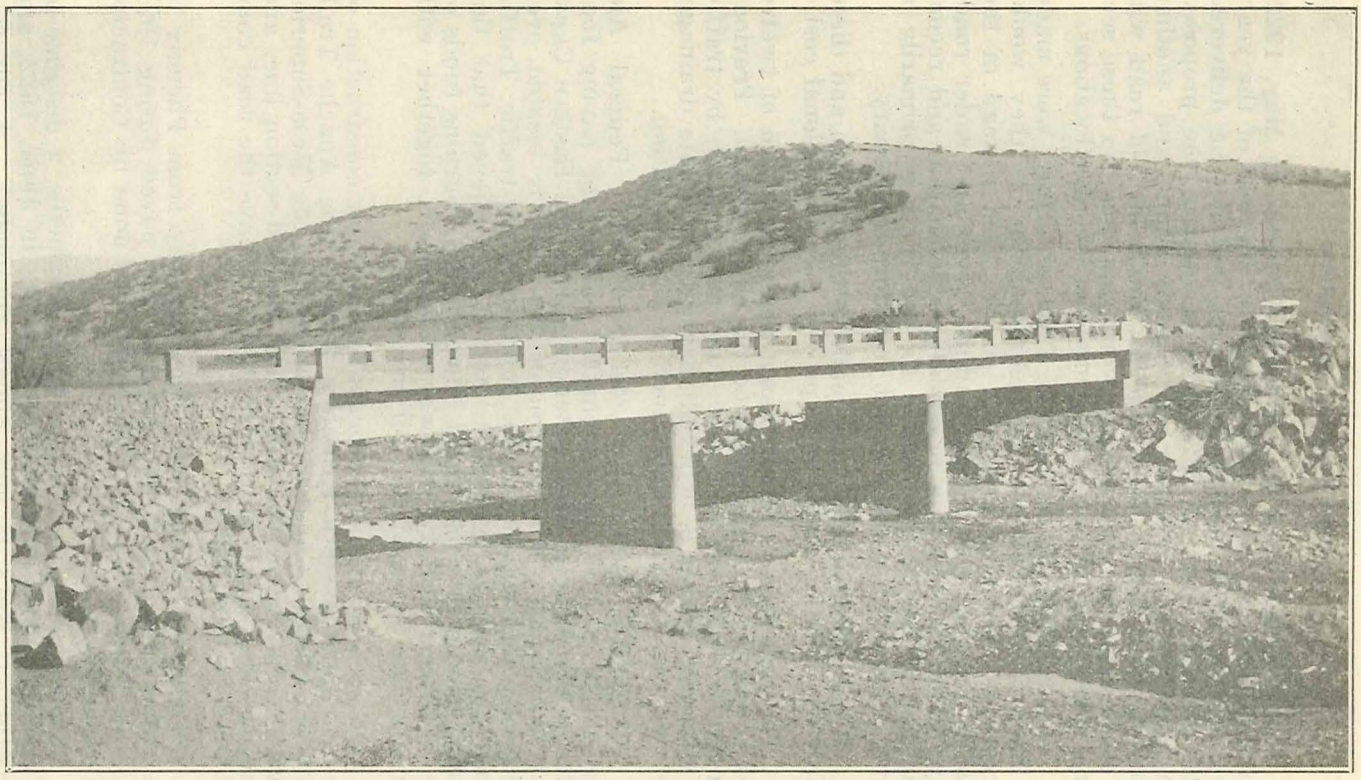
The roadway as rebuilt has a minimum width of twelve feet, is well drained and surfaced the entire length. Previous damage to this road has been done not so much by traffic as by water, and it is believed that with adequate drainage, the road can be easily maintained in good condition.

EASTERN CANAL—4 MILES EAST. Federal Aid Project No. 65 has been submitted calling for paving four miles of the Apache Trail extending from the Eastern Canal east four miles. This portion of the road is located over light, silty soil, which does not hold up under traffic. Traffic conditions require pavement, and it is believed that this project should be constructed immediaetly. Surplus funds of the Maricopa County Highway Commission, together with Federal Aid, are available for this work.

On account of the prospects for the early construction of the Auxiliary Eastern Irrigation Project, the Apache Trail, from the Eastern Canal to the junction of the Mesa-Superior Highway, has been relocated along the mid-section line, and grading work has been done in order to have the road compacted by winter rains.

PHOENIX-PRESCOTT. The highway from Phoenix to Glendale, known as Grand Avenue, was paved during 1921 as F. A. Project No. 32. The work was done by Contractor Dan La Roe.

From the end of Project 32 to Marinette, a distance of 7.79 miles, contract was let for paving in June, 1922, and construction work is now almost completed. A concrete



GRANITE CREEK BRIDGE—PRESCOTT-JEROME—YAVAPAI COUNTY

bridge, designed by the Arizona Highway Department, 360 feet in length, is being constructed across New River. The highway from Glendale to Marinette is known as Federal Aid Project No. 48.

Project Statement No. 70 has been submitted covering an additional four miles extending from Marinette in a northwesterly direction, crossing the Agua Fria River Bridge, which was constructed in 1920 as Federal Aid Project No. 12.

From the end of this project to Hot Springs Junction, a distance of 23 miles, the road is to be graded and drainage structures put in at the numerous washes. It is proposed to provide an underpass at one of the Santa Fe bridges.

Federal Aid Project No. 59 extends from Hot Springs Junction to Wickenburg. This project has been approved and construction is now in progress. This stretch of road provided an unusual problem as regards location. After a thorough reconnaissance of several routes, covering the area on both sides of the Hassayampa River, a line following approximately the east side of the river was decided upon as being the most feasible route. As all routes investigated called for heavy grading and involved difficult drainage problems, it was found that the shorter route by the river, while no more expensive than the alternative routes, gave a much greater saving of distance and better consolidation of the drainage. The reduction in distance as compared with the present traveled road amounts to 8.5 miles.

The material available for surfacing is more abundant and better distributed than on the alternative routes investigated.

The road from Wickenburg to the county line in the direction of Congress Junction was constructed by the State Highway Department in 1922.

Mohave County

TOPOCK-OATMAN HIGHWAY. The highway from Topock to Oatman is 26.16 miles in length. Beginning at Topock, the first half mile is unimproved. It was originally included in Federal Aid Project No. 39, but this half mile of road work was postponed in a desire to have a grade separation installed later. The Santa Fe Railway has recently decided to double track in this vicinity, at which time a grade separation should be made.

Federal Aid Project No. 39 begins one-half mile from Topock and extends 22.5 miles toward Oatman. It was con-

structed with State forces in 1920 and 1921, and was financed by funds from Mohave County bond issue and Federal Aid.

The remainder of the road to Oatman consists of 3.16 miles of road improved by Mohave County.

The entire project from Topock to Oatman is maintained by the State.

OATMAN-GOLDROAD HIGHWAY. The highway from Oatman to Goldroad is 2.68 miles in length, and was constructed as two separate Federal Aid Projects.

Federal Aid Project No. 44 consists of one-half mile, beginning at Oatman, which was constructed with State forces in 1921.

Federal Aid Project No. 5 consists of the remaining 2.18 miles, and was built in 1920-1921 by Contractors Alvey and Larson. It was financed with State and Federal Aid funds.

KINGMAN-GOLDROAD. The highway from Kingman to Goldroad, approximately 24.36 miles in length, begins at Goldroad. The first 4.2 miles are known as Goldroad Hill. Three miles of this section were built by the State in 1915-1916, and 1.2 miles have been built by Mohave County.

The next 3.16 miles constitute Federal Aid Project No. 54, and are known as the "17-Mile Hill." Construction was started in November, 1922.

The remaining 17 miles were improved by Mohave County. Some changes were made by the Santa Fe Railroad in their recent double tracking.

KINGMAN-HACKBERRY. Two miles of the Old Trails Highway extending east from Kingman are being reconstructed on account of the double tracking of the Santa Fe Railroad. The work is being done by Mohave County forces and is being financed by the Santa Fe Railroad Company and the State. Work was started in August, 1922.

The remaining 26 miles to Hackberry were improved by Mohave County. It is located over most excellent road material

HACKBERRY-PEACH SPRINGS. The first five miles of highway east of Hackberry were partially improved by Mohave County.

A new route has been laid out from a point a mile east of the Crozier ranch to a point near the Indian School at Valentine. The survey was made early in 1921 by Locating

Engineer T. S. O'Connell. This change of line eliminated two railroad crossings and avoided a canyon which required extensive maintenance after each flood. After this location was completed, the A., T. & S. F. Railroad commenced construction on a relocated second track and the new line conflicted with the survey made by the Highway Department, necessitating a new survey. However, the railroad company has co-operated with the Department by placing two undercrossings to be utilized by the proposed road, and will, when their tracks are moved, permit the Department to use the old grade for the new highway. As the cost of these bridges has been borne by the railroad company, and with the utilization of their roadbed to be abandoned, the route as now contemplated will cost less than the one originally surveyed. The remaining distance to Peach Springs has been improved by Mohave County.

The entire distance from Hackberry to Peach Springs is in fairly good condition, although not complying fully with Federal Aid requirements.

SELIGMAN-PEACH SPRINGS. From Peach Springs to the Yavapai County line, near Nelson, a distance of about 7 miles, the road was constructed by State forces in 1921, and was financed with State funds.

Navajo County

WINSLOW-COUNTY LINE. Project Statement No. 22 has been approved covering the road from Winslow west to the Coconino County line, on the Flagstaff-Winslow road. Navajo County has available $8,000 for the construction of this road, which, together with Federal Aid, is sufficient to complete the project.

Owing to a change in the location of the road in Coconino County, construction of this project was held up. It should be constructed in conjunction with Federal Aid Project No. 74.

WINSLOW PAVING. Approximately one mile of the Old Trails Highway thru the town of Winslow is being paved by the State Highway Department and Federal Aid, the project being known as Federal Aid Project No. 20. Contract was awarded to Warren Brothers in July, 1922, and work would have been completed by the first of the year had the contractor not secured permission to lay some city paving simultaneously with the State work.

WINSLOW-HOLBROOK. Federal Aid Project No. 40

extends from Winslow to Holbrook, a distance of 32.2 miles. The work was let by contract in four sections, in June, 1922. Work should be finished by the end of the year. It is being financed with State road funds, appropriations made in the Omnibus Bill, and Federal Aid. The roadway is being surfaced with gravel.

HOLBROOK-ST. JOHNS. The first six miles beginning at Holbrook were constructed by the State in 1914 and 1915. The roadway is surfaced with gravel. A concrete arch bridge was constructed across the Little Colorado River. Some reconstruction work will be necessary to bring this road to Federal Aid requirements. The next 10.6 miles constitute Federal Aid Project No. 42, which is now under construction. Contract was let for this work in August, 1922, and the work should be finished in January, 1923. The roadway is being surfaced with gravel.

4.2 miles of this road in Navajo County lie within the Petrified Forest. The road was constructed in 1920 and 1921, as Federal Aid Project No. 4. The roadway is surfaced with gravel.

HOLBROOK-ADAMANA. The road from Holbrook to Apache County line near Adamana, a distance of 22 miles, was improved by Navajo County in 1921 and 1922. Portions of the roadway are surfaced, and the road put in good passable condition.

The State location between Holbrook and Adamana was followed with a few changes improving alignment by Navajo County.

Pima County

TUCSON-FLORENCE. The first four miles of the Tucson-Florence Highway lying within Pima County, and extending from the city limits of Tucson to the Rillito Bridge, was paved in 1919 and 1920, and is maintained by the State Highway Department. The remainder of the road in Pima County is now being reconstructed. While it is not a Federal Aid Project, it is being built according to Federal Aid standards. Numerous abrupt dips are changed so as to provide smooth-riding crossings in their place. Sharp curves are also being eliminated. The work will be almost completed by the end of 1922.

TUCSON-VAIL HIGHWAY. This project was constructed a number of years ago, being one of the first proj-

ects constructed by the State Highway Department. The location has many sharp curves. Considerable distance can be saved by their elimination.

VAIL-BENSON, Federal Aid Project No. 18, Sections A, B, and C. This project consists of 17.4 miles of road from a point 3.5 miles east of Vail-Empire Ranch road to the Pima-Cochise County line. Work was completed in 1921. The project has since been maintained by the State Highway Department A feature of this road is the Cienega Creek Bridge, known as Section F, which crosses both Cienega Creek and the Southern Pacific Railroad tracks. A picture of this bridge is shown in this report.

VAIL-EMPIRE RANCH HIGHWAY. A brief description of this road is contained in the Fourth Biennial Report of the State Engineer.

TUCSON-NOGALES HIGHWAY, Federal Aid Projects No. 29 and No. 25.

Project No. 29 consists of 8.5 miles of highway, extending from the city limits of Tucson toward Nogales. The roadway was paved during 1920 by John Hoopes, contractor, under contract with the State Highway Department. The cost of the work was $256,206.35.

Project No. 25. The remainder of the Tucson-Nogales Highway lying in Pima County was improved a number of years ago, by grading and surfacing. Several important drainage structures, however, were built in 1921 and 1922, as Federal Aid Project No. 25.

Several more structures remain to be constructed, and a revised set of plans, specifications and estimates have been submitted to the Bureau of Public Roads, calling for the construction of these bridges and culverts.

Pinal County

MESA-SUPERIOR HIGHWAY, Sections 2A and 2B.

Section 2A. This project was constructed in 1919 and 1920. It consists of 8.8 miles of road, surfaced with caliche and other selected local materials. It has been maintained by the State Highway Department, but owing to the fact that it becomes corrugated, and in places becomes rough, due to fine particles blowing away and leaving the coarse particles exposed, it is difficult to maintain it in first-class condition.

Section 2B. This project consists of 11.712 miles of highway, surfaced with caliche and other selected material.

The project joins Section 2A, and is practically the same type of construction. The same difficulties are encountered in maintenance. Included in this project is an arch bridge crossing Queen Creek. The project was constructed in 1919 and 1920.

The State Highway Department contemplates surfacing five miles of this road with 2 inches of asphaltic concrete. The caliche foundation is now adequate as a base, but if allowed to deteriorate a few more years will not be adequate for that purpose. The remainder of these two sections is now being resurfaced.

Section 2B of this project is known as Federal Aid Project No. 7.

FLORENCE-SUPERIOR HIGHWAY, Federal Aid Project No. 23, consists of 30.78 miles of highway, extending from the north end of the Florence Bridge to the town of Superior. It is divided into six sections, beginning at the Florence end, and known as Sections A, B, C, D, E and F, respectively.

Section A consists of 9.597 miles. It is surfaced with caliche. Construction work was done during the years 1920 to 1922. Work on this section is practically completed.

Section B consists of 5.2 miles, extending from the end of Section A to the junction of the Mesa-Superior road. This section was constructed during 1920 and 1921.

Section C is two miles in length, and was constructed during 1920.

Section D is 8.66 miles in length, extending from the end of Section C to the Queen Creek bridge. This section was constructed in 1920 and 1921 by Contractor Maurice Ryan.

Section E, being the bridge across Queen Creek, was constructed during the year 1920 by Contractors English and Pierce.

Bids were received and contract let for the construction of Section F, which extends from the Queen Creek Bridge to the town of Superior, in the month of July, 1922. This work is being done by Contractors Goodman and Merrill. This part of the Florence-Superior Highway was located by H. D. Alexander in 1920 and the survey approved by this Department. Subsequently the Magma Railroad made a survey with the view of changing that part of their route from a narrow-gauge railroad to a standard gauge. The relocated

line of this railroad conflicted at several points with the survey of the highway. As far as the question of prior location and filing was concerned, the Highway Department had a valid title to the right of way. However, it was obvious that the highway, with its more elastic grade and alignment, could be more easily changed than the railroad location. An alternate route was found that did not conflict with the railroad survey and, while the estimated cost was slightly in excess of the previous highway survey, the amount of curvature eliminated and the distance saved made this change worth while.

RAY-SUPERIOR HIGHWAY, Federal Aid Project No. 28. This project was originally intended to extend the entire distance from Ray to Superior, but as funds from Pinal County were not available as contemplated, only 3 miles of the project were constructed, and the remainder cancelled as a Federal Aid Project. The portion of the road built was constructed by Contractor Redmond Toohey.

FLORENCE-TUCSON HIGHWAY. During the year 1922 practically the entire length of the Florence-Tucson Highway, lying within Pinal County, was reconstructed by the State Highway Department. The roadway is being graded and surfaced and drainage structures installed. A relocation has been made of nearly the entire distance. Much bad curvature has been eliminated, grades have been reduced to a maximum of 6 per cent and a material reduction made in the distance between the two points. (Work will be completed within sixty days.)

Santa Cruz County

TUCSON-NOGALES HIGHWAY was constructed as a surfaced highway in 1917. Owing to the large amount of traffic, maintenance costs on the Nogales end were excessive. Bids were received and contract let to Ben Pearce for paving two miles with concrete. This work is now completed.

A bridge 109 feet in length, about 14 miles from Nogales, was also constructed as a part of Federal Aid Project No. 25. Several other bridges will be built in 1923, as project statement has been submitted to the Bureau of Public Roads covering these structures.

PATAGONIA-COCHISE COUNTY LINE. This project consists of two sections, extending from Patagonia to Sonoita and from Sonoita to the county line, respectively.

They were first constructed in 1921 by the State High-

way Department, excepting the bridge crossing the river at Patagonia. Contract for the bridge was let during the month of September, 1922, and construction work is now in progress. This work is being done by Lown & Woods, contractors.

Yavapai County

SELIGMAN-PEACH SPRINGS. A survey was made from Chino to Peach Springs by Locating Engineers F. N. Grant and T. S. O'Connell. Four railroad crossings were eliminated. The new road avoids Nelson Canyon, a stretch of road that was impractical to maintain. The new route is one of long tangents, easy curves, and easy grades. It reduces the distance five miles. Construction was done with State forces in 1921. A few additional drainage structures are needed. Four miles of this road lie in Coconino County.

The remaining distance to Seligman was constructed by State forces in 1921, and were financed with funds from Yavapai County bond issue.

SELIGMAN-ASHFORK. Beginning at Seligman, the first 10.22 miles were constructed by State forces in 1921 and 1922, and were financed with funds from Yavapai County bond issue and State road funds. This project eliminates Pan Canyon.

The next 9.34 miles constitute Federal Aid Project No. 57, and extent from Pineveta to Crookton. The roadway is surfaced with cinders. Construction was done during 1922, and was financed with funds from county bond issue and Federal Aid.

The remaining 7.75 miles to Ashfork were constructed with State forces in 1921 and 1922, and were financed with funds from Yavapai County bond issue and State road funds. The project is surfaced with cinders and other local materials.

WILLIAMS-ASHFORK. The highway from Ashfork to the Coconino line was constructed by State forces in 1921 and 1922. The approximate length is 3 miles. Construction was financed with State road funds. The roadway is surfaced with cinders.

PRESCOTT-JEROME. The Prescott-Jerome Highway was constructed during the years 1919, 1920, 1921 and 1922. The road was described in the Fourth Biennial Report of the State Engineer.

Since that report was published the work has been al-

most entirely completed, only a small amount of surfacing and an under-pass under the Santa Fe Railroad remaining to be constructed.

Granite Creek is crossed twice with permanent bridges. A bridge one mile north of Prescott has just been completed by Contractor L. C. Lashmet. This is a three-span girder bridge with a length of 145 feet 6 inches over all. The second is a three-girder deck bridge of two spans each 42 feet 6 inches in length.

Grading work on Federal Aid Project No. 36, which consists of the first 4.5 miles out of Prescott, was done by Morgan and Ford, contractors, during 1922.

Section B of Federal Aid Project No. 19, being 4 miles in length, was constructed by State forces in 1921. Section A, which extends across Lonesome Valley, was completed in 1922.

PRESCOTT-ASHFORK. The highway from Prescott to Ashfork is a part of the Yavapai County program. A survey was made by Yavapai County with the intention of building this as a county road. However, after the survey had been completed, it was decided to apply for Federal Aid. To meet the requirements of the Bureau of Public Roads as to grades and alignment, it was necessary to make a re-survey of this route. It was found, after meeting the requirements of the Bureau, that further material improvements could be made, at no great additional cost. The revised survey reduces the distance over the county survey by four miles, and by connecting with the Prescott-Jerome Highway at a point farther north than the first survey, gives a reduction of six miles of new road to be constructed.

The road is divided into two F. A. Projects. No. 61 starts 4.5 miles north of Prescott, where it joins the Prescott-Jerome road, and extends 22.24 miles to the southern boundary of the Tusayan National Forest. Grading work on this project has been completed and drainage structures are now being built. Project No. 62 covers the remaining 23.55 miles to Ashfork. Plans have been approved by the District Engineer of the Bureau of Public Roads and grading is already under way.

The total distance from Prescott to Ashfork will be 50.29 miles, as compared with the present traveled road of 64.5 miles.

PRESCOTT-PHOENIX. The roadway from the county

line near Wickenburg to Congress Junction was constructed during the summer of 1922, and was financed with funds secured from the sale of bonds in Yavapai County. The location of the remainder of the road in Yavapai County was a subject of considerable discussion and investigations. The route finally adopted, at the request of Yavapai County, goes by way of Congress Junction and White Spar, the latter being a station near the southern boundary of the Prescott National Forest. Project Statement No. 72 has been submitted covering the road from Congress Junction to White Spar, a distance of 29.5 miles. The southern portion of this road follows in a general way the road formerly known as the Yarnell route. A new location, however, has been made providing a maximum grade of six per cent on Yarnell Hill.

The United States Forest Service have agreed to improve the road from White Spar to Prescott, as that portion of the road lies within the Prescott National Forest. Survey has been made and it is expected work will be started early in 1923.

Yuma County

YUMA-PHOENIX, Federal Aid Project No. 26, is divided into Sections "B" and "D".

Section "B" begins 7.1 miles from Yuma and extends to Blaisdell, 8.8 miles. This work was done with State forces. Construction was started July 23, 1920, and completed January 18, 1922. It was financed with funds appropriated in the Omnibus Bill and Federal Aid. The work was in charge of William C. Lacy and later in charge of A. W. Van Fleet.

Section "D" extends from Ligurta to Wellton, a distance of 9.9 miles. This was done under contract by Robert Mckay, during the spring and summer of 1922. The work was in charge of L. A. Hicks, Resident Engineer. It was financed with money appropriated in the Omnibus Bill and Federal Aid.

The total cost of this project was $147,844.33.

WELLTON to MARICOPA COUNTY LINE. Federal Aid Project No. 55 originally extended from Wellton to Aztec, a distance of 42.6 miles. Bids for the construction of this project were received and contract awarded to Kisselburg and Schmidt in October, 1922. As the cost of the project, based on this contract, will be considerably less than was estimated in 1921, a revised Project Statement has been submitted, providing for extending the project to the County line, a distance of 7.0 miles, making the total length of the

project 49.6 miles. The work is being financed by proceeds of the Yuma County bond issue, and Federal Aid. Funds available are sufficient to fully complete the work to the county line, including surfacing full width instead of only part width, as was originally intended. Construction was started in October, 1922. The contrac tprovides for completing the road to Aztec in 205 working days.

PARKER-BOUSE ROAD. Chapter 62, Session Laws 1921, provided that $30,000 previously appropriated for the construction of a bridge across the Colorado River at Parker should be used in the construction and repair of the highway running from Wickenburg to Parker, thru the towns of Wenden, Salome, Vicksburg, Bouse and Parker, to be expended under the direction of the State Engineer, on that portion of the road lying within the County of Yuma.

As Yuma County had authorized $240,000 bonds for the improvement of roads in this vicinity, the Highway Department, after consulting with Yuma County, designated the portion of the road to be improved with this money. The location selected extended from Parker toward Bouse, a distance of 18.7 miles. This work was done in 1921.

DIVIDING THE DOLLAR

Diagrams are herewith presented which are designed to show at a glance to the taxpayers of Arizona what portion of their tax dollar goes into State and County road construction as a result of direct taxation. Diagrams are also given showing who pays the dollar for Federal Aid roads and illustrating the sources from which the tax dollar is received.

Distribution of the State Tax dollar is shown, that is the tax dollar paid into the State treasury. Also the proportion of the tax dollar paid into the county treasury in direct taxation, which is used for road construction and other activities.

It is interesting to note that the ordinary taxpayer is only paying about one-eighth of the cost of Federal Aid highways, and also that the corporations are paying 65.7 cents of each tax dollar. State roads receive an average of 3½ cents of each tax dollar paid the County Treasurer.

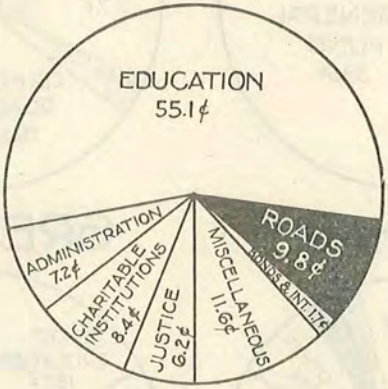
The comparative amount of taxpayers' money going into both State and county roads, education, administration, etc., is obvious, as well as the fact that the wealthier counties with small tax rates are paying a greater proportion of the state tax than the poorer counties (See table following diagrams). This is largely influenced by the expenditure for schools and roads. The information that the ordinary taxpayer is paying about one-eighth of the cost of federal highways is startling.

In diagraming the totals no separation has been made of the purposes of various county bond issues, but the proportionate amount of the dollar necessary to cover the item of interest and principal on all bonds is indicated in total.

The county tax dollar has been divided into general county expenses, schools, roads and bonds. The relative cost of county administration is plainly shown. The portion of the dollar paid to the county treasurer that goes into the state has been subdivided.

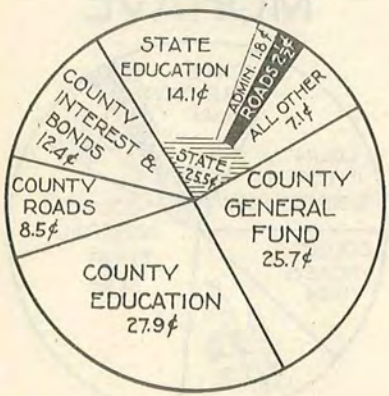
STATE TAX DOLLAR

STATE

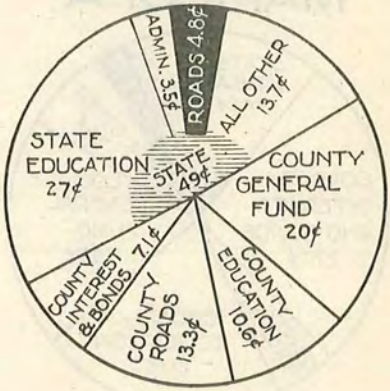


COUNTY TAX DOLLAR

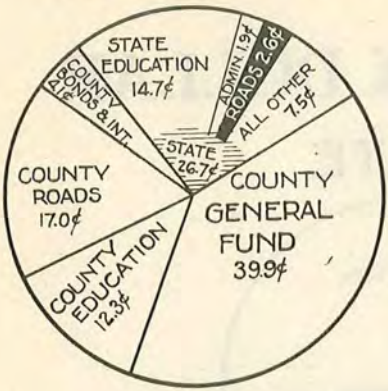
APACHE



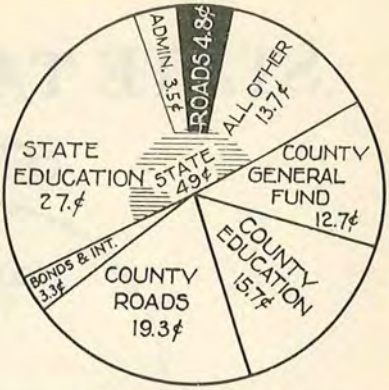
COCHISE



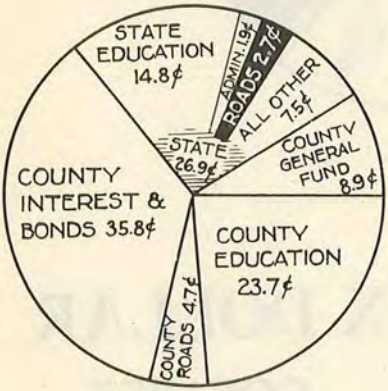
COCONINO



GILA



GRAHAM



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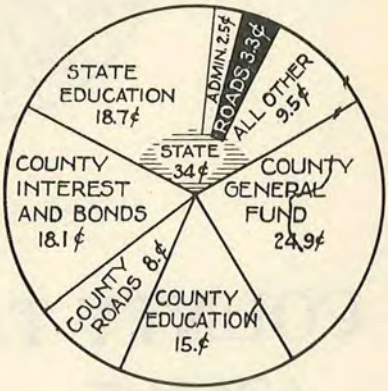
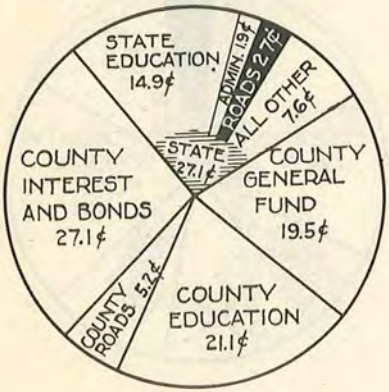
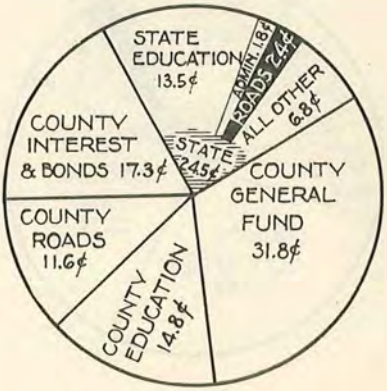


MARICOPA



MOHAVE



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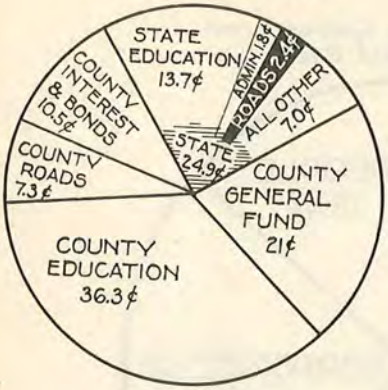
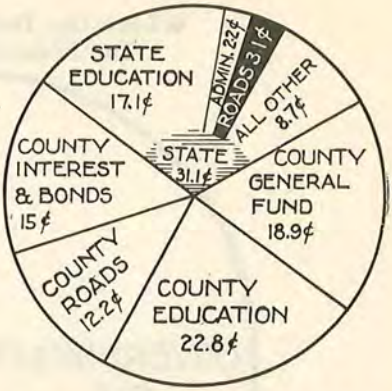


PIMA



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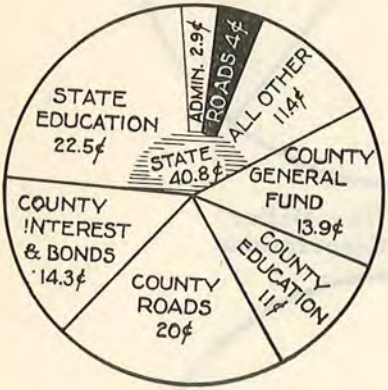
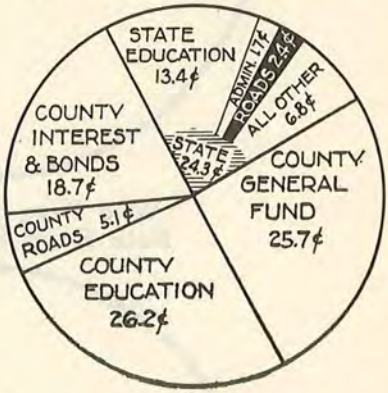
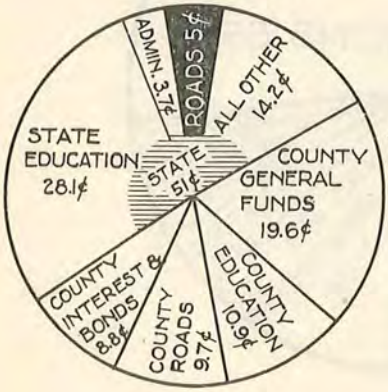


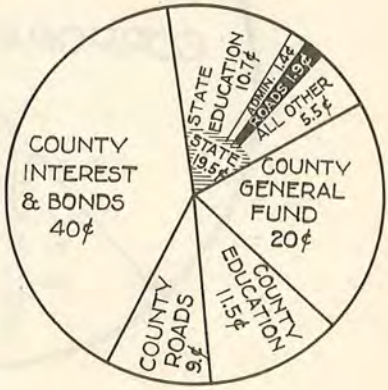
SANTA CRUZ



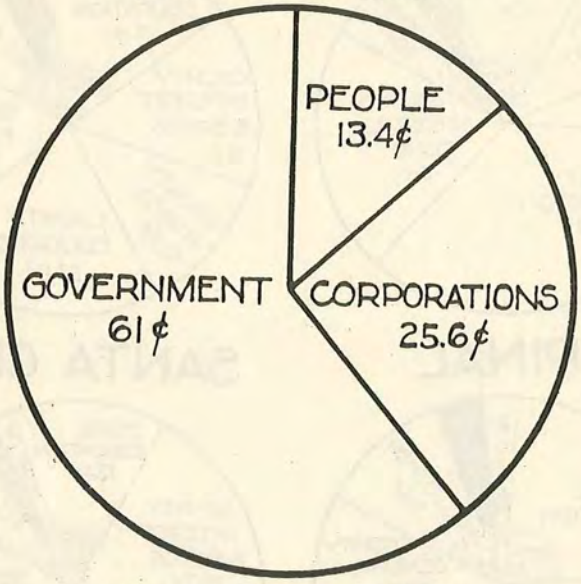
YAVAPAI



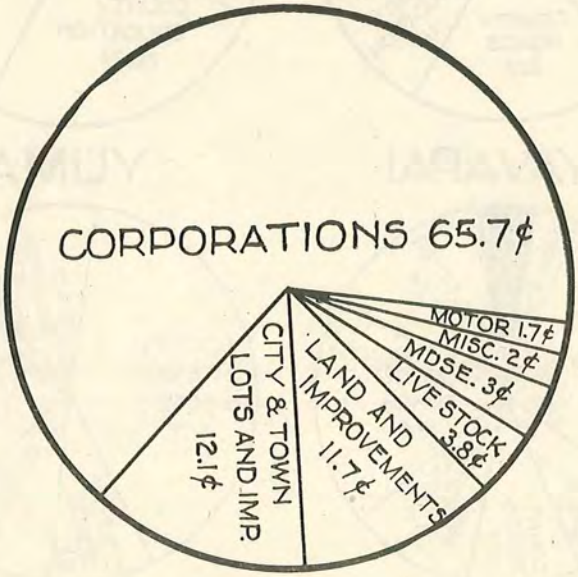
YUMA



Where the Dollar Comes From for Federal Aid Roads



Who Pays the Tax Dollar Note Ratio by Corporations

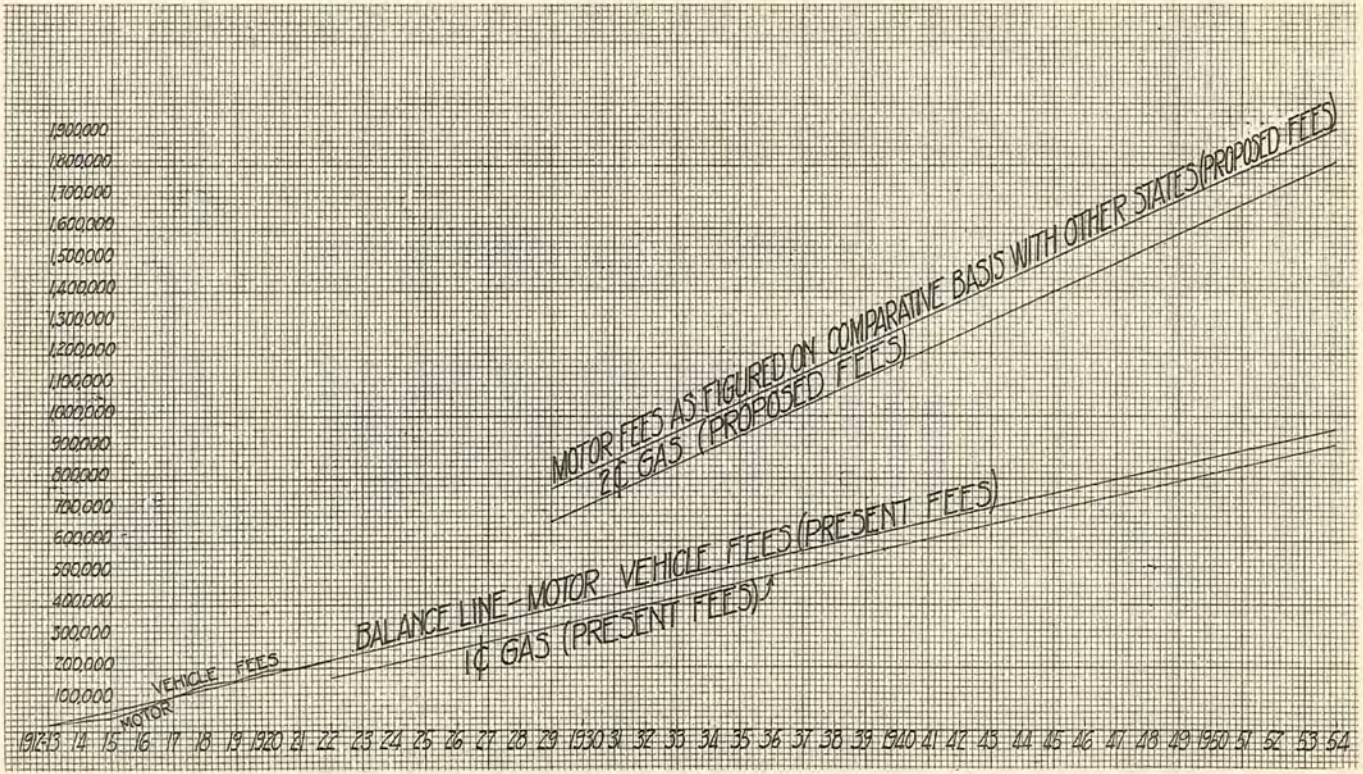


CURRENT YEAR TAX RATE

The following table shows the assessed valuation, the county tax rate, the state tax rate, and the combined rate for each county for 1922:

	Assessed Valuation	County Rate	State Rate	Combined Rate
Apache	$ 8,776,318	1.49	.51	2.00
Cochise	143,525,605	.53	.51	1.04
Coconino	20,128,235	1.40	.51	1.91
Gila	124,067,362	.53	.51	1.04
Graham	12,480,418	1.39	.51	1.90
Greenlee	24,911,059	.99	.51	1.50
Maricopa	116,826,456	1.37	.51	1.88
Mohave	20,113,636	1.57	.51	2.08
Navajo	11,393,701	1.54	.51	2.05
Pima	56,001,132	1.13	.51	1.64
Pinal	52,809,912	.74	.51	1.25
Santa Cruz	12,013,806	1.59	.51	2.10
Yavapai	107,909,313	.49	.51	1.00
Yuma	21,064,333	2.10	.51	2.61

Note that School and Road Taxes assessed by the State fall on all alike, while County expenditures are a heavy burden on the poorer counties.



EXTERPOLATION GAS AND AUTO TAX RECEIPTS

STATE BOND ISSUE

The diagram on the opposite page illustrates that the present gasoline tax and motor vehicle fees would be paying five per cent interest on a bond issue of $14,360,000 within five years after the election of 1924.

With a gasoline tax of two cents per gallon, and motor vehicle fees equal to the average in the United States, Arizona could in 1929 pay the interest on a bond issue of $28,720,000.

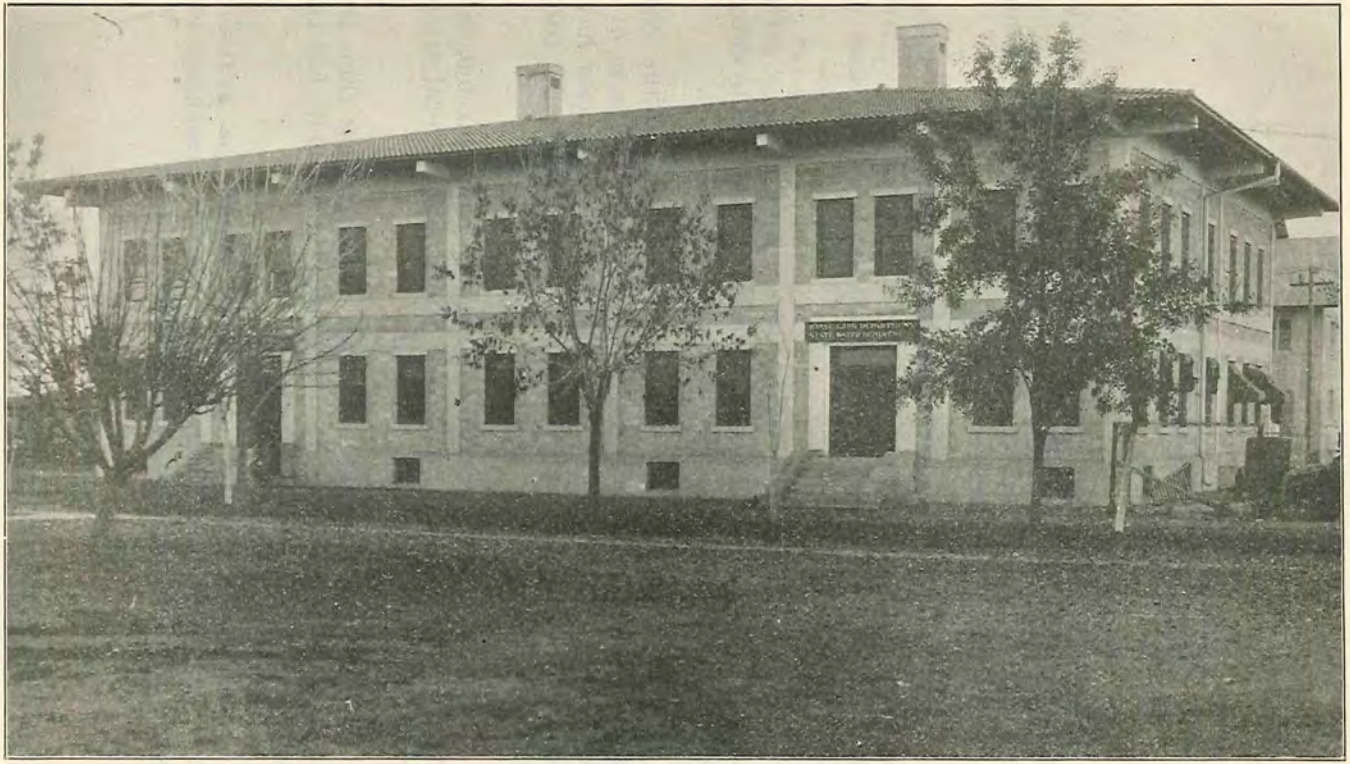
The increased returns after 1929 would produce sufficient revenue within the next 24 years to amortize the entire bond issue, in addition to paying the interest.

A very conservative calculation indicates that the Arizona motor vehicle fees and gasoline tax will take care of a bond issue of $20,000,000 for paving. Several states have issued bonds for highway construction, to be repaid from these sources.

The present Arizona motor fee law is producing but one-half of the average in the United States, and several states now have a two-cent tax on gasoline.

The Arizona five mill road tax, which is less than the rate in most of the western states, would provide for the maintenance of the State Highways.

An additional source of revenue should be available from a fair tax on the franchises granted to passenger and freight carriers using the public highways.



ADMINISTRATION BUILDING.

ADMINISTRATION BUILDING

The basement of the administration building was completed at the time of the submission of our last report. The entire building was completed in 1921, the final cost being $53,000, or some $2,000 under our estimate. This building has the same floor space as the addition to the State Capitol, which cost approximately $185,000.

It was at one time suggested that only half of the building be completed on the foundation previously constructed, waiting until additional funds could be secured to complete the entire structure. As the State Land Department and the State Water Commission were improperly housed in a light wooden building, and irreplaceable documents covering land sales and leases of the Department were in jeopardy from possible fire destruction, it was determined to complete this entire structure, housing these two Departments with the State Highway Department.

The building is of reinforced concrete with curtain walls of concrete block. The ceilings in the second story are high and extra large ventilation was provided beneath the roof so that this is one of the coolest buildings in the summer in the city of Phoenix. A discarded furnace was secured from the Pioneers' Home and installed in the basement, in which are also the highway laboratory, where materials used in highway construction are tested, a large room used to store rubber tires secured from the Government and the undivided remaining portion of the basement, which is used for storage purposes.

The first floor is used by the office force of the State Land Department and Water Commission and the administrating portion of the Arizona Highway Department. On the second floor is a large, well lighted drafting room, auditing and bookkeeping room, blue print room, assembly room and two small offices, one used for records of State equipment and the other for printing, mimeographing and stationery supplies. The building was completed at reduced cost by the use of form lumber which had previously been used on bridge construction. Some expanded metal secured from the Federal Government was also used in this building.

During the spring and summer of 1920 there were many idle men in the State. The Department had money due from the Federal Government, but did not have funds available for immediate construction. On this account a crew of men was organized who agreed to go to work immediately on the building and wait for their wages until funds were available. This resulted in the building being completed three of four months before it would otherwise have been possible. The splendid work done by the workmen on this building while having to wait for their wages is an excellent example of the belief of these men in the integrity of your administration and the future prosperity of the State of Arizona.

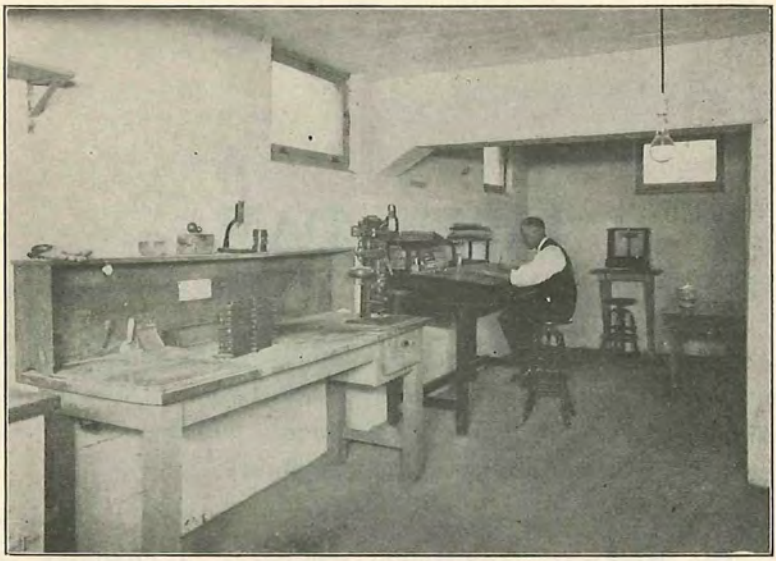
Before this building had been completed the Arizona Highway Department had received from rentals, etc., on Federal equipment a sum much larger than the cost of this building. Some criticism has been expressed of this Department in our action in constructing this building, as no precedent existed except the construction of the bungalow in the rear of the Capitol building, by a previous administration. In our opinion, however, if the Highway Department has funds for the construction of roads, the expenditures for which naturally include the purchase, rental and storage of equipment, the preparation of maps and the keeping of records and the payment of rent for structures to house equipment or provide quarters for employees, there is no legal prohibition on the payment of claims for permanent improvements to this same end, as against the dissipation of State funds in monthly rentals. All of the buildings and facilities of the Arizona Highway Department have been with a view to utility and permanence. We have had some opportunity to investigate similar facilities in other states, and in doing so, as in the comparison of our roads, have had no occasion to feel embarrassed at the results secured by the Arizona Highway Department. As the securing of Federal equipment, its conversion to highway use and construction of buildings, shops, warehouses, etc., to administer this Department has been paid from current road appropriations with the exception of the $50,000 special appropriation for freight in the 1922 Legislature, while State road construction has progressed to a greater extent than ever before, we feel that this action on our part has been well taken and future road funds, with the aid of the present facilities, should secure even better returns.

LYMAN DAM

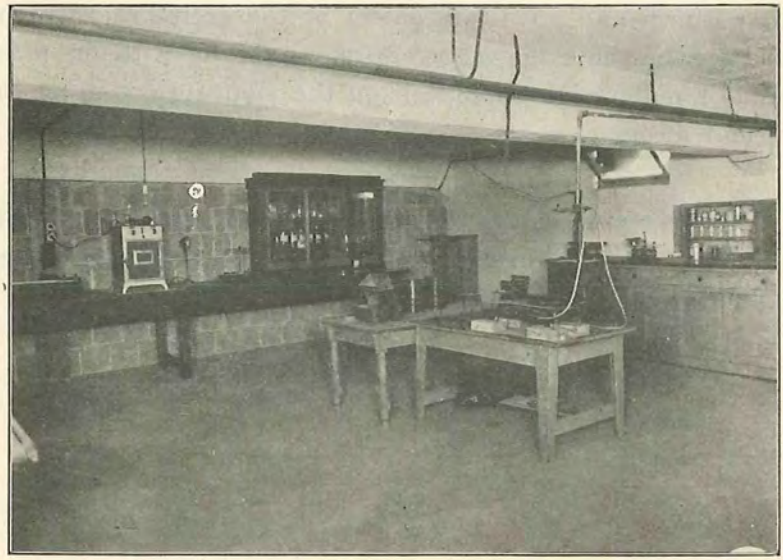
The Arizona Highway Department takes some pride in pointing out the changes made in the Lyman Dam, by the engineering forces of this Department, which were proven to be vital to the stability of that structure.

The Highway Department engineers in changing the Lyman Dam plans placed the rock fill on a natural slope or its proper angle of repose. When the anticipated settlement of the foundation of this rock fill occurred, the settlement was uniform and no displacement of the entire rock fill on the back of the dam occurred, as would have taken place had this material been placed on the slope provided in the original design.

While the Highway Department had nothing to do with the supervision or construction of this dam, it is our understanding that it is functioning in a satisfactory manner.



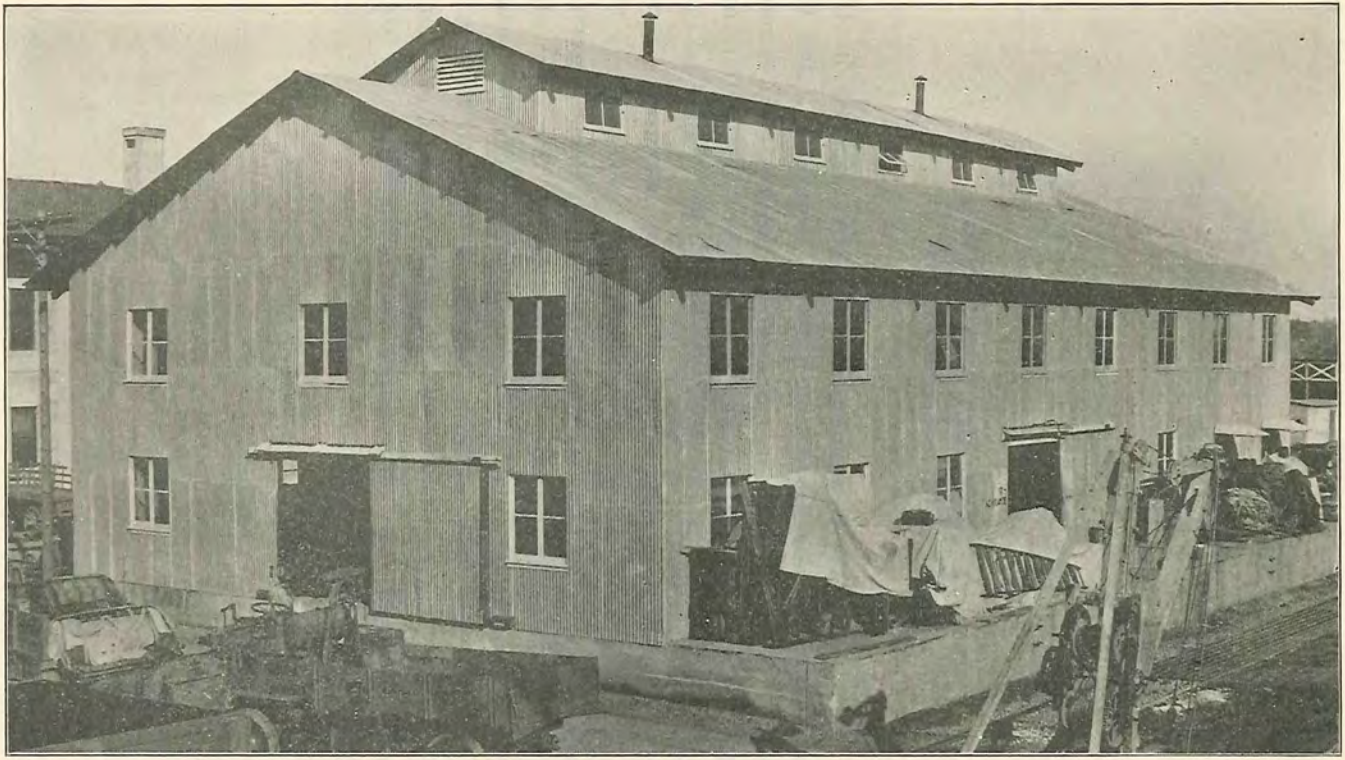
A. H. D. LABORATORY ROOM.



ANOTHER VIEW OF LABORATORY.

LABORATORY

The Highway Department laboratory, located in the basement of the administration building, is indispensable for scientific road construction. Samples of all Portland cement and asphalt used for pavings and bridge construction are tested. The thickness of the spelter coat and gauge of corrugated metal pipe are tested on culvert material. Sand, gravel and crushed rock are mixed with cement and the strength of pavings and structures built with these materials are pre-determined. Clay, sand and gravel, etc., are also tested for ordinary road-making purposes, with the result that frequently slight additions of one of these materials to the natural roadway will make a good road of a poor one. These materials are also tested for permeability in dam structures.



TWO STORY WAREHOUSE—48x96.

STOREHOUSE AND SHOPS

STOREHOUSE

The Arizona Highway Department warehouse is centrally located in the yard. It is 50x96 feet in plan and of two-story galvanized iron construction. A ten-foot concrete platform on the south side is adjacent to the railroad spur track so that material can be easily loaded and unloaded. An average of four cars of material are handled per week, an amount probably greater than that of any wholesale hardware firm in the State. The warehouse is designed primarily for the storage of vehicle and implement parts, supplies, etc. Approximately three thousand bins hold nearly every truck part needed for replacements. Some of these were new when received from the Government, and others have been salvaged from the dissembling of old equipment. A card index system has been installed for keeping track of all equipment, shipping and receiving clerks are constantly busy checking in and shipping out supplies by both train and trucks to the outlying camps and counties. Wire orders for spare parts are thus quickly secured by the various road-building forces. It is estimated that there are enough shovels, picks, mattocks, nails, wrenches, blacksmith tools, saws, hammers, rope, canvas, harness, anvils, grinders, crow-bars and numerous other articles in this warehouse to last for five or six years of active road-building work.

GARAGE AND SHOPS

The activities in the various divisions of the repair shops are enumerated under separate heads in order to properly designate the function of each department. Most of the equipment and tools in these departments were received from the Federal Government:

1. Garage Department.
2. Machine Shop.
3. Steam Cleaning Plant.
4. Paint Shop.

ARIZONA HIGHWAY DEPARTMENT WAREHOUSE

5. Blacksmith Shop.
6. Carpenter Shop.
7. Plant Yards.
8. Tool Room.

1. GARAGE DEPARTMENT

The concrete pits on the main repair floor are centrally located and large enough to park five trucks side by side, with clearance sufficient to afford constant action in dissembling and assembling of trucks and cars. The pits are furnished with electric lights. In this section of the building all preliminary work is done, while the main branches of the garage are adjacent thereto.

The motor division is devoted exclusively to the repair of truck and car motors. It is here that motors are dissembled, rebuilt and assembled. All equipment necessary for this work is at hand, and the labor is done by men qualified to reconstruct the worn-out units into new ones.

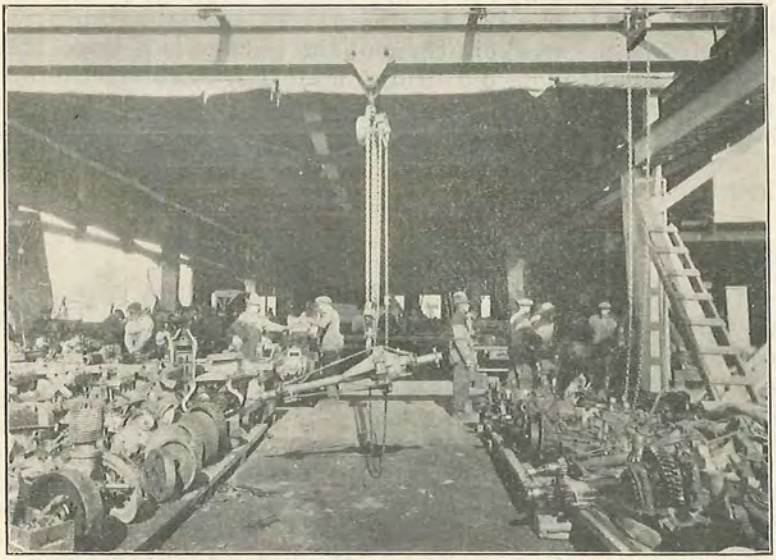
The transmission and differential division is where these particular units undergo repairs and is adjacent to the motor section. This branch is separated from the others in order to confine the working efficiency of men adapted to this line, thereby guaranteeing the best results in specialization.

Assisting the workers thruout the garage is a large traveling crane, built from old bridge material, enabling the men to transfer any large unit or vehicle to any part of the shops. When equipment ceases to be worth repairing, it is dissembled and the good parts cleaned and stored to be used to repair other equipment.

2. MACHINE SHOP

Directly adjoining the working floor of the garage are the well-equipped machine shops with facilities for machining almost all of the essential work needed in the upkeep of motor vehicle equipment and any work for general repairs. Included in this shop are the following: One 21-inch Le Blond lathe, one 12-inch Liberty lathe, one drill press, one Brown and Sharpe Universal milling machine, one Norton Universal grinding machine, one tool grinder, one Cincinnati shaper, one Peerless high-speed power hack saw. These machines are all driven by an electric motor attached to a ball-bearing line shaft, belted to the individual machines.

THE CARPENTER SHOP.



DIFFERENTIALS AND TRANSMISSIONS.

3. STEAM CLEANING PLANT

The steam cleaning division is a recognized feature of the plant, serving in a dual capacity. All greasy, oil and dirt covered machinery is cleaned with a steam and hot water jet. This work requires but a few moments' time and not only saves on the use of gasoline and waste in cleaning parts, and in the time of men repairing this machinery, but it makes this work much more agreeable. All vehicles are given a thorough steam cleaning before being painted, as this insures the removal of dirt and oil and provides a clean surface for paint to adhere to.

Connected to the steam cleaning plant boiler are the engines of a large stiff leg derrick. By means of this derrick the heaviest machinery is easily loaded and unloaded from railroad cars on the spur track. Large trucks are lifted bodily out of gondola cars, while truck bodies are swung from the truck chassis into the blacksmith and machine shops. It is the Giant of the yard—both a time and labor saver.

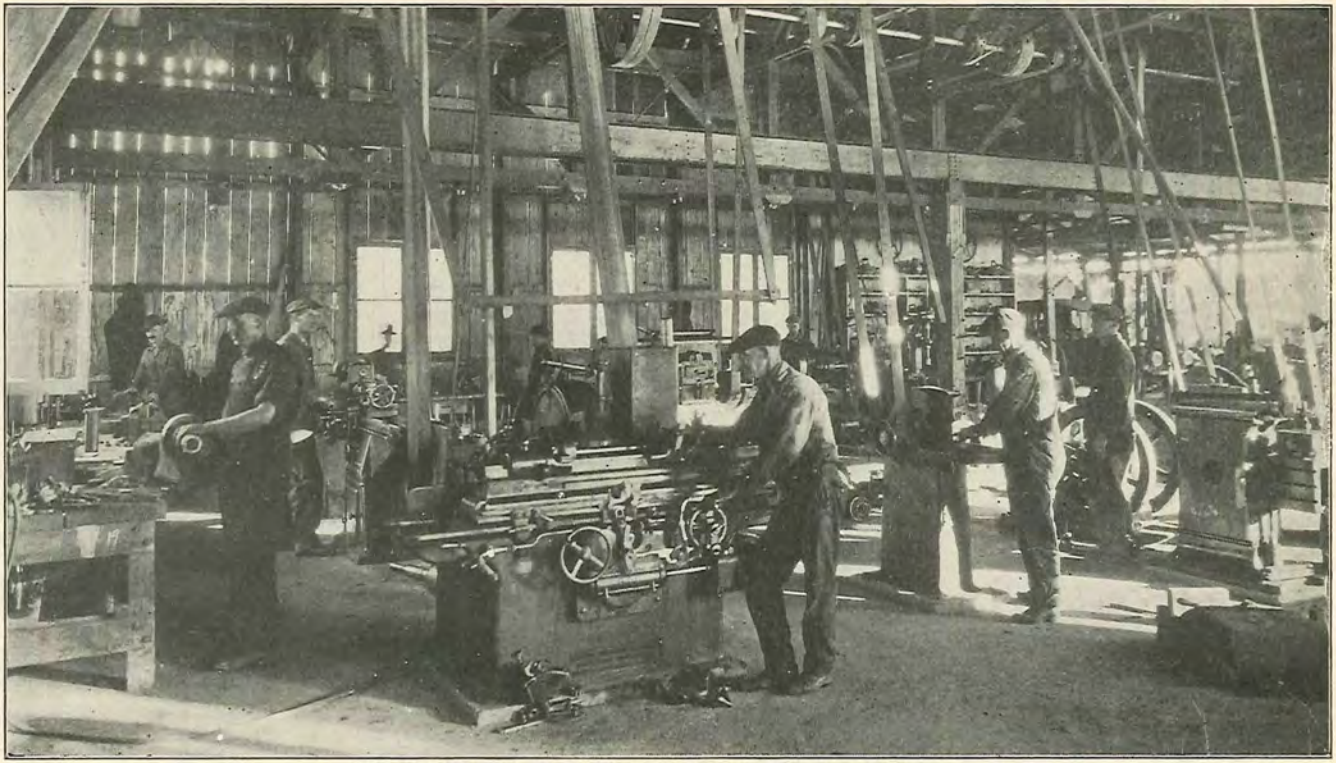
4. PAINT SHOP

The standard highway gray paint is applied to all vehicles, equipment, implements and tent houses, with a compressed air spray brush. This system of paint spraying penetrates every nook and crevice, insuring a thorough coating evenly applied. The compressed air spraying machine, driven by a gas engine, is portable and can be readily transported from place to place, ready to function wherever needed. It is a fast worker and labor saver, as one man can paint five large trucks daily. This machine was made by employes out of old equipment. The varnish and sign-painting room is dust-proof, and a feature of this division.

5. BLACKSMITH SHOP

The blacksmith department is equipped with facilities for all general work. The tools, driven by an electric motor and belted direct thru a ball bearing line shaft, include: three forges; one circular power hack saw; one pipe threading machine; one large drill press; one grinding machine; one 500 lb. power hammer.

The general work in this department varies from vehicle equipment to road machinery, and there is sufficient working space to care for blacksmithing of any size and dimension necessary for highway department use.



MACHINE SHOP—COMPLETELY EQUIPPED.

Adjacent to this department are the acetylene welder and steel truck body makers, where steel bodies go thru a transformation of rigid and set mountings, to mechanical dump trucks with hoists attached.

An oven of sufficient capacity to hold the largest crank case, is built into this division. Its purpose is to pre--heat and anneal the broken parts before and after welding and to allow them to cool gradually, thereby preventing any cracking thru metallic expansion or contraction..

6. CARPENTER SHOP

The carpenter shop is fitted up to take care of all wood work needed at the camps and plant. Wagons are repaired and new tent and wagon houses built. The machine equipment includes one circular saw and one band saw.

7. PLANT YARDS

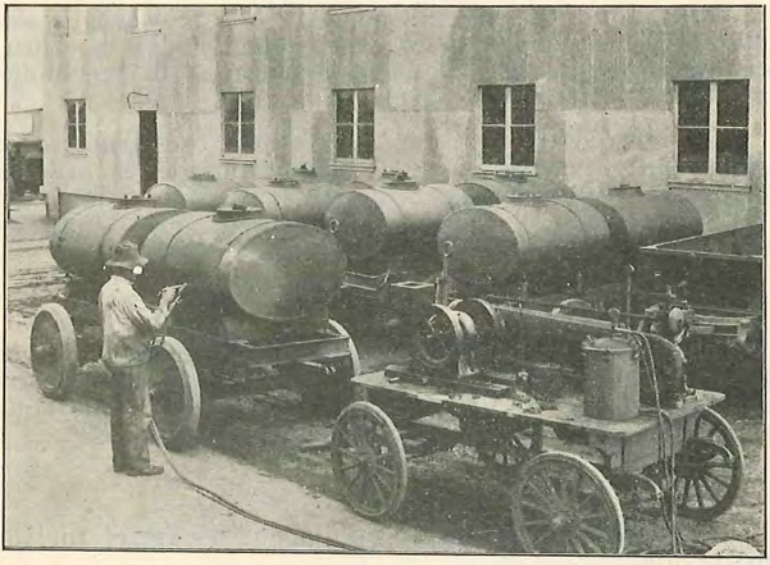
In the yard is housed all equipment necessary for road construction.

Large road building equipment, such as steam hoists, gasoline and steam concrete and asphalt mixers, all kinds of pumps, air compressors, jack-hammers, wagons, fresnos and blades are overhauled in this yard when needing repairs.

To keep all of this equipment in working order and ready for action at the call of the outlying camps, boiler makers and gas engine men are kept constantly at work, rebuilding and refitting.

8. TOOL ROOM

The tool room is centrally located in the shop building. It contains many valuable tools used by all the mechanical departments, such as: machinists' precision tools; milling cutters; drills; reamers; wrenches; hammers; bars and tools for various and sundry needs. A check system has been established whereby the mechanic is issued necessary tools thru the clerk in charge of this department, everything being returned at night.



A. H. D. ASSEMBLED PAINT MACHINE—EVOLUTION OF AN ARMY "CANDY WAGON."

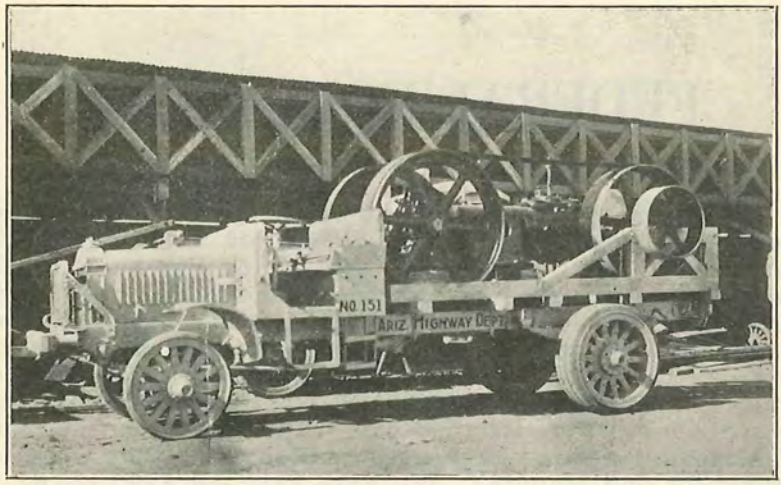
HOT WATER JET—FOR CLEANING MOTOR PARTS.

FEDERAL EQUIPMENT

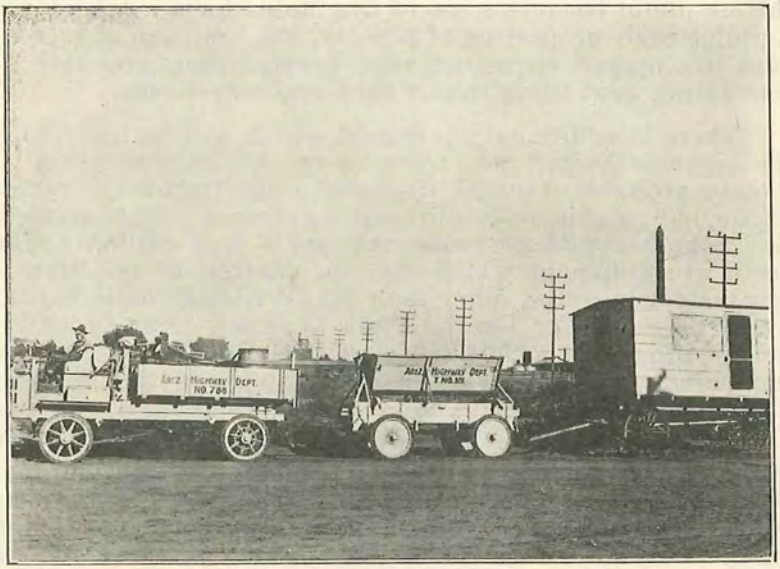
Two years ago, when our biennial report was submitted, we had received approximately $2,500,000 worth of Federal equipment. The report of the Chief of the Bureau of Public Roads to the Secretary of Agriculture shows that up to June 30th, 1922, $2,436,823 worth of material had been delivered to the State of Arizona out of a total distribution of approximately $140,000,000. As we have continued to receive Federal equipment during the last six months, and the Federal figures were based on 60 per cent of the valuation, the State of Arizona has today received more than $4,000,000 worth of equipment and material. We have paid out $290,423.67 to secure this, or approximately seven cents on the dollar. We have received $146,614.78 in rentals, etc., on part of this equipment. Within the next few years the entire cost of this equipment and material should be returned to the Department from the small portion rented. Under the law, we are entitled to 1.4 per cent of this Federal equipment, and have received approximately 1.7 per cent of the total distributed. This no doubt because some of the States have not been able to utilize their proportion of powder, etc. Most of this equipment is engaged on actual road construction, probably not over 25 per cent being in our yard and warehouse.

There is additional equipment which will be received by the Highway Department upon its receipt from overseas. It is quite probable that the Highway Department will receive $1,000,000 worth of additional equipment and material. This, together with probably one and a half million dollars' worth of equipment which may be allotted to the State of Arizona for purposes other than road building, indicates that it will be necessary for the State to make arrangements to handle altogether $2,500,000 worth of additional equipment. Fortunately, $15,000 or $20,000 will provide the necessary warehouse construction to house this equipment and material.

Legislation is now pending in Congress to give to the States $100,000,000 worth of surplus war equipment under the same provisions that the State Highway Departments have already received road building equipment and materials. Arizona will probably be allotted between one and two million dollars' worth of this equipment and material.



PORTABLE AIR COMPRESSOR RUN BY TRUCK



MAINTENANCE OUTFIT

The facilities of the Arizona Highway Department are sufficient for unloading and storing any equipment secured with the exception that an additional storehouse should be provided for material needing protection from the weather. This should not cost over $15,000 or $20,000. Room for this warehouse is available in the Highway Department block on a track already installed.

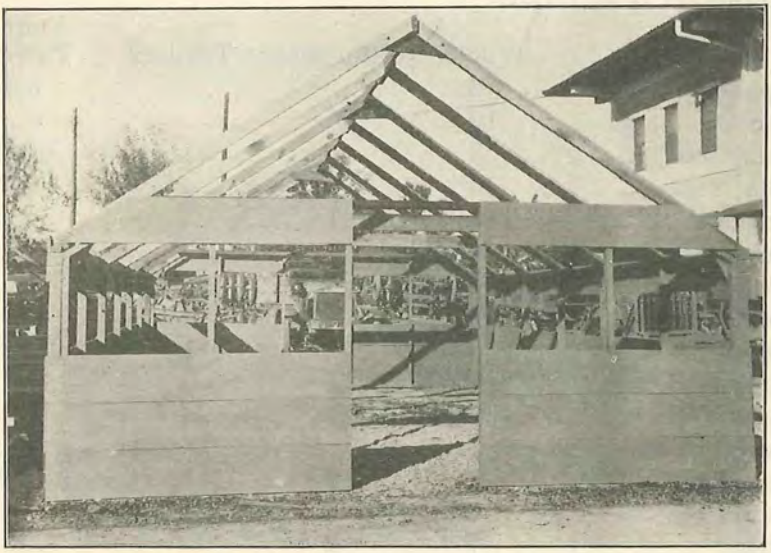
Some idea of the varied equipment and material received from the Government may be gathered from the fact that included therewith are steam shovels, caterpillars, trucks, trailers, automobiles and light trucks, motorcycles, steam hoists, derrick compressors, electric motors, jack hammers, tool steel, power and hand pumps, pile drivers and hammers, wheelbarrows, road rakes, shovels, picks, mattocks, hose, rope, tents, nails, bolts, canvas, culverts, corrugated iron, water pipe, and small tools too numerous to mention. Also a complete narrow-gauge construction railroad, including locomotives, cars, rails and ties.

EQUIPMENT TO COUNTIES

More than a million dollars' worth of surplus war material turned over to the State is now in use by the several counties. The distribution of some of the larger pieces of equipment is as follows:

County	Trucks	Caterpillars	Trailers	Pounds Powder
Apache	2	....	....	3,400
Cochise	10	3	....	.....
Coconino	3	....	....	4,000
Gila	13	1	....	80,000
Graham	3	1	....	.....
Greenlee	4	....	....	.....
Maricopa	11	3	1	.....
Mohave	12	4	4	.....
Navajo	7	....	1	4,000
Pima	6	3	....	.....
Pinal	12	1	....	.....
Santa Cruz	5	....	....	.....
Yavapai	11	2	2	1,200
Yuma	3	6	1	.....
Cities	7	2	....	.....
S. R. V. W. U. A.	22	....	10	.....

TRUCK TARPAULINS FOR PORTABLE TENTS.



PORTABLE TENT FRAMES.

Approximately $10,000.00 worth of other tools and equipment have also been distributed to the counties, cities and Salt River Valley Water Users' Association, the latter at the request of the Department of Agriculture.

INGENIOUS USES BY STATES

In transferring the many millions of dollars' worth of surplus war materials to the several States the only reservation made by the Government was that they should be used only in the construction and maintenance of roads.

Purchased originally to meet the needs of the Army in times of war, there were necessarily many items of material declared surplus by the War Department, which were not suitable for road-construction purposes in their existing form.

Quoting from an article in PUBLIC ROADS, a monthly publication issued by the U. S. Department of Agriculture:

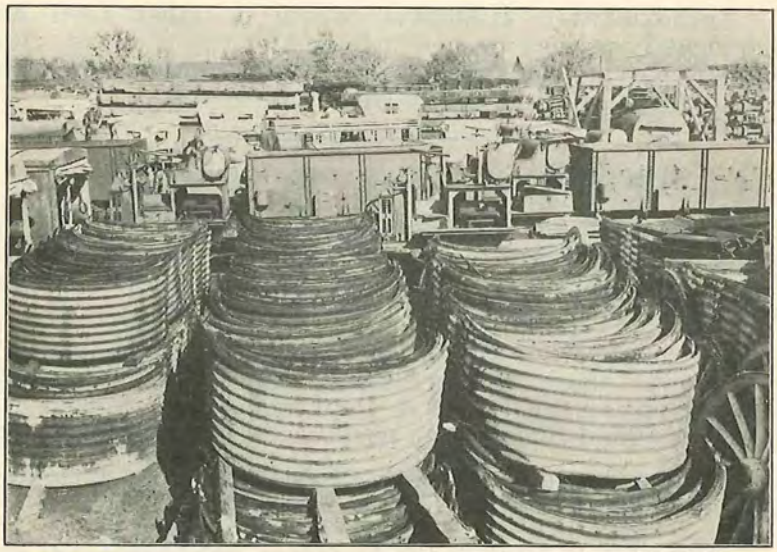
"The story of some of the ingenious and economical uses of this material designed primarily for warlike purposes forms an interesting chapter in the record of the tremendous salvaging operation which has been carried on under the Wadsworth-Kahn Act."

The major portion of the article referred to is devoted to the uses made of this surplus war material by the Arizona Highway Department. Quoting therefrom:

ARMY TRUCKS CONVERTED BY CHANGING BODIES

"The motor trucks, of which over 23,000 have been transferred, are perhaps the most valuable equipment which the States have received. As they were received from the Army they were generally not suitable for road-construction purposes, on account of the shape and size of their bodies, which were designed especially for Army use. The States have altered these bodies, in some cases in their own shops built for the purpose, thereby converting the trucks to a number of special uses.

"Arizona sized up the trucks equipped with steel ordnance bodies and decided that for road work they were too high and not wide enough. To make them suitable, they cut the bottoms in half from front to back and then used the sides for a new bottom and the two halves of the bottom for the new sides, thus making the body about twice as wide and half as high. The change makes it easier to shovel into



ONE MAN ARMY SHELTERS—USED FOR CULVERTS.

SOLID RUBBER TIRES FROM GOVERNMENT.

the truck when necessary and also permits the hauling of more bulky material. In addition, the trucks have been equipped with hand hoists and offset bars on the rear end in order to pull road scrapers and drags. As shown in two of the illustrations, the original body is hardly recognizable in the converted form.

WAREHOUSE AS WELL AS CONTENTS FROM GOVERNMENT

"Arizona has built a warehouse for the storage of its transferred equipment out of material also received from the Government. The sides of the 50 by 100 foot building are covered with corrugated iron, of which some 5,000 sheets have been distributed by the bureau. The very efficient awnings over the office windows are made of extra tops for truck drivers' seats.

BOMB-PROOF SHELTERS SERVE VARIETY OF USES

"Among the items which appear in the list of distributed material are two described as 'shelters, elephant and trench.' It would be difficult to imagine anything less likely to be of value in road construction than these heavy, semi-cylindrical bomb-proof iron shelters which were designed for the one purpose of protecting our soldiers from the shells of the enemy. Yet thousands of these shelters have been distributed by the Department of Agriculture and put into service in a number of useful ways by the States. Arizona has gone farther afield in its ingenious use of them as culverts. In the large desert areas of the State it seldom rains, but the rain that does fall is likely to come in cloudbursts which flood the desert and frequently wipe out the roads which cross the wide, shallow drainage channels unless they are amply protected by culverts of liberal size. It is as a means of protection against these floods that the State is transforming the bomb-proof shelters into culverts. They are built on concrete foundations where sand and gravel are accessible, or on redwood in the absence of these materials. The rainfall is so infrequent and the desert soil is so porous that excess moisture is quickly absorbed, and it is thought that the shelters, well painted, even if not galvanized, will have a length of life which will amply justify the cost of installation.

ALTERATION OF ARTILLERY HARNESS REPAID BY THREE MONTHS' USE

"'Although no material has been sent to any State except

RUBBER.

CARLOAD OF CANVAS.

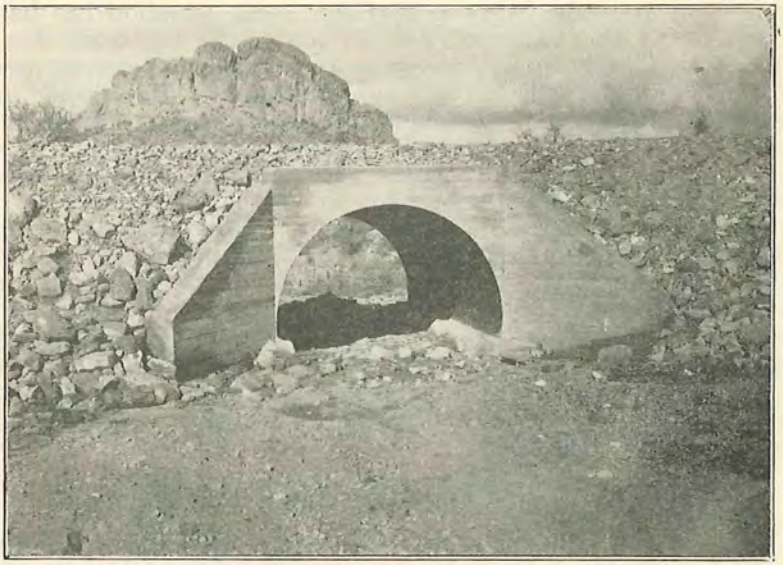
upon request of the State authorities, some question has been raised as to the value of certain materials for road work. One of the items questioned was the artillery harness, over 16,000 sets of which have been distributed. For Army use this was made as breast harness, which differs from the hame harness commonly used. In its original form, therefore, it was valueless, but that it was far from valueless when properly altered has been shown by the experience of a number of the States typified by the following report from Arizona. The State Engineer says: 'The breast harness received by the State of Arizona from the Government has been changed to hame harness by our local saddleries at a cost of $10 per set. Thus changed, each set is easily worth $40 to the State. We are now hiring stock without harness at a decreased price of $5 per team, so that the rent saved in three months pays all the expenses of freight on the harness and necessary alterations.

NEARLY 150 MILES OF PIPE SALVAGED

"Nearly 150 miles of pipe, of assorted types and sizes, has been saved from useless deterioration and put to work by the several States. It is safe to say that it has been used in nearly all the ways pipe can be used. A great deal of it has been used to carry water to concrete mixers. A most interesting example of the manner in which the transferred material is helping the States to solve their problems is that of the Queen Creek Bridge on the Superior-Miami Highway, Arizona. The handrail of this bridge is made of 4-inch wrought-iron pipe received from the Government. Before it went into the bridge rail, however, it was used to carry compressed air from ex-Government air compressors to the jack hammers used in the excavation of the bridge foundations."

TRUCK COMPRESSOR

One of the most clever utilizations of old equipment was designed by Ran Bone, Superintendent of the Superior-Miami Highway. When his compressor engine became worn out he mounted the compressor on a truck with shafting so arranged that the compressor could be driven by the rear wheels of the truck when the same was jacked up off the roadway. Air receivers were mounted on trailers so that this entire equipment was portable and yet could be converted into a two jack hammer drill outfit within a short time after arriving on the job. This portability decreased the length of pipe line, etc. The motors in the trucks were so geared with



ELEPHANT HUT WITH CONCRETE HEAD WALLS—APACHE TRAIL

TOOLS AND MORE TOOLS.

the compressors as to run at the same rate they did if the trucks were going 15 miles an hour. The first engine of this kind was so successful that two additional compressors have been installed on trucks and are now in active service.

PAINTING MACHINE

Practically all of the Federal equipment received by the State of Arizona stood outside in the weather until it was badly in need of paint. The Department took a pot and pan army wagon, an engine from a discarded centrifugal pump, a small tire air compressor, a house hot water tank for a receiver and a pressure cooker for a mixing tank and assembled these into a portable paint machine which is painting the State equipment and buildings, with a spray, not only better than can be done with a hand brush, but at approximately one-sixth of the cost of hand work.

WATER HOSE

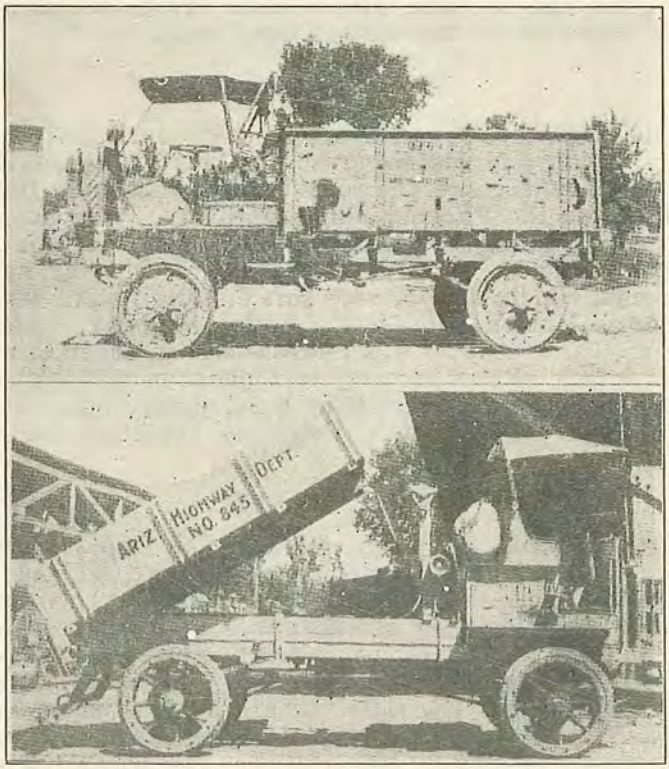
The Highway Department received nearly two miles of rubber suction and discharge hose. This was used to most excellent advantage on the road between Gillespie Dam and Gila Bend on the Phoenix-Yuma Highway. The hauling of the surfacing material needed on this route was one of the greatest problems. In order to facilitate this, the new embankments, which were of very soft material, were wet down in order to harden and form a better roadway. After the surfacing was spread, it was likewise wet in order to procure a quick set up. Rains are very infrequent in this section, and without the use of Government hose, pump, etc., this road could not have been put in first-class condition for a long time.

CATTLE GUARDS

Cattle guards are being made by the Department from all sizes of T-rails from 25-pound to 80-pound sections. Two rails, one with the top and the other with the base upward, are placed on the edge of the cattle guard to receive the initial impact; the remaining rails are placed with the base up in order to increase the surface and to avoid the lodgment of material between the rails. The rails are spaced approximately five inches apart, as this distance is such a small gap as to be easily crossed by auto traffic. The whole top section is bolted together and placed on concrete foundations. It makes an excellent cattle guard. Gates are built in the fence to one side of the cattle guard in order to permit horse-drawn vehicles to use the road.

NO MORE TOWING

Shop forces are engaged on the construction of a set of pulleys which will run with an electric motor placed so that trucks and automobiles can run on to these pulleys and have their entire machinery set in motion without the use of the auto or truck engine. This is being done in order to break in motors after being repaired and also to hear and better locate engine trouble. It will avoid the use of towing engines and trucks in order to start motors in cold weather and when the equipment is new. It is also planned to attach a brake to this same equipment and measure the brake horsepower on all repaired trucks in order to be sure that they are in first-class working condition before being sent out on the road.



TOP—ORDINANCE TRUCK AS RECEIVED FROM THE GOVERNMENT

BOTTOM—THE SAME BODY AS CONVERTED BY ARIZONA FOR ROAD WORK

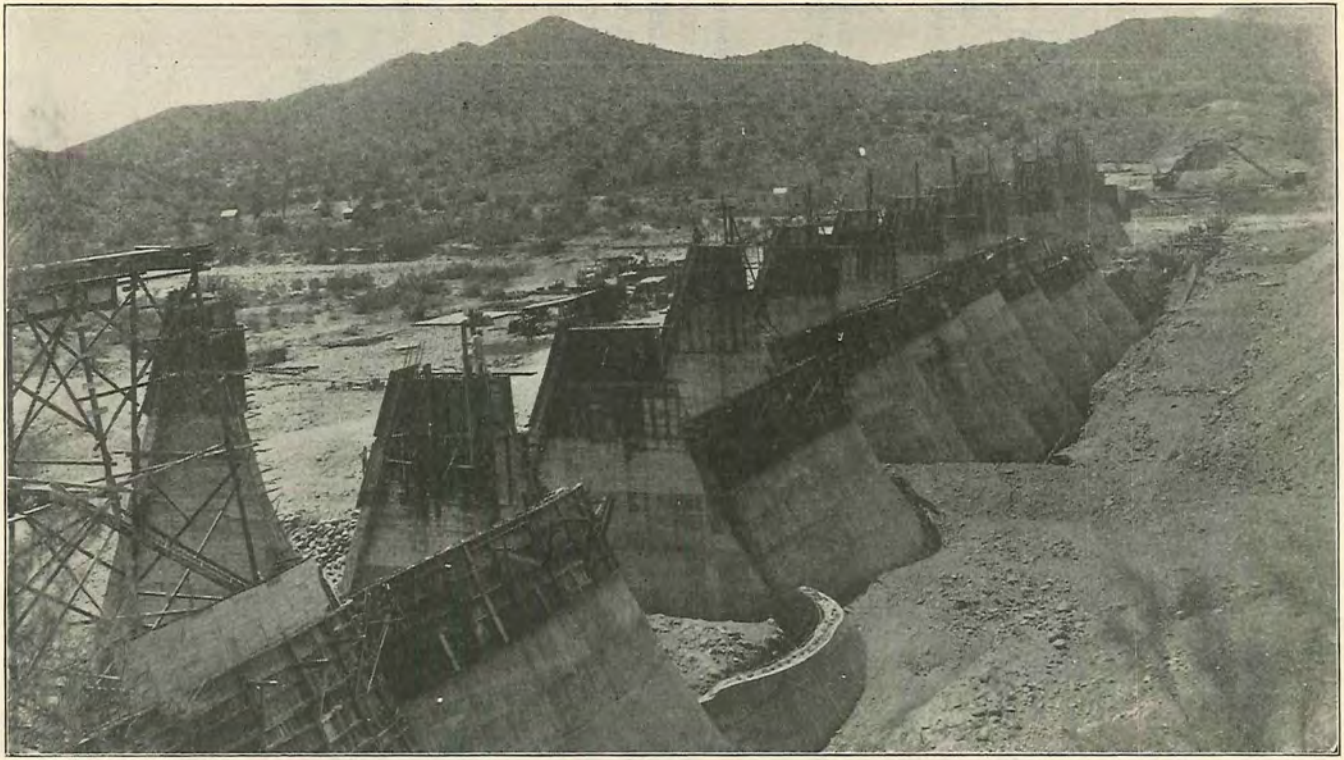
CONVICT LABOR

The special session of the Legislature in 1922 repealed the $60,000 appropriation for the use of convict labor on highway construction. This action was no doubt caused by the fact that a great mass of free labor was unemployed, and also by the knowledge that free labor had proven more economical on highway construction than prison labor.

On the Superior-Miami Highway the State was fortunate in having some heavy rock work particularly fitted for the use of convict labor.

While much of this work was being done the wages of free labor were higher than they had been for many years. In spite of these two factors, which should be particularly advantageous in a comparison of the cost of free and convict labor, it was found that the free labor was moving material cheaper than it could be handled by convict labor.

From a purely highway construction point of view, therefore, convict labor should not be employed except on local roads in the vicinity of the prison, where extra expense will not be incurred for guard hire, stockades, etc. The use of convicts outside of this limited area can only be justified by their physical and mental improvement while working in occupations which will prepare them for employment when they are released.



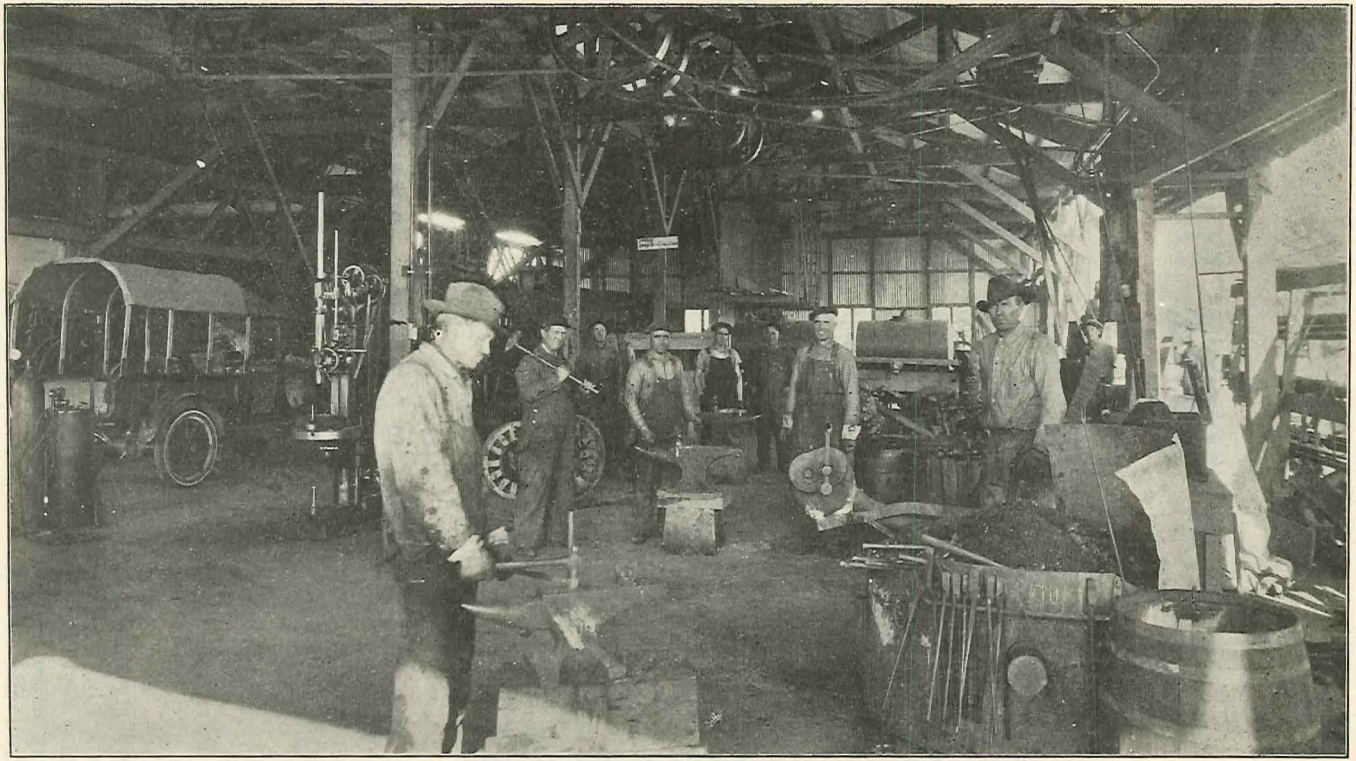
CAVE CREEK DAM—SEPTEMBER, 1922.

CAVE CREEK DAM

Much of the west end of the City of Phoenix, including the Capitol, the Highway Department yard and 9,200 acres of agricultural land south of the Arizona Canal have been subjected to periodical floods from Cave Creek. This stream has its source about 60 miles northeast of Phoenix in the Bradshaw Mountains and has a drainage area of about 225 square miles, above the dam. The flood waters rush down to the Arizona Canal and then spread out slowly over the lands to the south and cause considerable damage at times. The Fifth Legislature appropriated $50,000 to be applied toward the construction of a dam to retard the flow of Cave Creek and regulate the discharge into the Salt River Valley irrigation system. This money was placed under the jurisdiction of the State Engineer. Various other political subdivisions and corporations supplied the following amounts:

County of Maricopa	$100,000.00
City of Phoenix (bond issue)	100,000.00
Salt River Valley Water Users' Ass'n	50,000.00
Arizona Eastern Railroad	5,000.00
A., T. & S. F. Railroad	25,000.00
Union Oil Company	5,000.00
Standard Oil Company	10,000.00
Greenwood Cemetery	1,750.00
	$296,750.00

Making a grand total of $346,750.00, including the $50,000.00 from the State. The board organized to handle the expenditure of this money is known as the Cave Creek Flood Control Board and consists of the State Engineer, the chairman of the Board of Supervisors of Maricopa County, the City Manager of Phoenix, the General Manager of the Salt River Valley Water Users' Association, and the President of the Paradise-Verde Irrigation District. The latter organization had the rights to the damsite and were interested in the matter, as a portion of their land lies within the flood area. Their rights to the damsite were turned over to the Cave Creek Flood Control Board. Mining claims covered a portion of the reservoir site. A payment of $5,000.00, made out of court after a suit for $200,000.00 damages had been filed, settled the latter.



BLACKSMITH SHOP.

From the first, considerable difference of opinion developed among the engineers representing the various parties to the contract. As a result when bids were received, figures were submitted on the official plan of the board, on an alternate prepared by the State Engineer and on a design submitted by John S. Eastwood. The official plan was for an earth dam with a concrete core wall. The State Engineer proposed an earth dam with a rip-rap face wall on the water side and Mr. Eastwood designed a reinforced concrete multiple arch dam of a type evolved by himself.

The total bids were as follows:

Official design (bid by Cotey & Black)	$601,225.00
State Engineer's design (bid by Cotey & Black)	476,360.00
State Engineer's design (bid by Lynn S. Atkinson, Jr.)	370,165.00
Eastwood Multiple Arch Dam (bid by Lynn S. Atkinson, Jr.)	372,294.30

In view of the difference in price between the Eastwood type and the official design, the former received the serious consideration of the board. The only other possibility was the plain earth dam, but against this was a strong public sentiment. Therefore, the State Engineer's plan was rejected.

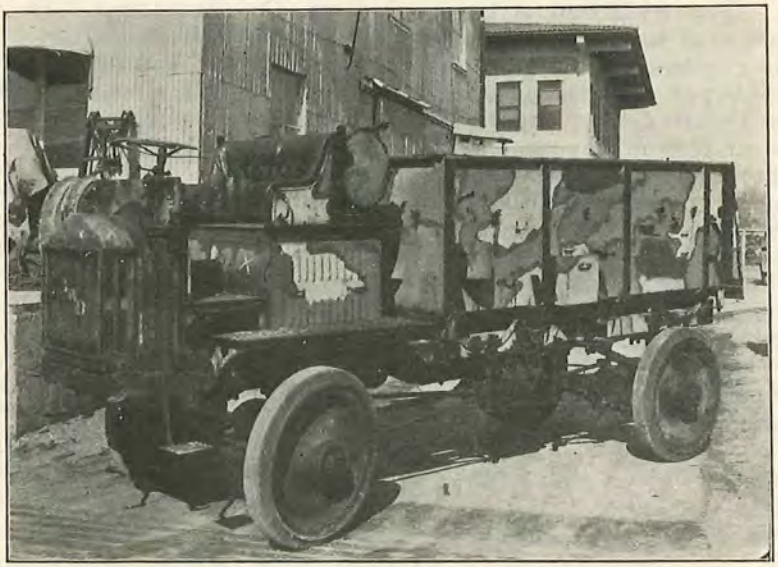
The $372,000 Atkinson bid on the Eastwood type of dam was based on the engineer's estimate of quantities and the contractor's unit bid prices. The amount did not include the 5 per cent fee of the designing engineer, the payments for right of way, engineering and inspection charges nor any estimates on the cost of the work on the spillway, sluice gates, channel, etc. It was also realized by the board that the foundation depths could not be accurately determined until the excavations had demonstrated the character of the material. On this account an agreement was entered into by which the county, city and Water Users' Association were to advance any additional funds necessary to complete this structure. The foundations of many of the buttresses were carried much deeper than was originally intended. Additional steel was also placed in the buttresses. A careful estimate indicates that the final cost will approximate $540,000. The county, city and Water Users' Association are advancing the extra $195,000 needed above the amount originally subscribed. An effort will be made to secure an additional appropriation from the Sixth Legislature when it convenes.

The Paradise-Verde directors have agreed to pay their proportionate share of the excess cost when their bonds are sold. This will be one-quarter of $195,000, or $48,750, in

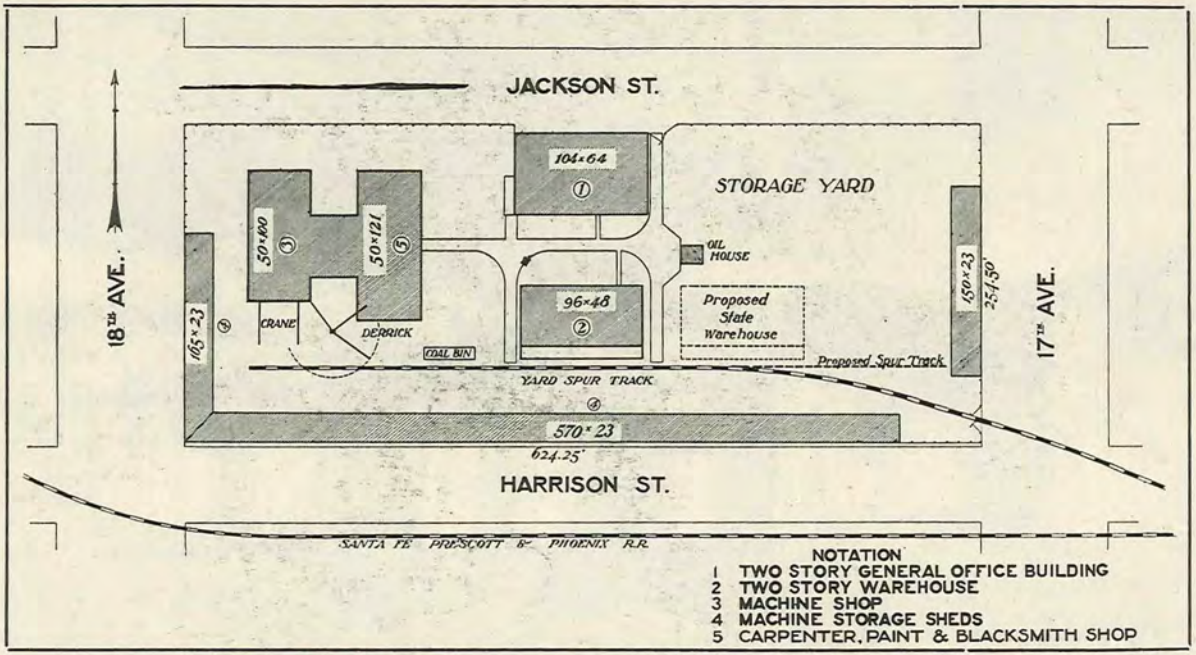
case the State refuses an additional appropriation. It, therefore, seems probable that the cost will be more equitably divided among the various parties to the contract.

The multiple arch type of dam is one which has been in very successful use in a number of States. Cave Creek Dam, as designed by Mr. Eastwood, has some modifications not found in any of the earlier structures of this type and has been the subject of some criticism on this account. The majority of the board have held that the dam as designed, modified and constructed will be a secure structure. The capacity is such that twice the amount of water in the flood of August, 1921, can be impounded. It seems doubtful if this capacity will ever be required to handle any future flood. Winter floods may discharge more water, but owing to the longer duration will not require any greater storage facilities. Hence with the completion of this dam, about the middle of January, 1923, the menace from Cave Creek should be removed.

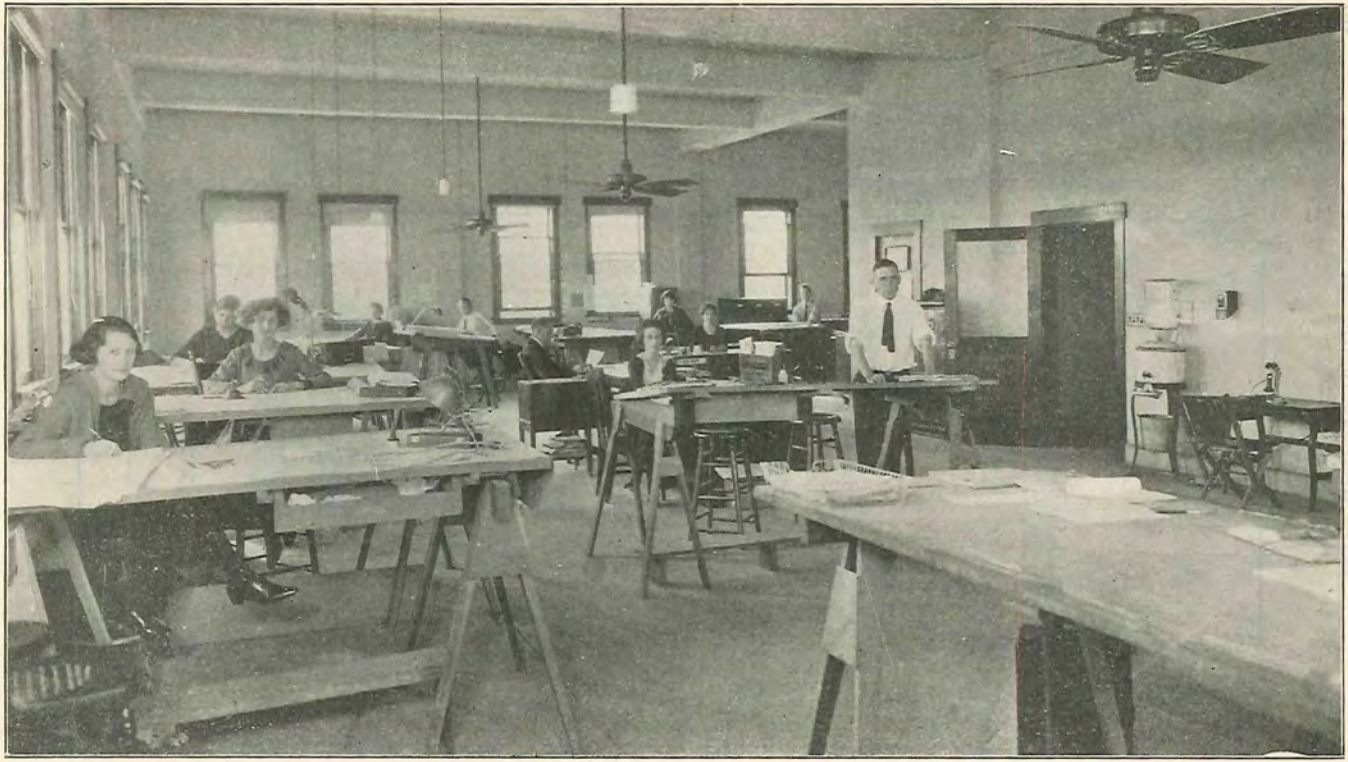
J. B. Girand is engineer of construction for the board.



CAMOUFLAGED ARMY TRUCK AS RECEIVED



SKETCH SHOWING LAY-OUT OF STATE YARD AT PHOENIX



DRAFTING ROOM— A. H. D. PLANS, ESTIMATES, ETC. AVERAGE LESS THAN THREE-QUARTERS OF ONE PERCENT OF COST OF ROAD.

IRRIGATION

STATE CERTIFICATION BOARD

Section 38, Chapter 149, Session Laws of 1921, creates the State Certification Board, consisting of the Attorney General, the State Engineer and the Superintendent of Banks. This chapter provides for the organization of irrigation districts and the certification of bonds issued by such districts by the Certification Board.

Section 44 provides that bonds so certified shall be legal investments for funds of savings banks within the State of Arizona and may be deposited to secure public money in the State of Arizona. Prospects for irrigation development in Arizona indicate that many millions of dollars will be expended for the development of irrigation projects within the next few years. The certification of bonds issued by irrigation districts is too important to be an incident in the duties of the Attorney General, State Engineer and Superintendent of Banks. If securities of this character are to be legal investments by savings banks and security for public money there should be a strict supervision by some Department of the State Government which shall have this as its principal duty and not simply a small side issue among the many important duties devolving on these three officials. Apparently a state agency has been created to supervise the expenditure of funds secured from the sale of Certified Bonds. In reality no organization or appropriation has been made for this purpose and Savings Bank Deposits and State money are quite apt to be lost.

We believe that the necessity of thorough investigation will be realized when it is noted that in the near future one single project may come before the Board with the request

to issue bonds to cover an estimated cost of approximately $10,000,000.00. The above is not a comment on the feasibility of the project which has no yet been submitted, but is to call your attention to the magnitude of the projects involved.

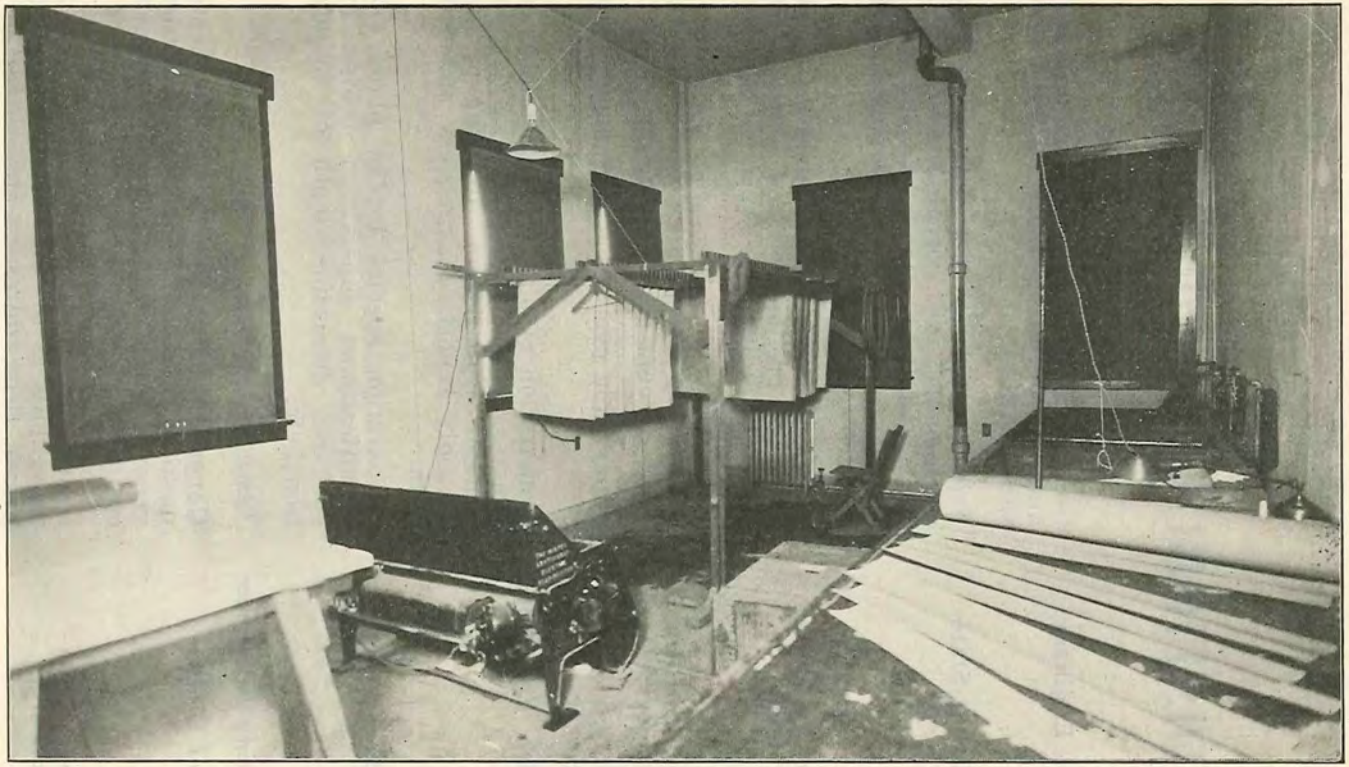
There is an apparent tendency in recent legislatures to place upon public officials, already burdened with the multitudinous details of their respective departments, duties on other boards the purposes of which are foreign to the organization under their direction.

Recommendation is therefore made that this provision of the law relating to savings banks and security for public money be either repealed or amended so as to provide greater safety for depositors or savings banks and for the public treasury.

MOTOR REPAIRING.

DISTRIBUTION OF DUTIES

State Engineer:	General supervision; reviewing plans; authorizing all changes in plans and specifications.
Assistant State Engineer:	Federal Aid Project statements and agreements; all correspondence with Bureau of Public Roads except relating to Federal equipment; preparing calls for bids, contracts, etc.
Chief Locating Engineer:	Reconnaissance and estimates, supervision of preliminary and location surveys, including the size of drainage openings.
Chief Construction Engineers:	Supervision over all State Highway force account construction work.
Maintenance Engineers:	Supervision over all maintenance work.
Office Engineer:	Preparation of plans, specifications, estimates, except special bridge designs, general supervision drafting room, monthly reports of progress and cost data.
Bridge Engineer:	Preparation special bridge plans and specifications; supervision bridge inspection, determine depth of foundations, etc.
Testing Engineer:	Testing Materials.
Chief Clerk:	General correspondence, disbursements, payrolls, expense accounts, supervision general office force—camp bookkeepers, timekeepers and commissary men.
Department: Purchasing	Issue requisitions, make purchases, approve bills as to form and price; keep prices, firm addresses, etc.



BLUE PRINT ROOM—THREE MILES OF BLUE PRINT PAPER PASS THROUGH THIS DEPARTMENT ANNUALLY.

Accounting Department:	Charge of claims in transit from Purchasing Department to Chief Clerk, bookkeeping and distribution; check Imprest Fund.
Traveling Auditor:	Check Camp Accounts.
Equipment Department:	Record of equipment purchased, received, transferred and its distribution, includes Federal Equipment used by State and counties; receive and issue material and supplies, fill requisitions, make shipments, keep record of stock in Phoenix.
Master Mechanic:	Repairs to equipment.
Location Engineers:	Preliminary and location surveys; furnish data for preparation of plans, specifications and estimates, including property lines.
Construction Engineers	In charge of construction, stake out work, make monthly estimates, supervise contracts on State work, authorize expenditure, O. K. requisitions, supervise General Foremen.
Inspectors:	Conform all construction to plans and specifications unless alterations permitted in writing by State Engineer.
General Foremen:	Complete charge of camp under general orders of the construction engineer.
Timekeepers and Bookkeepers:	Make payrolls and disbursement records, reporting to Chief Clerk. Other duties as defined by Construction Engineer or General Foreman.
Commissarymen:	Make camp purchases; keep camp supplies and records of same.

PARTS, ACCESSORIES AND TOOLS IN WAREHOUSE BINS.

A SECTION OF THE 3,000 BINS IN WAREHOUSE.

COSTS

The following tables show the costs on projects completed or under construction during the fiscal years 1920-21 and 1921-22:

Projects	Mileage	Cost to Dec. 1, 1922
Apache County		
Holbrook-Lupton	52	$ 28,500.21
Holbrook-St. Johns (Survey)	....	1,843.09
Holbrook-St. Johns 4A	3	21,636.73
Holbrook-St. Johns 4B	10	36,914.49
Holbrook-St. Johns, Concho Bridge	....	7,711.25
St. Johns-Springerville	13.5	1,964.87
Rio Puerco Bridge	....	12.80
St. Johns-Zuni	....	15,000.00
Cochise County		
Benson-Vail, Sec. D	3.9	27,978.38
Benson-Vail, Sec. E	6	78,248.24
Bisbee-Douglas 2A	4	146,882.69
Bisbee-Douglas 2B	4.463	136,823.53
Douglas-Rodeo A & C	23	85,347.67
Douglas-Rodeo D & 2	26.5	192,783.85
Bisbee-Tombstone Paving	10	90,630.29
Nogales-Fairbank 49	16	86,823.53
Douglas-Rodeo Dips	....	2,066.92
Coconino County		
Flagstaff-Williams A & B	15.1	127,089.01
Flagstaff-Williams 2 R C	18	27,635.15
Flagstaff Paving	1	24,205.97
Flagstaff Paving, West	.5	12,752.53
Williams-Ashfork A, B, C	16.3	183,967.07
Gila County		
Globe-Geronimo A & B	18	76,212.46
Globe-Roosevelt 1B	....	7,291.54
Superior-Miami A, B, C, D, E, F, G, K (includes entire Project)	20.5	995,830.04
Superior-Miami, Pilot Road	....	20,349.69
City of Miami	....	10,603.83

Graham County

Projects	Mileage	Cost to Dec. 1, 1922
Globe-Geronimo D	5	45,050.65
Globe-Geronimo C (San Carlos Bridge and Approach)	....	65,000.00
Geronimo-Solomonville	....	42,034.74
Solomonville-Duncan	....	3,000.00

Greenlee County

Clifton-Franklin Contract 1	....	3,782.39
Clifton-Franklin Contract 2	5.4	38,254.25
Clifton-Franklin Railroad Wash Bridge	....	9,505.88
Clifton-Mule Creek	19	151,137.97
Clifton-Solomonville, 1919 to date	....	247,965.71

Maricopa County

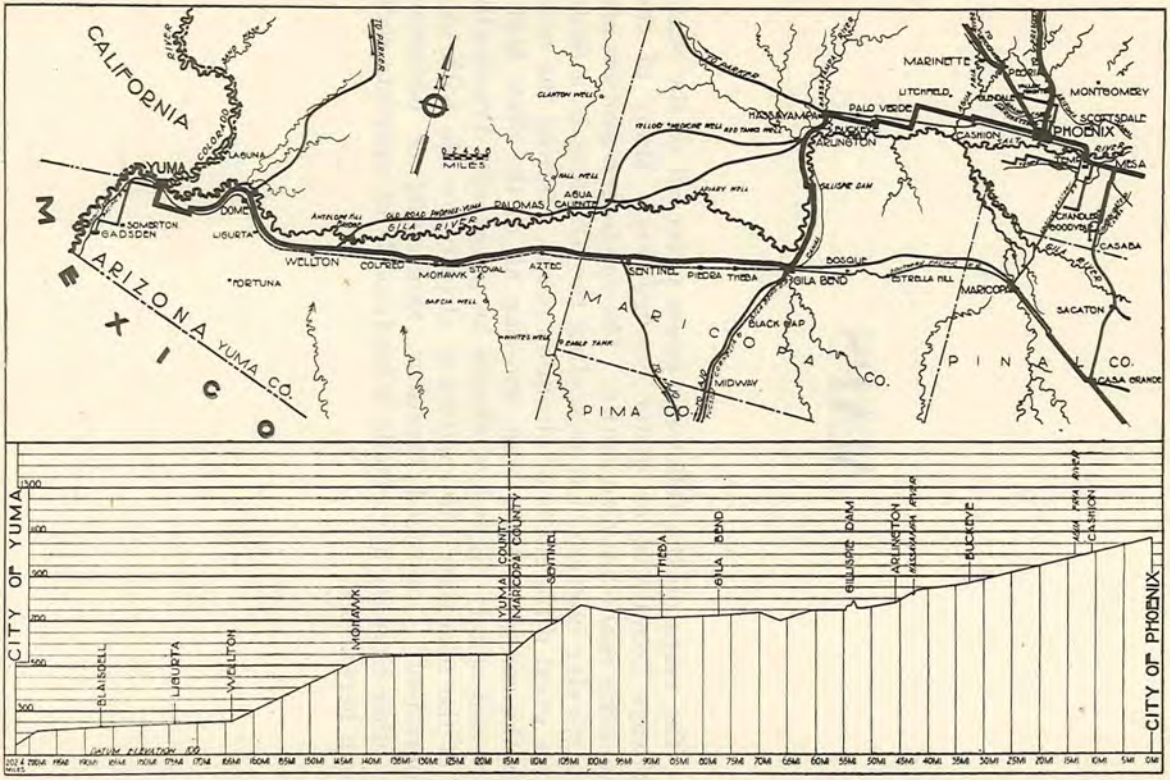
Chandler-Casa Grande Survey	....	$ 1,115.81
Agua Fria Bridge	....	94,351.03
Apache Trail	60	176,099.99
Cave Creek Flood Control	....	1,138.87
Marinette Bridge	....	62,265.68
Mesa Paving	.5	13,019.03
Phoenix-Yuma (Phoenix-Buckeye)	32.9	8,103.04
Phoenix-Glendale	7.1	205,504.97
Phoenix-Yuma (Arlington Bridge)	....	32,854.20
Dam	23.5	125,557.78
Phoenix-Yuma (Arlington-Gillespie Dam)	10.6	925.31
Phoenix-Yuma (Gila Bend-Gellespie Dam)	23.5	125,557.78
Phoenix-Yuma (Gila Bend-Piedra)	14.9	10,182.26
Phoenix-Yuma (Piedra-Stanwix)	22.2	447.22
Phoenix-Yuma Survey	....	330.64
Phoenix-Tempe 1	3.0	77,756.35
Tempe Bridge (From November, 1919)	....	76,846.84
Tempe-Mesa 1 and 2	6.4	229,001.39
Wickenburg Bridge	....	69,780.19
Wickenburg-Hot Springs Junction	10.6	9,596.43
Mesa-Canal Paving	4.1	289.56
Glendale-Marinette	6.5	1,491.70

Projects	Mileage	Cost to Dec. 1, 1922
Glendale-Marinette (New River Bridge)	....	142.20
Grand Avenue Paving	.5	13,753.92
Phoenix-Yuma (Buckeye-Arlington)	12.0	2,034.07
Mohave County		
Arrowhead Trail 1	....	34,579.17
Arrowhead Trail 2	....	18,341.54
Crozier Canyon	....	620.81
Kingman-East	....	6,456.03
Oatman-Goldroads 1	2.2	65,692.66
Oatman-Goldroads 2	.5	9,948.38
Topock-Oatman 1	21.1	178,896.14
Topock-Oatman 2	3.2	2,109.31
Kingman-Oatman	....	677.70
Navajo County		
Winslow-Coconino County Line	2.7	391.25
Holbrook-St. Johns (Petrified Forest)	4.2	30,633.87
Holbrook-St. Johns, Section 5	10.6	5,245.46
Holbrook-Winslow Survey	35.0	1,499.27
Holbrook-Winslow Schedule 1	7.8	17,402.58
Holbrook-Winslow Schedule 2	7.9	16,386.44
Holbrook-Winslow Schedule 3	7.9	22,210.37
Holbrook-Winslow Schedule 4	8.6	22,750.84
Winslow Paving	.9	15,105.65
Pima County		
Benson-Vail A	3.9	39,148.30
Benson-Vail B	6.9	110,461.62
Benson-Vail C	7.1	29,891.69
Benson-Vail (Mescal Wash Bridge)	....	13,644.59
Benson-Vail (Cienega Bridge)	....	40,335.80
Tucson-Florence	16.0	36,564.15
Tucson-Florence Paving	3.8	139,339.51
Tucson-Nogales Bridges	....	26,021.69
Tucson-Nogales Paving	8.9	258,300.94
Vail-Empire Contract	22.0	163,886.00
Pinal County		
Florence-Superior A and B	14.8	132,176.54
Florence-Superior C	2.1	11,632.58

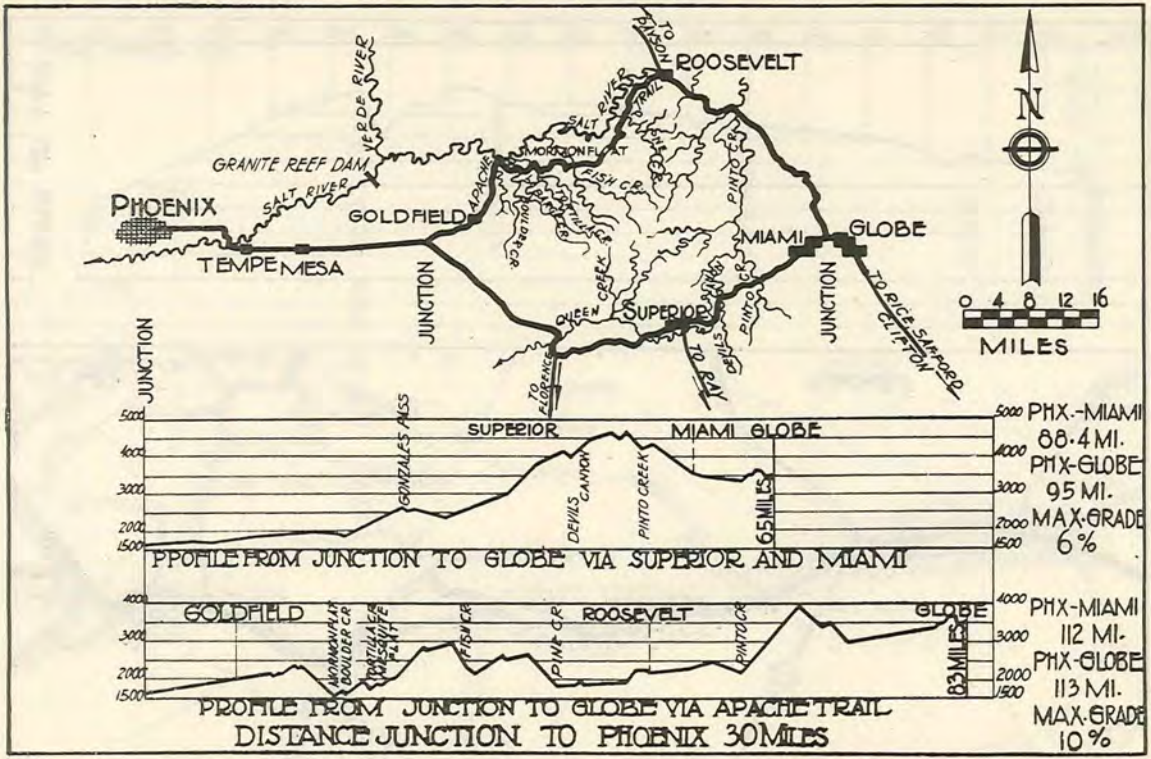
Projects	Mileage	Cost to Dec. 1, 1922
Florence-Superior D	9.4	34,940.25
Florence-Superior E (Queen Creek Bridge)	....	3,878.72
Florence-Superior F	4.5	17,276.04
Mesa-Superior 2B	12.7	225,109.12
Ray-Superior	3.0	34,008.38
Tucson-Florence	47.2	67,998.05
Santa Cruz County		
Nogales-Fairbank (Patagonia Bridge)	....	1,019.99
Nogales-Fairbank, Section A	9.4	46,062.30
Nogales-Fairbank B	5.0	31,695.34
Nogales-Fairbank 50	13.1	129,508.07
Nogales-Willows Paving	....	42,076.15
Tucson-Nogales Bridges	....	14,548.00
Vail-Sonoita	....	987.97
Yavapai County		
Prescott-Ashfork Schedule C (Willow Creek Bridge)	....	1,327.80
Prescott-Ashfork Section A	....	1,160.96
Prescott-Ashfork Schedule B	22.197	767.52
Prescott-Ashfork D (Verde River Bridge)	....	590.40
Ashfork-Chino-Nelson	18.0	53,870.57
Ashfork-Pineveta	9.75	41,722.92
Cottonwood Bridge	....	40,439.31
Prescott-Jerome 1, 2A, 2B, 4A, 4B, 5, and Yaeger Canyon	32.93	782,133.50
Prescott-Jerome (Granite Creek Bridge)	....	14,992.91
Prescott-Jerome 5 (Granite Creek Crossing)	....	24,865.59
Prescott-Ashfork	45.75	74,502.34
Pineveta-Crookton	9.34	106,723.54
Seligman-Chino	7.0	14,061.83
Seligman-Crookton	10.22	67,577.75
Wickenburg-Congress Junction	16.0	20,973.09
Yuma County		
Antelope Hill Bridge	....	13,802.82
Colorado River Bridge	....	733.31
Parker Highway	18.7	30,000.00
Yuma-Wellton B	13.0	129,506.69
Yuma-Wellton D	9.9	42,353.70
Yuma-Wellton (Wellton-Aztec)	42.6	1,858.08

MAPS

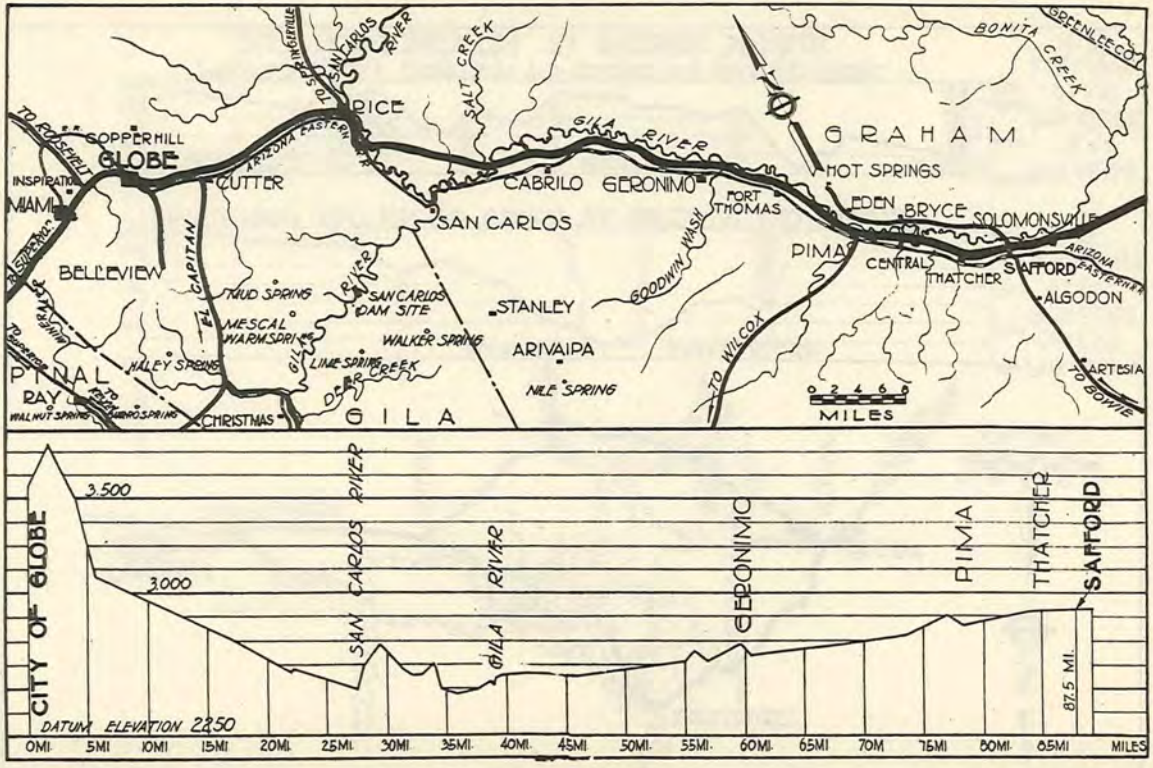
The maps on the following pages cover all of the State highways completed or under construction. Many of the connecting roads are also shown. The condensed profiles are of particular interest in representing the altitudes in a State where great differences of elevation occur. During the next year the complete State map, showing all of the State highways and county highways, should be prepared. Practically all of the necessary information is already on file with this Department. Improved locations, shortening of distances and other changes have made it inadvisable to complete such a map heretofore.



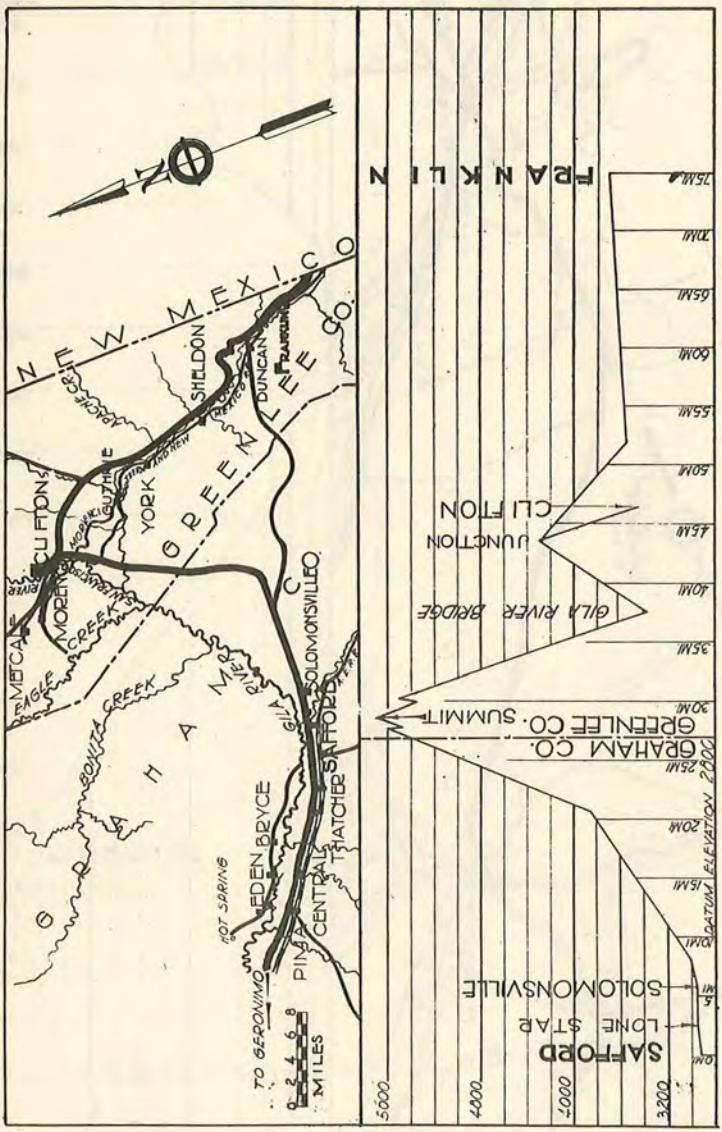
Map No. 1 YUMA-PHOENIX



Map No. 2 PHOENIX-SUPERIOR-MIAMI-GLOBE

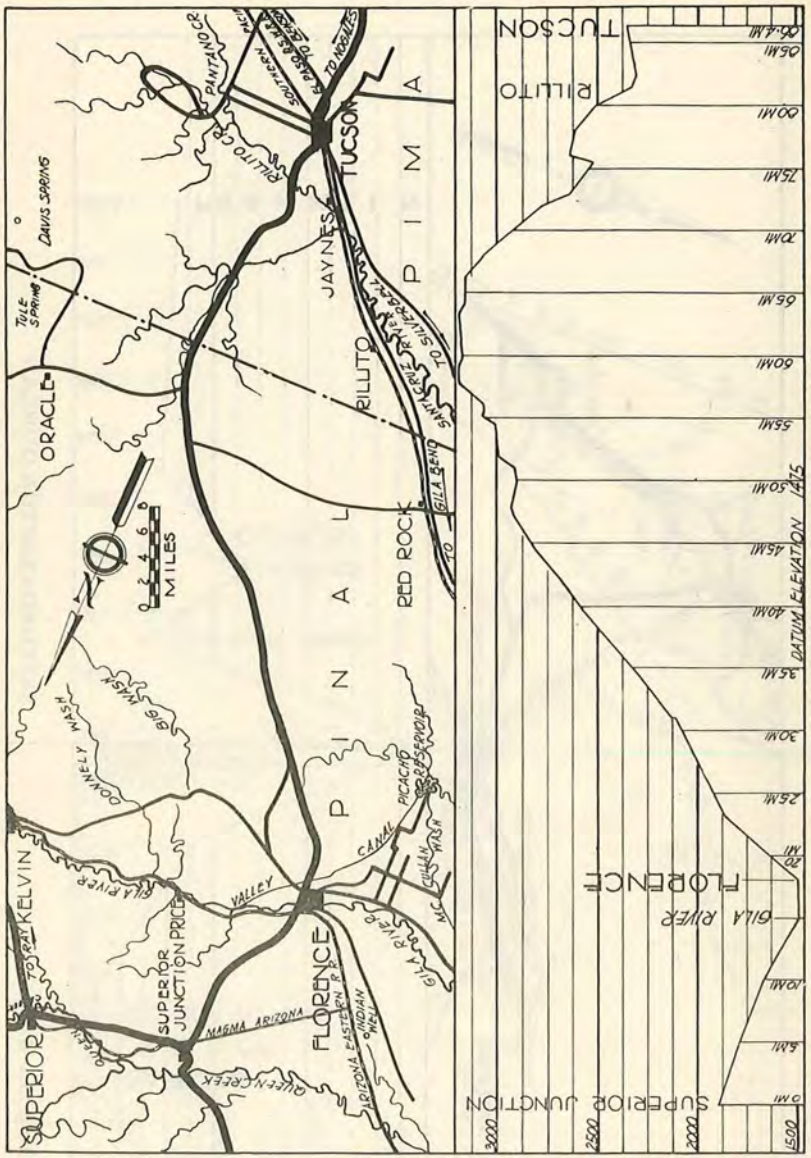


Map No. 3 GLOBE-SAFFORD

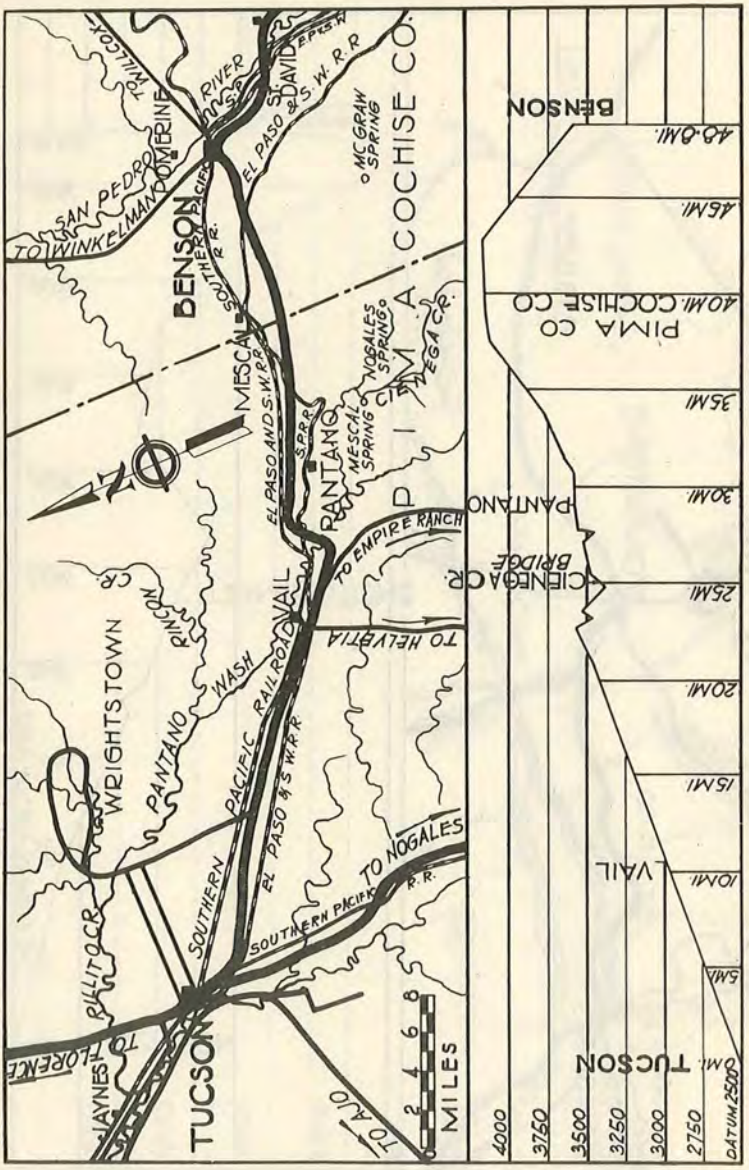


Map No. 4

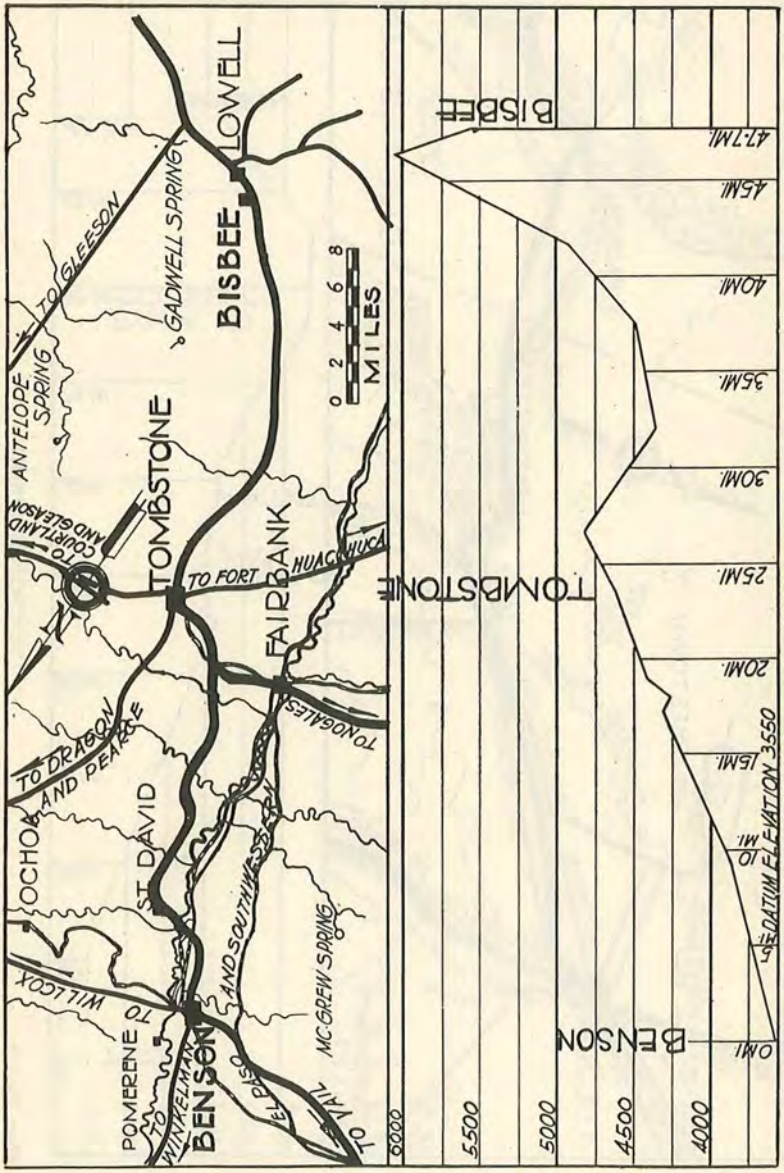
SAFFORD-CLIFTON-DUNCAN



Map No. 5 JUNCTION-FLORENCE-TUCSON

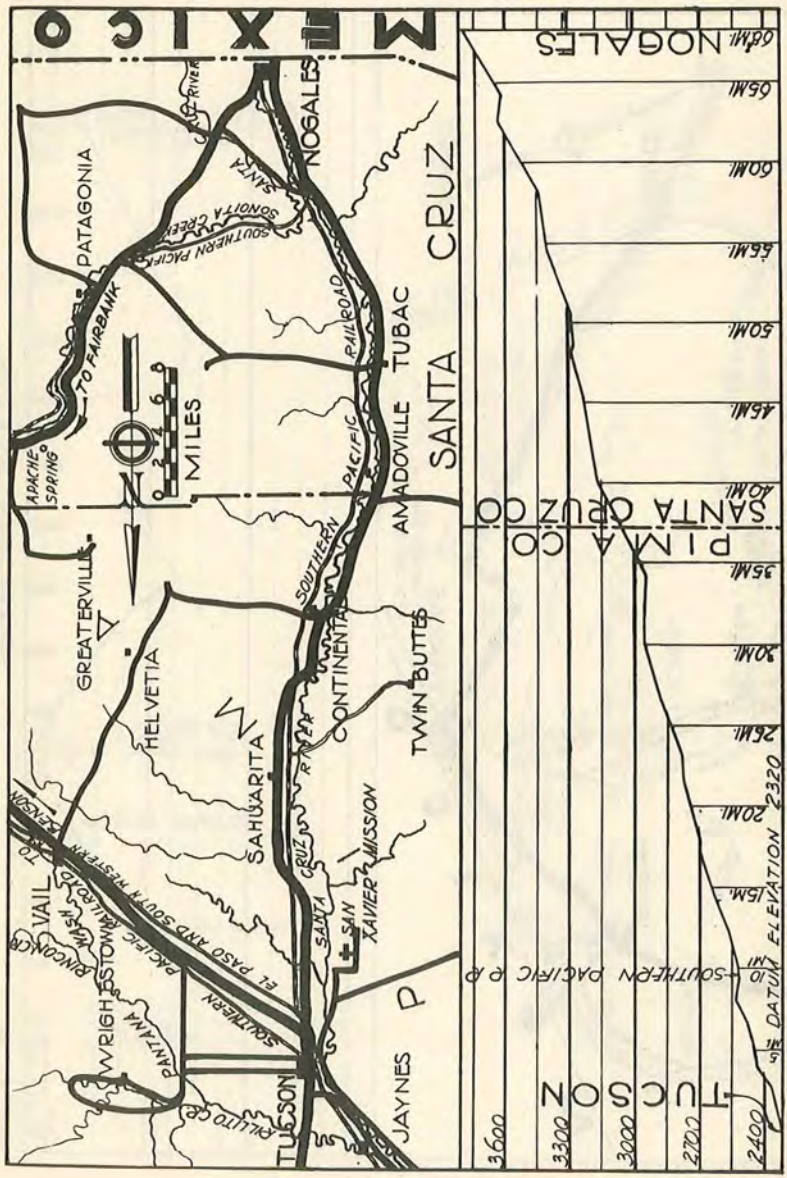


Map No. 6 TUCSON-BENSON

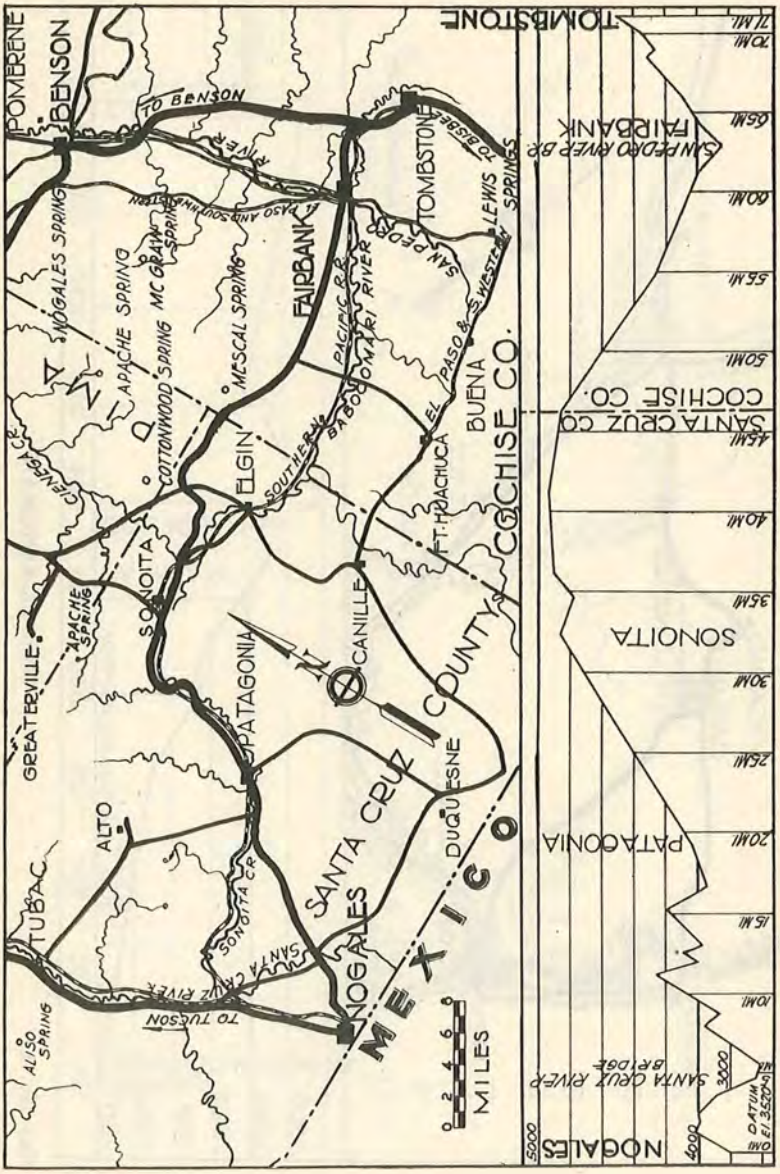


Map No. 7 BENSON-TOMBSTONE-BISBEE

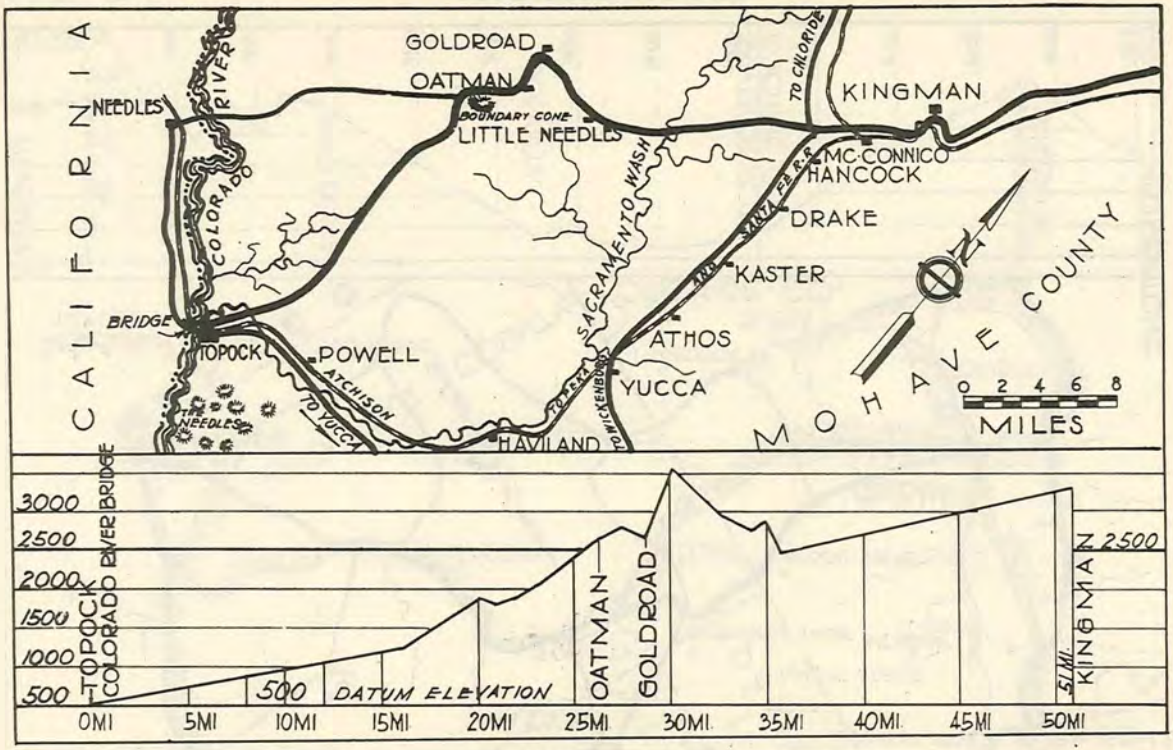
Map No. 8 **BISBEE-DOUGLAS-RODEO**



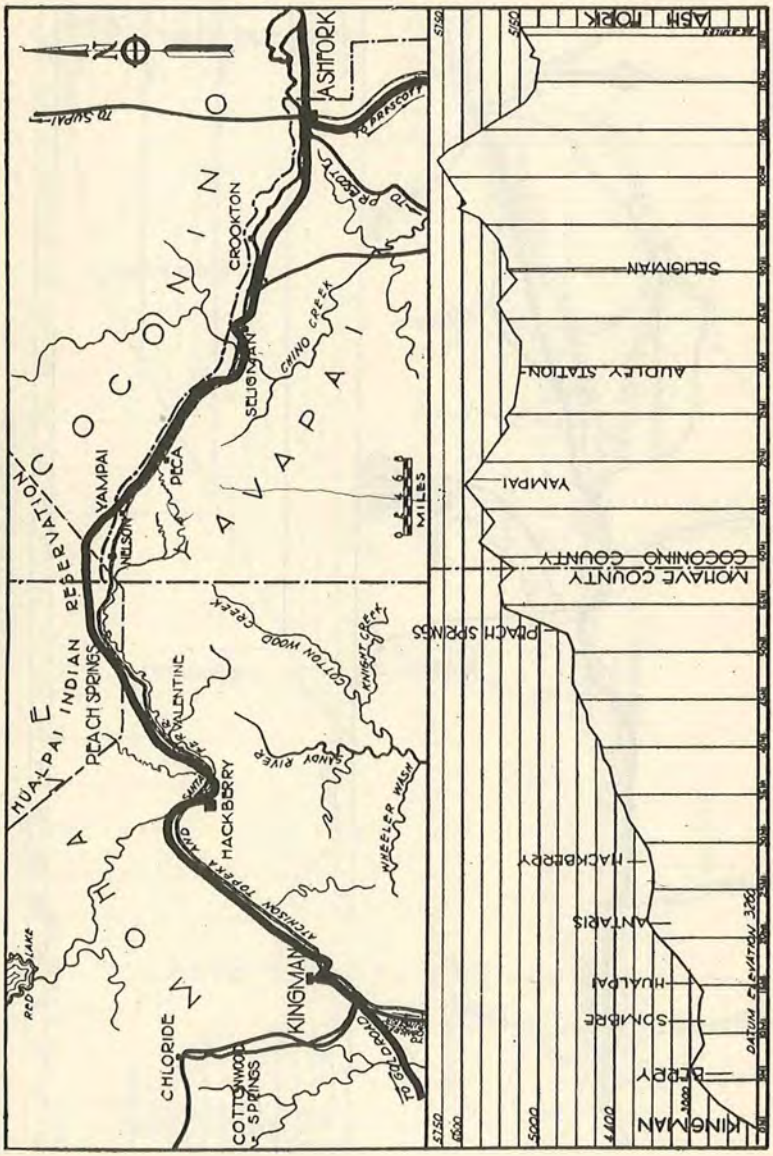
Map No. 9 TUCSON-NOGALES



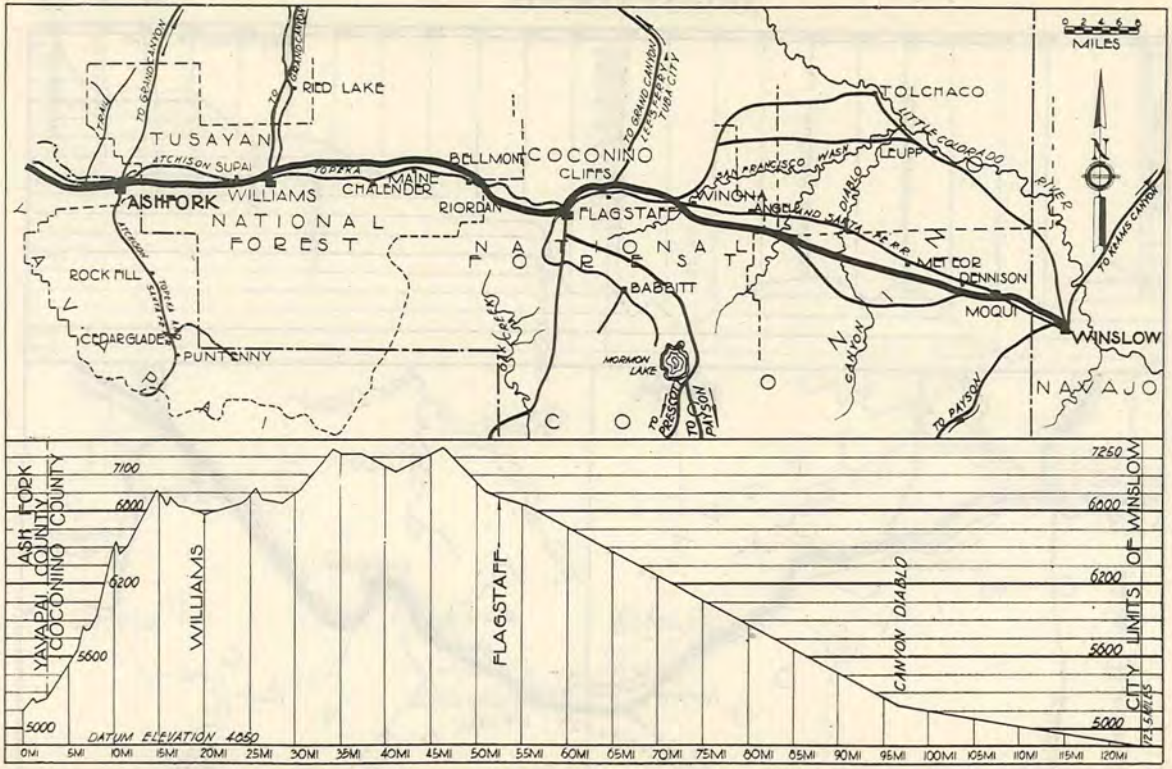
Map No. 10 TOMBSTONE-NOGALES



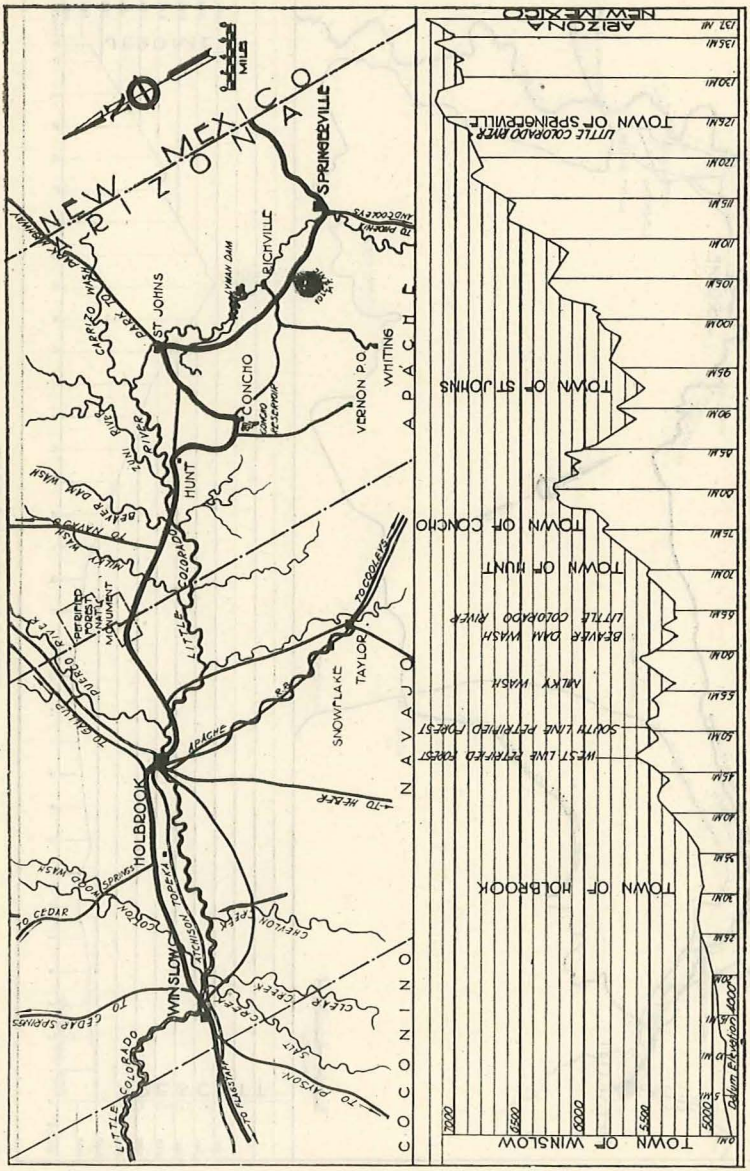
Map No. 11 **TOPOCK-KINGMAN**



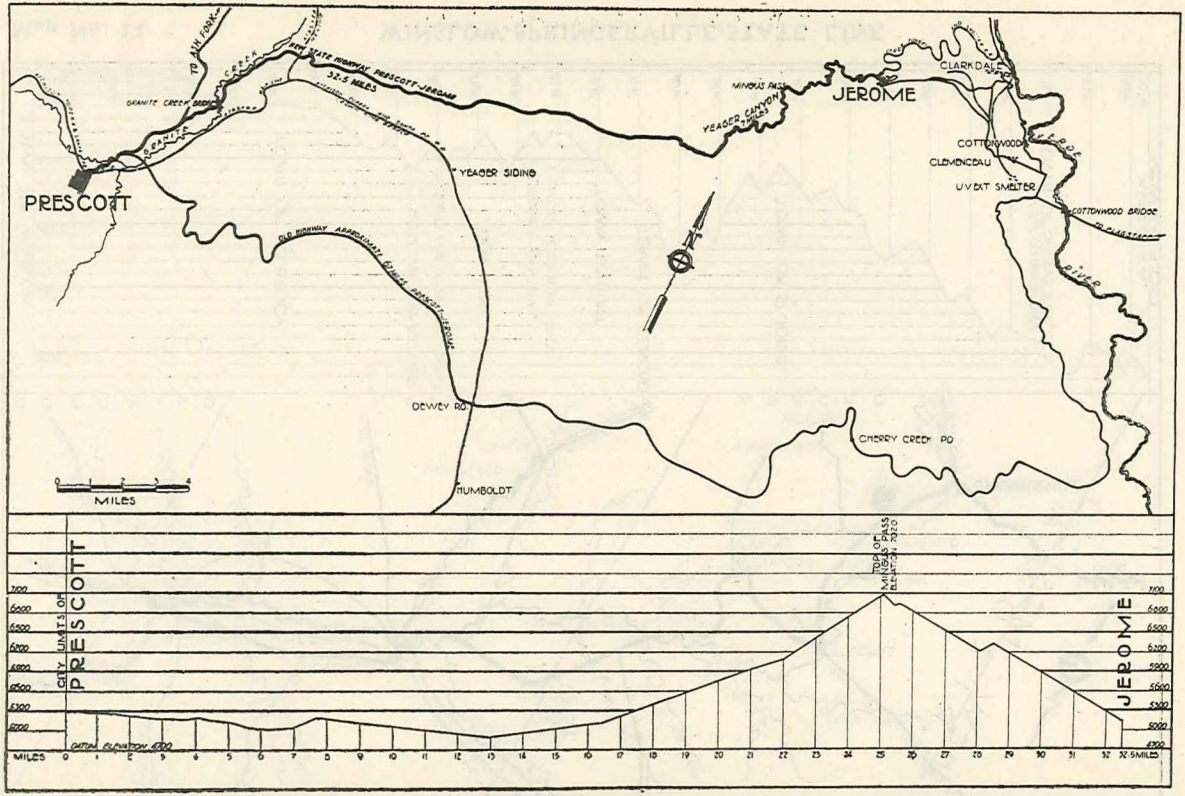
Map No. 12 KINGMAN-ASHFORK



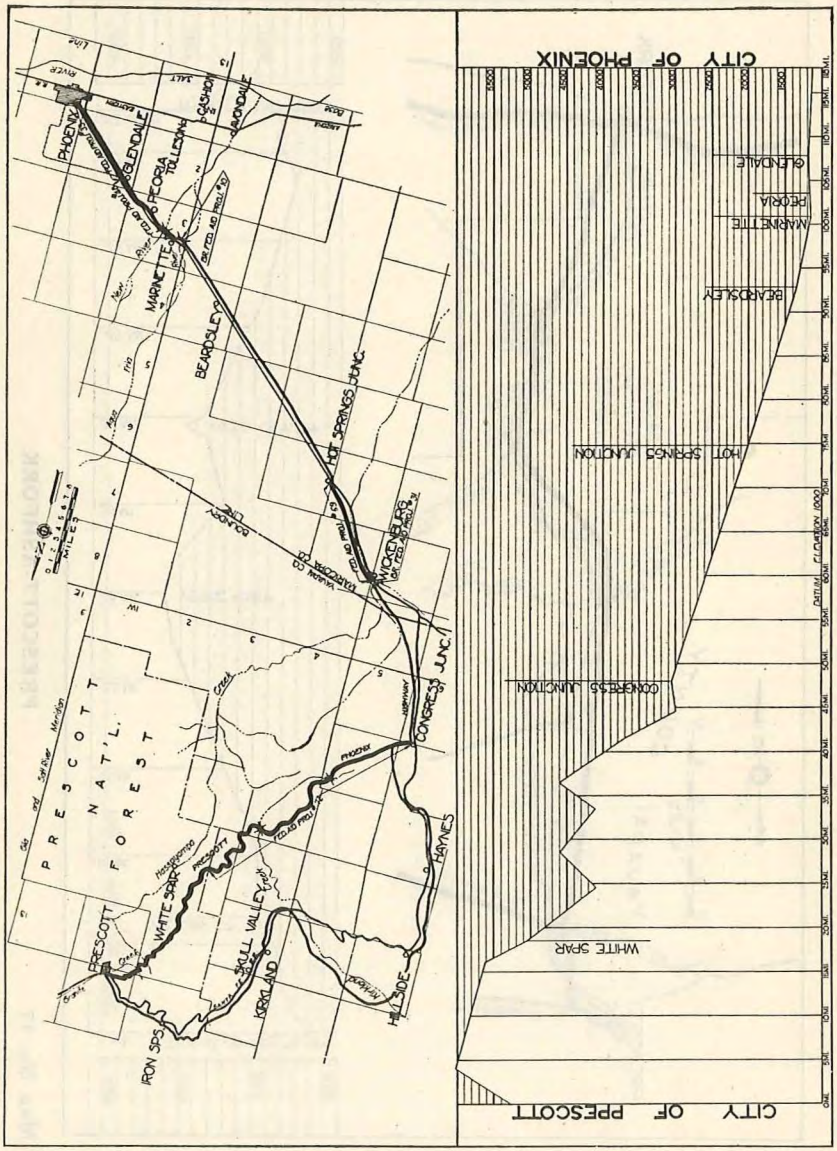
Map No. 13 **ASHFORK-WINSLOW**



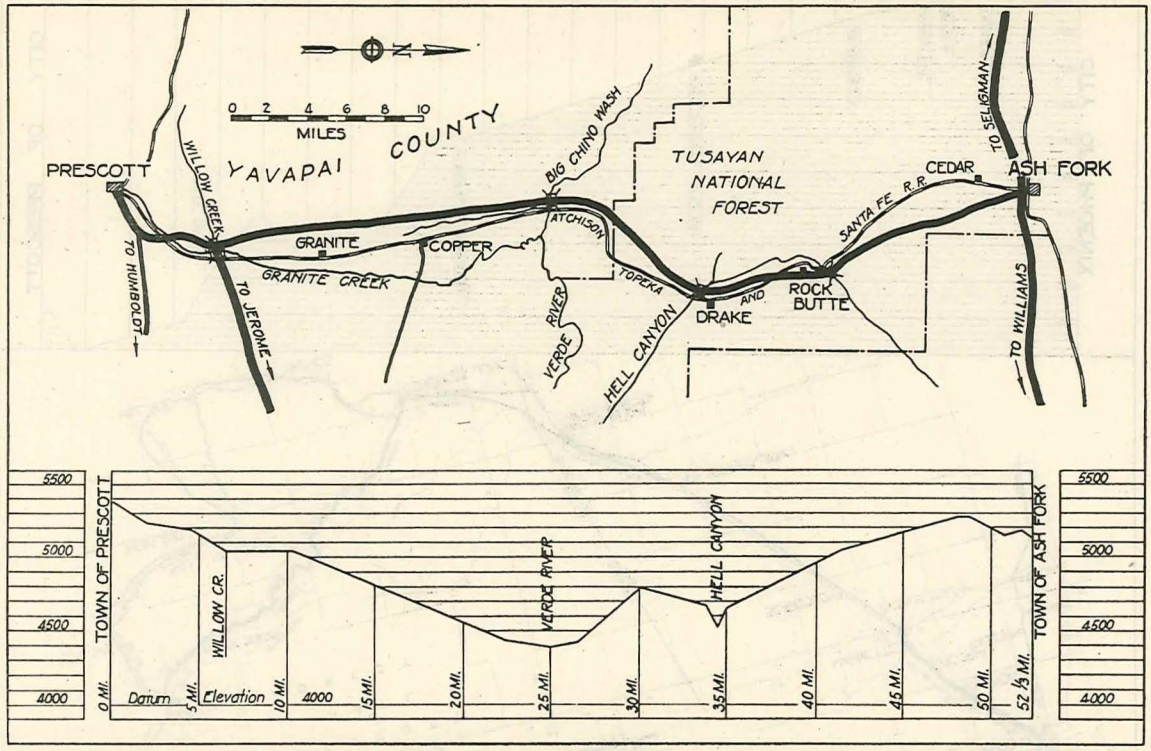
Map No. 14 WINSLOW-SPRINGERVILLE-STATE LINE



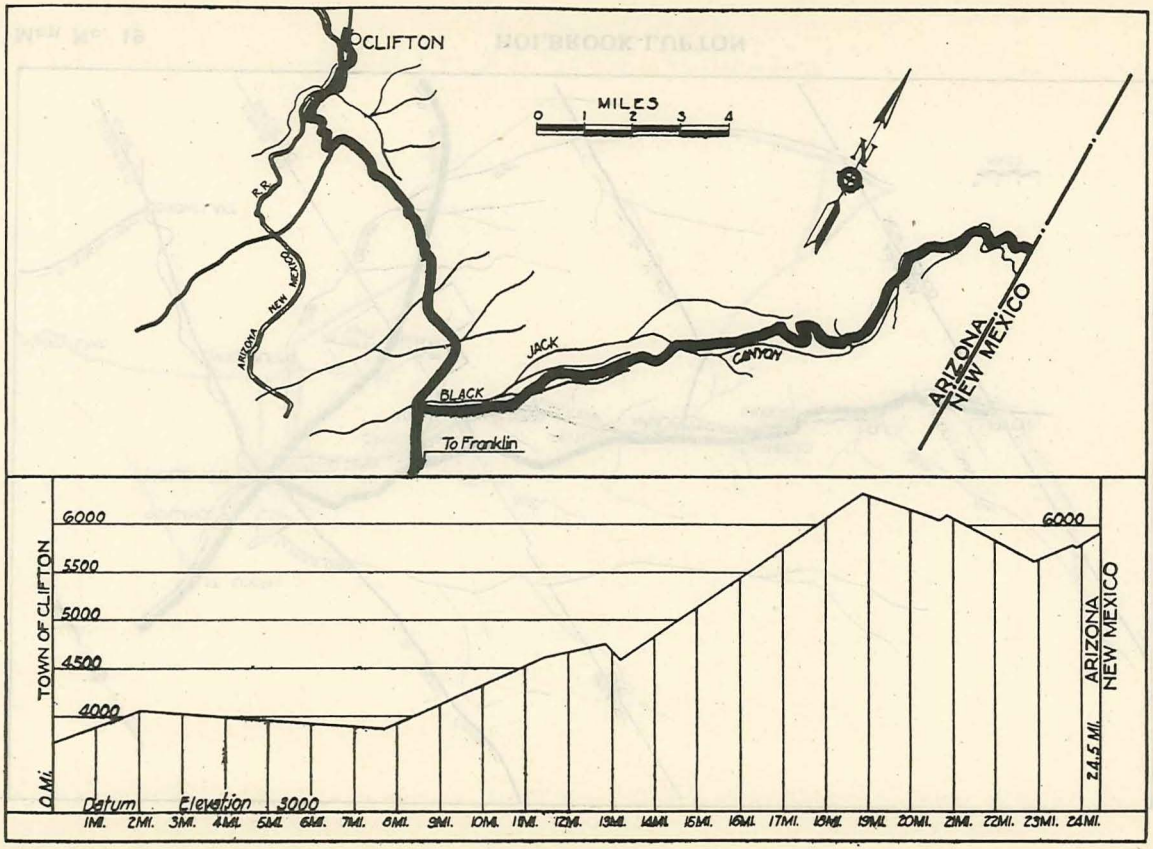
Map No. 15 **PRESCOTT-JEROME**



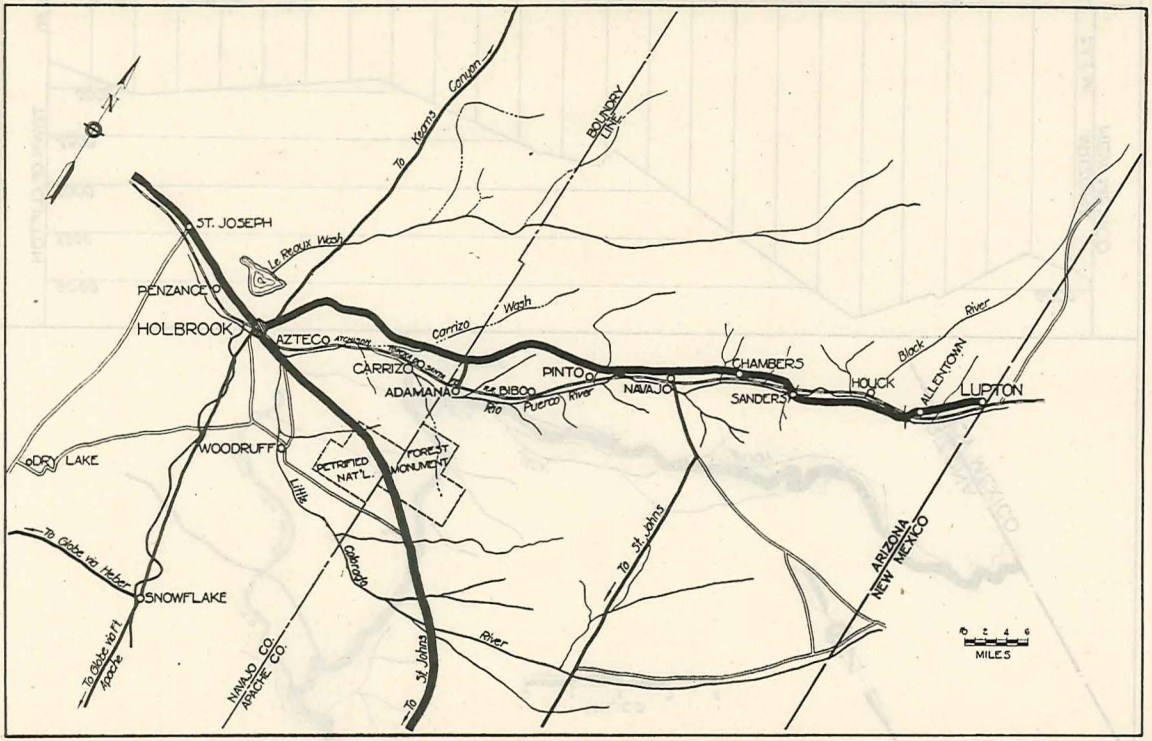
Map No. 16 PHOENIX-PRESCOTT



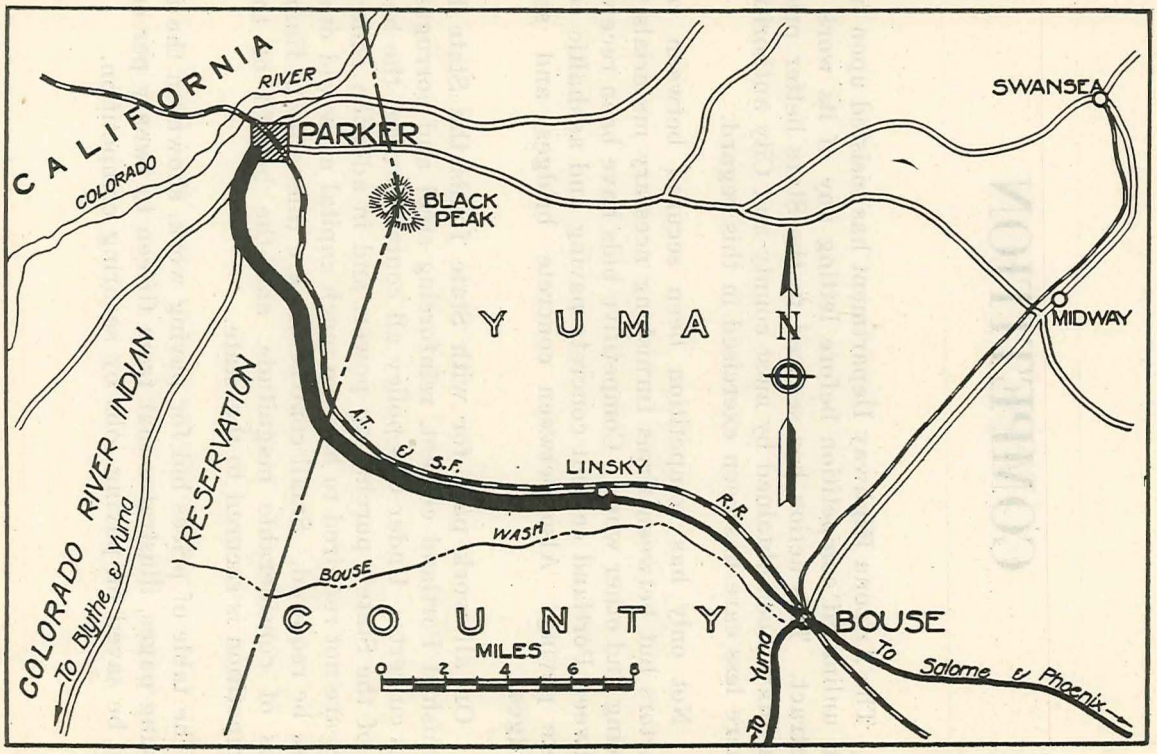
Map No. 17 **PRESCOTT-ASHFORK**



Map No. 18 MULE CREEK



Map No. 19 **HOLBROOK-LUPTON**



Map No. 20 PARKER-BOUSE

COMPETITION

The Arizona Highway Department has insisted upon free and unlimited competition before letting any of its work by contract. This action has secured to the State better prices than have been obtained by most county and City authorities, where less care has been exercised in this regard.

Not only has competition been secured between contractors but between firms furnishing ncessary materials for paving and other work. Competitive bids have been received between Portland cement concrete paving and asphaltic concrete paving. Also between concrete bridges and steel bridges.

On all work paid for with State funds the State has furnished Portland cement, reinforcing steel and corrugated iron culverts. Under this policy all contractors get the benefit of the State's purchasing power, and in addition contractors are not required to have so much capital as would otherwise be required. Small contractors are thus able to finance jobs of considerable magnitude, and the benefit of their competition is secured to the State.

The table of prices bid for paving work, shown on the following pages, illustrates that from fifteen to twenty per cent can be saved on paving jobs by securing competition.

MARICOPA COUNTY HIGHWAY COMMISSION

County Program	1920	Twohy Brothers Company	Conc.	5-3/8"	(Total)		2.62	
" "	1920	" " "	Conc.	6-1/3"	(130)		2.964	
" "	1922	" " "	18' Conc.	6-1/3"	(Total)		2.31	
" "	1922	" " "	16' Conc.	6-1/3"	(180)		2.33	
" "	1922	" " "	18' Conc.	5-3/8"			2.02	
" "	1922	" " "	16' Conc.	5-3/8"			2.04	
" "	1922	" " "	18' Asph.	6"			2.00	(1)
" "	1922	" " "	16' Asph.	6"			2.07	(1)
" "	1922	" " "	18' Asph.	5"			1.75	(1)
" "	1922	" " "	16' Asph.	5"			1.86	(1)
Nineteenth Avenue	1922	Phoenix-Tempe Stone Co.	Asph.	6"		.20	2.18	
Liberty Road	1922	" " " "	Asph.	4"		5.00	1.70	

CITY OF TUCSON

Alameda, Tolle, Driscoll	1922	Geo. B. Singleton (Willite)	Asph.	5"	12,000 sy. yds.		2.00	(2)

YUMA COUNTY HIGHWAY COMMISSION

County Program	1922	White and Miller	Asph.	5"		40.0	1.57½	

YAVAPAI COUNTY

Sheldon Street	1922	Warren Brothers Company	Asph.	5"	3083 sq. yds.		2.58	

PIMA COUNTY

West Congress Street	1922	Borderland Constr. Company	Asph.	5"	5000 sq. yds.		1.65	

CITY OF PRESCOTT

Cortez-Goodwin-Montezuma and Gurley Streets	1922	Warren Brothers Company	Asph.	4" conc. 2" asph.	45,600 sq. yds.		3.15	(2)
S. Pleasant Street	1922	Phoenix-Tempe Stone Co.	Conc.	5"	8000 sq. yds.		2.70	(2)
Montezuma and Willis Sts.	1922	Warren Brothers Company	Asph.	5"	8000 sq. yds.		2.77	(2)
Sheldon Street	1922	Warren Brothers Company	Asph.	5"	3000 sq. yds.		2.58	

Note: (1) indicates no award made.
(2) indicates payment made with Street Improvement Bonds.

CITY OF PHOENIX

Project	Date	Contractor	Type	Av. In. Thickness	Length Miles	Cost Per Sq. Yd.	
E. Culver Street	1921	White and Miller	Asph.	4	.5	2.51	(2)
E. Portland Street	1921	R. L. Ballenger	Asph.	5	.5	2.70	(2)
E. Washington Street	1921	Twohy Brothers Company	Conc.	6	1.2	2.92	(2)
West Adams Street	1921	Southwest Contracting Co.	Asph.	4	1.03	2.12	(2)
E. Van Buren Street	1921	Southwest Contracting Co.	Asph.	4" conc. 2" asph.	1.5	2.67	(2)
Fifth Avenue	1921	Warren Brothers Company	Asph.	4"	.30	2.27	(2)
W. McDowell Road	1921	Twohy Brothers Company	Conc.	6"	.75	2.95	(2)
West Jefferson Street	1922	Warren Brothers Company	Asph.	5"	.9	2.67	(2)
Sixth Street	1922	R. L. Ballenger	Asph.	4" conc. 2" asph.	.58	2.85	(2)
Buchanan Street	1922	Warren Brothers Company	Asph.	4" conc. 2" asph.	.21	2.77	(2)
First Street	1922	Warren Brothers Company	Asph.	4"	.4	2.40	(2)
First Street	1922	Warren Brothers Company	Asph.	5"	1.2	2.65	(2)
E. Garfield Street	1922	Warren Brothers Company	Asph.	5"	.1	2.55	(2)
Almeria Road, Palm Street	1922	Phoenix-Tempe Stone Co.	Conc.	5"		2.18½	(2)

PINAL COUNTY HIGHWAY COMMISSION

Superior—Street	1920		Conc.	6¾"	.25	4.25	
Ray—Street	1920		Conc.	7-5/12"	1.00	3.04	

TOWN OF GLENDALE

	1922	J. L. Hoopes	Conc.	5"		2.25	(2)
	1922	J. L. Hoopes	Conc.	6"		2.60	(2)

STATE OF ARIZONA

Project	Date	Contractor	Type	Av. In. Thick-ness	Length Miles	Cost Per Sq. Yd.	
Phoenix-Tempe	1918–19	Force Account	Conc.	5″	3.80	$2.22	
Tempe Paving	1919	Southwestern Contr. Co.	Asph.	2″ asph. 5″ conc.	1.10	2.42	
Tempe-Mesa	1919	O. C. McElrath	Conc.	6-1/6″	5.50	2.34	
Tucson-Oracle	1920	West Coast Constr. Co.	Conc.	6-1/6″	4.00	2.27	
Tucson-Nogales	1921	J. L. Hoopes	Conc.	6-1/6″	8.85	2.26	
Bisbee-Douglas	1920	G. H. Oswald	Conc.	6-1/6/	4.00	2.86	
Bisbee-Douglas	1920	McPeak & Dillon	Conc.	6-1/6″	4.50	3.17	
Flagstaff	1920	Warren Brothers	Asph.	6″	1.10	3.43	
Phoenix-Glendale	1921	Dan La Roe	Conc.	6-1/6″	7.00	2.29	
Phoenix-Tempe	1921	White and Miller	Asph.	6″	3.00	2.25	
Flagstaff Paving	1922	Warren Brothers Co.	Asph.	6″	.47	3.09	
Mesa Paving	1922	Pacific Const. Co.	Asph.	6″	.50	2.18	
Bisbee-Tombstone	1922	White and Miller	Asph.	2½″	10.00	1.09	
Winslow Paving	1921		Asph.	6″	.94	3.86	(1)
Winslow Paving	1922	Warren Brothers Co.	Asph.	6″	.94	2.99	
Nogales-Willows	1922	B. J. Pearce	Conc.	6-1/6″	2.33	2.17	
Grand Ave. Paving	1922	Pacific Const. Co.	Asph.	6″	.50	2.25	
Geronimo-Solomonville	1922	Lee Moor Contr. Co	Conc.	6-1/6″	6.14	2.01	
Mesa East	1922	Twohy Brothers Company	Conc.	6-1/3″	4.1	2.25	
Glendale-Marinette	1922	Twohy Brothers Company	Conc.	6-1/3″	7.79	2.24	

ADMINISTRATION BUILDING—AUDITING DEPARTMENT.

ACCOUNTING DEPARTMENT

By W. R. Inghram, Chief Clerk

The work of the Accounting Department falls roughly into three divisions—purchasing, auditing and general supervision. All purchases with the exception of emergency buying by camp engineers and suuperintendents are made through the purchasing agent. The records of all highway funds and disbursements therefrom are handled by the Auditing Department, the central offices of which are maintained in a large room on the second floor of the Administration Building. General correspondence relating in any way to expenditures or accounting as well as general supervision of the Accounting Department is under the Chief Clerk.

The steadily increased volume of highway improvement made by the Arizona Highway Department and the counties which have seen fit to place their construction under State supervision has developed in the Accounting Department a personnel qualified to meet the requirements. In this connection it is interesting to note that despite a three-fold increase in the scope of highway activities, the number of employes in this department has been held to that of two years ago. High-class efficiency has been maintained in the Accounting Department, and this, together with the simplification of methods touched on above, has made possible the results obtained.

SYSTEM SIMPLIFIED

Several important improvements have been effected during the last two years in the auditing division. Most notable is that involving the handling of claims and is based on the economic practice of grouping several invoices of the same vendor under one claim, thus simplilying not only the work of the Highway Department, but that of the State Auditor and State Treasurer as well.

Some idea of the value of the new system may be gained from a comparison of the number of claims handled before and after its inauguration. For the fiscal years 1918-19 and

ADMINISTRATION BUILDING— GENERAL OFFICE.

1919-20 a total of 13,645 claims were written and these amounted to $2,401,651.25. For the fiscal years 1920-21 and 1921-22 the total number of claims was reduced to 10,088, and this notwithstanding the fact that the amount of the claims was increased nearly threefold, or to $6,601,722.21, and that the number of individual invoices was three times greater during the last-mentioned period than during the former.

PROJECT LIABILITY SHOWN

A very successful system of handling requisitions and invoices was adopted July 1, 1921. Under this system the department keeps check, not only of the expenditures of each project as they are paid, but of the outstanding orders as well, thus showing at all times the liability against each piece of construction.

The work of the Accounting Department extends to every road camp where State forces are engaged, the records of every camp being checked at least once a month by the traveling auditor. Each camp is provided with a cashier, under bond, who is held responsible for the payroll and all other disbursements. If the size of the camp justifies a timekeeper is also provided. Detailed unit cost records are kept at each camp, and a study of the rise and fall of these costs under changing conditions constitutes one of the most valuable aids to practical road engineering.

PURCHASING AGENT

Though approximately 90 per cent of all purchases are made through the Purchasing Agent at a tremendous saving to the State, camp superintendents are authorized to make purchases direct from the nearest dealer in cases of emergency, the aim being to eliminate delays.

BONDED EMPLOYES

The bonding of employes of the Highway Department is under the Chief Clerk. Any employe who is placed in charge of any cash or equipment is required to give surety proportionate to the maximum amount of State property which may be in his charge at any time. The bond of the State Engineer is $50,000.00 and that of the Chief Clerk is $50,000.00, and from this figure bonds ranging all the way down to $1,000 for resident engineers and inspectors are required. The total amount of highway employes' bonds is $305,000.00.

CRAMPED IMPREST FUND

Operations of the Accounting Department have been hampered materially by the inadequacy of the Imprest Fund. The needs of the department have long since outgrown the $50,000 fund originally allowed for this purpose by the legislature. The truth of this statement will become evident with the disclosure that the monthly payroll of the Arizona Highway Department will average $150,000. Owing to the length of time required to secure approval of the Board of Directors of State Institutions, the State Auditor's and Governor's office, it is impossible to secure the reimbursement of Imprest funds soon enough to secure the semi-monthly payrolls, and the situation is worse in the case of a county claim, which has to go before the Board of Supervisors as well as the other checking agencies mentioned before it can be acted upon. To make the department function properly, the Imprest fund should be increased from $50,000 to at least $150,000.

Here lies the body of William Jay,
Who died maintaining his right of way;
He was right, dead right, as he sped along,
But he's just as dead as if he'd been wrong.

"There was a man who fancied,
By driving good and fast,
He could get his car across the track
Before the train came past.

"He would miss the engine by an inch
And make the train crew sore.
There was a man who fancied this,
But—there isn't any more!"

In addition to the automobile used by the State Engineer, seven other State cars are in use by employes of the Highway Department. They are assigned as follows: One for the General Office; a general utility car used by the Bridge Enginer, Chief Locating Engineer, Superintendent of Equipment, and Paving Engineer; two machines for the Construction Department, one of which is kept in Northern Arizona, and the other in Central and Southern Arizona; a car is also assigned to each of the Maintenance Engineers in the Northern, Central, and Southern Districts.

RECAPITULATION

STATUS OF FUNDS

July 1, 1920—June 30, 1922

	Total Receipts	Claims Paid	Balance
Apache County	$ 22,515.18	$ 22,515.18	$.....
Cochise County	191,675.71	191,673.67	2.04
Coconino County	38,991.44	38,991.44	.....
Gila County	165,464.10	165,464.10	.....
Graham County	19,753.29	19,753.29	.....
Greenlee County	59,272.43	59,272.43	.....
Maricopa County	161,436.24	161,436.24	.....
Mohave County	40,875.04	40,875.04	.....
Navajo County	24,001.00	22,246.74	1,754.26
Pima County	75,439.52	71,398.77	4,040.75
Pinal County	87,576.17	87,576.17	.....
Santa Cruz County	17,082.62	17,082.62	.....
Yavapai County	148,141.60	148,141.60	.....
Yuma County	42,175.74	37,634.14	4,541.60
25% Fund	4,506,353.63	4,234,561.63	271,792.00
Senate Bill No. 51	1,107,184.07	956,822.36	150,361.71
General Fund	227,277.34	226,276.79	1,000.55
Total	$6,935,215.12	$6,501,722.21	$433,492.91

RECAPITULATION

NET EXPENDITURES

July 1, 1920–June 30, 1922

County	Distribution				Funds				
	Indirect	Engineering	Construction	Maintenance	25%	75%	S. B. 51	General	
Apache		$ 10,440.13	$ 43,331.27	$ 8,419.65	39,675.87	22,515.18			5
Cochise		23,502.29	511,023.70	34,861.21	297,720.03	191,667.17	80,000.00		3
Coconino		1,849.38	356,662.28	10,676.92	280,197.14	38,991.44	25,000.00	25,000.00	3
Gila		12,582.29	293,578.18	29,601.25	104,215.11	165,074.75	66,471.86		1
Graham		6,330.69	121,151.15	14,000.80	35,422.97	19,753.29	24,055.17	62,251.21	1
Greenlee		6,841.48	167,649.51	12,003.38	130,554.77	55,939.60			6
Maricopa		18,855.47	662,114.08	11,555.08	342,527.85	161,436.24	107,709.15	80,851.39	2
Mohave		19,786.92	243,568.93	19,724.55	230,783.83	39,891.33		12,405.24	
Navajo		7,730.79	30,300.12	2,421.36	14,244.36	22,246.74	3,961.17		6
Pima		16,218.48	601,829.17	43,591.11	563,339.48	71,391.07	26,908.21		7
Pinal		11,816.79	741,127.74	20,029.58	559,526.34	79,859.17	133,528.14	60.46	2
Santa Cruz		5,152.31	219,952.71	22,466.34	216,025.18	17,082.62	14,463.56		5
Yavapai		7,556.96	571,664.51	12,997.47	373,526.51	146,151.40	72,541.03		2
Yuma		2,074.84	197,011.80	3,026.72	34,479.22	37,634.14	100,000.00	30,000.00	
State Engr's Salary	9,903.22							9,903.22	
State Engr's Expense	3,999.45							3,999.45	
General	611,398.80				611,398.80				6
Totals	$625,301.47	$ 150,738.82	$4,760,965.15	$ 245,375.42	$3,833,637.46	$1,069,634.14	$ 654,638.29	$ 224,470.97	$5,7

TWENTY-FIVE PER CENT FUND

RECEIPTS and DISBURSEMENTS

July 1, 1920—June 30, 1922

	Total	Claims Paid	Balance
Balance, July 1, 1920	$ 206.53	$	$
Tax Apportionment, 1920-1921	221,110.78		
Tax Apportionment, 1920-1921 (Prison)	60,000.00		
Tax Apportionment, 1921-1922	103,817.05		
Tax Apportionment, 1921-1922 (Prison)	60,000.00		
Federal Aid	2,333,091.23		
Motor Vehicle Fees	402,806.97		
Gasoline Tax	150,257.85		
County Aid	592,765.66		
Refunds	582,264.22		
Peddlers' License	33.34		
Claims Paid		4,234,561.63	
Total	$4,506,353.63	$4,234,561.63	$271,792.00

SEVENTY-FIVE PER CENT FUND

RECEIPTS and DISBURSEMENTS

July 1, 1920—June 30, 1922

County	Balance July 1, 1920	Tax Appor. 1920-1921	Tax Appor. 1921-1922	Refunds and County Aid	Federal Aid	Total Revenue	Claims Paid	Jun
Apache	$12,052.38	$ 7,037.55	$ 3,425.25	$	$	$ 22,515.18	$ 22,515.18	$
Cochise	1,042.52	132,029.91	58,596.78	6.50		191,675.71	191,673.67	
Coconino	1,745.46	17,126.57	7,877.67		12,241.74	38,991.44	38,991.44	
Gila	1.69	110,332.50	54,740.56	389.35		165,464.10	165,464.10	
Graham	4,262.48	10,433.11	5,057.70			19,753.29	19,753.29	
Greenlee	11,150.07	31,475.99	13,313.54	3,332.83		59,272.43	59,272.43	
Maricopa	12,060.70	100,684.91	48,690.63			161,436.24	161,436.24	
Mohave	13,774.48	17,519.65	8,597.20	983.71		40,875.04	40,875.04	
Navajo	10,178.04	9,265.65	4,554.63	2.68		24,001.00	22,246.74	
Pima	5.61	47,773.12	22,992.90	4,667.89		75,439.52	71,398.77	
Pinal		55,331.16	24,528.01	7,717.00		87,576.17	87,576.17	
Santa Cruz	2,614.06	9,586.06	4,882.50			17,082.62	17,082.62	
Yavapai	2,733.01	97,533.32	45,885.07	1,990.20		148,141.60	148,141.60	
Yuma	16,664.04	17,202.90	8,308.80			42,175.74	37,634.14	
Total	$88,284.54	$663,332.40	$311,451.24	$19,090.16	$12,241.74	$1,094,400.08	$1,084,061.43	$

GENERAL FUND

RECEIPTS and DISBURSEMENTS

July 1, 1920—June 30, 1922

	Balance July 1, 1920	Appropriation	Refunds	Cancelled	Total	Claims Paid
State Engineer's Salary	$	$ 9,903.22	$	$	$ 9,903.22	$ 9,903.22
State Engineer's Expense		5,000.00			5,000.00	3,999.45
Agua Fria Bridge	25,372.50	10,000.00	2,324.70		37,697.20	37,697.20
Arrowhead Trail	12,405.24				12,405.24	12,405.24
Arrowhead Trail (Colorado Bridge)	40,000.00			40,000.00		
Lee's Ferry	10,000.00			10,000.00		
Oak Creek Bridge	10,000.00			10,000.00		
Parker Highway	30,000.00		1,805.82		31,805.82	31,805.82
Sacaton Power Line	50,000.00			50,000.00		
San Carlos Bridge	62,251.21				62,251.21	62,251.21
Superior-Miami	60.46				60.46	60.46
Tempe Bridge	13,154.19	30,000.00			43,154.19	43,154.19
Williams-Ash Fork	25,000.00				25,000.00	25,000.00
Total	$278,243.60	$ 54,903.22	$ 4,130.52	$110,000.00	$227,277.34	$226,276.79

SENATE BILL NO. 51

RECEIPTS and DISBURSEMENTS

July 1, 1920—June 30, 1922

	Appropriation	Refunds	Total	Claims Paid	B
Apache Trail	$ 75,000.00	$.....	$ 75,000.00	$ 40,713.67	$ 3
Ash Fork-Nelson	50,000.00	9,000.26	59,000.26	56,541.29	
Douglas-Rodeo	40,000.00	92,968.84	132,968.84	132,968.84	.....
Geronimo-Solomonville	50,000.00	.....	50,000.00	24,055.17	2
Nogales-Fairbank	40,000.00	.....	40,000.00	40,000.00	.....
Phoenix-Yuma	100,000.00	1,760.49	101,760.49	68,755.97	3
Prescott-Jerome	25,000.00	2,638.99	27,638.99	27,638.99	.....
Superior-Miami	200,000.00	65,808.17	265,808.17	265,808.17	.....
Tucson-Nogales Bridges	75,000.00	978.63	75,978.63	42,350.40	3
Williams-Ash Fork	25,000.00	117,718.27	142,718.27	142,718.27	.....
Winslow-Holbrook	25,000.00	.....	25,000.00	3,961.17	2
Yuma-Wellton	100,000.00	11,310.42	111,310.42	111,310.42	.....
Total	$805,000.00	$302,184.07	$1,107,184.07	$956,822.36	$15

APACHE COUNTY

July 1, 1920—June 30, 1922

Project	Distribution			Funds		
	Engineering	Construction	Maintenance	25%	75%	
Adamana-Lupton	$ 1,612.20	$ 1,030.06	$	$ 2,642.26	$	$
Holbrook-Gallup No. 1	25.13				25.13	
Holbrook-St. Johns Survey	401.75			401.75		
Holbrook-St. Johns 4A	1,664.86	13,078.51		136.63	14,606.74	
Holbrook-St. Johns 4B	4,602.52	29,222.70		30,761.58	3,063.64	
Holbrook-St. Johns (Concho Bridge)	168.80			168.80		
Holbrook-St. Johns			8,419.65	3,599.98	4,819.67	
St. Johns-Springerville	1,964.87			1,964.87		
Total County	$10,440.13	$43,331.27	$8,419.65	$39,675.87	$22,515.18	$

COCHISE COUNTY

July 1, 1920—June 30, 1922

Project	Distribution			Funds			
	Engineering	Construction	Maintenance	25%	75%	S. B. 51	
Benson-Vail, Sec. D	$ 1,332.34	$ 14,818.02	$	$ 7,450.24	$ 8,700.12	$	$
Benson-Vail, Sec. E	4,767.52	68,237.55		60,277.56	12,727.51		
Bisbee-Douglas Survey	419.57				419.57		
Bisbee-Douglas 2A	34.38	74,761.49			74,795.87		
Bisbee-Douglas 2B	1,808.13	61,011.81		22,790.98	40,028.96		
Douglas-Rodeo A–C	6,605.10	46,125.94		37,062.53	7,604.35	8,064.16	
Douglas-Rodeo D	363.14				363.14		
Douglas-Rodeo No. 2	7,565.68	175,903.21		105,493.26	46,039.79	31,935.84	1
Bisbee-Tombstone (Bisbee Hill)	338.08			338.08			
Bisbee-Tombstone Paving	35.75			35.75			
Nogales-Fairbank No. 49	232.60	70,165.68		30,398.28		40,000.00	
Douglas-Rodeo			14,060.31	13,772.90	287.41		
Bisbee-Douglas			1,101.39	1,101.39			
Bisbee-Tombstone			18,328.42	17,642.97	685.45		
Tucson-Benson			1,371.09	1,356.09	15.00		
Total County	$23,502.29	$511,023.70	$34,861.21	$297,720.03	$191,667.17	$80,000.00	$5

COCONINO COUNTY.

July 1, 1920—June 30, 1922

Project	Distribution			Funds				
	Engineering	Construction	Maintenance	25%	75%	S. B. 51	General	
Flagstaff-Williams A & B	*$ 379.56	$124,624.74	$	$116,693.36	$ 7,551.82	$	$	$1
Flagstaff-Williams 2RC	145.25	27,489.90		2,980.97	24,654.18			
Flagstaff Paving	747.84	23,251.59		23,999.43				
Flagstaff Paving, West	130.28			130.28				
Flagstaff-Williams 3-4		8.72			8.72			
County Aid Returned		9,424.18		9,424.18				
Williams-Ash Fork A	419.98	63,752.12		48,378.54	326.45	*1,832.07	17,299.18	
Williams-Ash Fork B	785.59	70,307.28		44,223.97		19,168.08	7,700.82	
Williams-Ash Fork C		37,803.75		30,139.76		7,663.99		
Flagstaff-Williams			10,438.92	4,226.65	6,212.27			
Ash Fork-Nelson			238.00		238.00			
Total County	$1,849.38	$356,662.28	$10,676.92	$280,197.14	$38,991.44	$25,000.00	$25,000.00	$3

* Credit.

GILA COUNTY

July 1, 1920—June 30, 1922

Project	Distribution			Funds			
	Engineering	Construction	Maintenance	25%	75%	S. B. 51	
Globe-Geronimo A	$ 843.28	$ 22,900.24		$ 11,946.49	$ 11,797.03	$	$
Globe-Geronimo B	24.26	52,444.68		135.83	52,333.11		
Globe-Roosevelt 1 B	40.70	110.09		146.79	4.00		
Superior-Miami E	3,761.49	54,910.75		17,991.27	21,685.53	18,995.44	
Superior-Miami F	7,231.28	127,376.51		37,862.71	65,185.48	31,559.60	13
Superior-Miami G	24.55	26,062.07		20,278.34		5,808.28	
Superior-Miami K	656.73	9,773.84		77.86	244.17	10,108.54	
Superior-Miami			2,864.05	2,117.05	747.00		
Globe-Roosevelt			21,966.97	10,533.98	11,432.99		
Globe-San Carlos			4,770.23	3,124.79	1,645.44		
Total County	$12,582.29	$293,578.18	$29,601.25	$104,215.11	$165,074.75	$66,471.86	$33

GRAHAM COUNTY

July 1, 1920---June 30, 1922

Project	Distribution			Funds				
	Engineering	Construction	Maintenance	25%	75%	S. B. 51	General	
Globe-Geronimo D	$ 76.62	$ 40,958.25	.....	$28,833.47	$12,201.40	$.....	$.....	$
Globe-Geronimo C	3,033.71	59,082.02	.....	*135.48	.....	.....	62,251.21	
Geronimo-Solomonville	3,220.36	21,110.88	.....	265.38	10.69	24,055..	.....	
Clifton-Solomonville	.....	.....	3,243.13	48.55	3,194.58	.....	.....	
Solomonville-San Carlos	.....	.....	10,757.67	6,411.05	4,346.62	.....	.....	
Total County	$6,330.69	$121,151.15	$14,000.80	$35,422.97	$19,753.29	$24,055.17	$62,251.21	$14

* Credit.

GREENLEE COUNTY

July 1, 1920—June 30, 1922

Project	Distribution			Funds		
	Engineering	Construction	Maintenance	25%	75%	
Clifton-Franklin (Contract 1)	$ 269.70	$ 3,512.69	$	$ 3,782.39	$	$
Clifton-Franklin (Contract 2)	1,732.00	36,522.25		34,686.60	3,567.65	
Clifton-Franklin (R. R. Wash Bridge)	440.26	9,065.62		7,664.51	1,841.37	
Clifton-Mule Creek	4,399.52	95,952.85		80,758.47	19,593.90	1
Clifton-Solomonville (Black Gap Bridge)		946.14			946.14	
Clifton-Solomonville 2		21,547.67			21,547.67	
Clifton-Solomonville 2A		102.29			102.29	
Clifton-Solomonville			11,002.43	3,662.80	7,339.63	
Clifton-Franklin			1,000.95		1,000.95	
Total County	$6,841.48	$167,649.51	$12,003.38	$130,554.77	$55,939.60	$1

MARICOPA COUNTY

July 1, 1920—June 30, 1922

Project	Distribution: Engineering	Construction	Maintenance	Funds: 25%	75%	S. B. 51	General	
Agua Fria Bridge	$.....	$ 41,105.37	$ 887.66	$ 4,068.93	$ 226.90	$	$37,697.20	$
Agua Fria Br. Surfacing	.....	554.72	.....	554.72	.....	.....	.....	
Apache Trail	152.45	40,561.22	.....	.....	.....	40,713.67	.....	
Cave Creek Flood Control	1,029.62	109.25	.....	1,138.87	.....	.....	.....	
Marinette Bridge	18.00	53,630.58	121.25	*941.90	54,711.73	.....	.....	
Mesa Paving	623.00	.....	.....	623.00	.....	.....	.....	
Phoenix-Buckeye	1,822.85	6,280.19	1,543.90	8,034.69	1,612.25	.....	.....	
Phoenix-Glendale	9,406.29	195,941.30	95.02	205,092.59	350.02	.....	.....	2
Phoenix-Yuma-Arlington Bridge	436.00	22,638.29	.....	6,191.55	2,050.13	14,832.61	.....	
Phoenix-Yuma-Arlington-Gillespie Dam	549.23	354.75	.....	.....	.....	903.98	.....	
Phoenix-Yuma-Gila Bend-Gillespie Dam	400.20	50,093.82	.....	.....	.....	50,494.02	.....	
Phoenix-Yuma-Gila Bend-Piedra	31.00	290.05	.....	.....	.....	321.05	.....	
Phoenix-Yuma-Piedra-Stanwix	148.20	295.62	.....	.....	.....	443.82	.....	
Phoenix-Yuma Survey	330.64	.....	.....	330.64	.....	.....	.....	
Phoenix-Tempe 1	2,203.92	75,552.43	.....	77,756.35	.....	.....	.....	
Phoenix-Tempe 2	5.50	390.12	.....	390.12	5.50	.....	.....	
Tempe Bridge	2.19	44,998.84	.....	1,846.84	.....	.....	43,154.19	
Tempe-Mesa 1	28.99	7,734.85	.....	7,763.84	.....	.....	.....	
Tempe-Mesa 2	278.03	49,188.39	.....	*5,130.76	54,597.18	.....	.....	
Wickenburg Bridge	1,288.78	68,850.61	207.43	26,272.96	44,073.86	.....	.....	
Wickenburg-Hot Sprs. Jct.	100.58	3,543.68	.....	3,644.26	.....	.....	.....	
Arlington Bridge	.....	.....	74.91	.....	74.91	.....	.....	
Arlington-Caliente	.....	.....	101.67	.....	101.67	.....	.....	
Phoenix-Mesa	.....	.....	8,467.24	4,891.15	3,576.09	.....	.....	
Mesa-Florence	.....	.....	56.00	.....	56.00	.....	.....	
Total County	$18,855.47	$662,114.08	$11,555.08	$342,527.85	$161,436.24	$107,709.15	$80,851.39	$6

* Credit.

MOHAVE COUNTY

July 1, 1920—June 30, 1922

Project	Distribution			Funds			
	Engineering	Construction	Maintenance	25%	75%	General	
Arrowhead Trail Survey	$ 18.35	$	$	$ 18.35	$	$	$
Arrowhead Trail 1	338.97	3,738.40	.....	*1,777.00	.....	5,854.37	
Arrowhead Trail 2	3,945.33	2,613.71	.....	8.17	.....	6,550.87	
Crozier Canyon	485.81	135.00	.....	332.30	288.51	.....	
Kingman East	1,422.36	.....	.....	1,397.21	25.15	.....	
Kingman-Oatman	.....	.....	3,554.66	1,788.20	1,766.46	.....	
Oatman-Goldroad 1	3,777.57	57,816.15	2,092.68	33,117.27	30,569.13	.....	
Oatman-Goldroad 2	.....	9,948.38	.....	9,948.38	.....	.....	
Topock Bridge	.....	.....	482.68	.....	482.68	.....	
Topock-Oatman 1	9,777.68	168,297.67	13,594.53	185,171.23	6,498.65	.....	
Topock-Oatman 2	20.85	1,019.62	.....	779.72	260.75	.....	
Total County	$19,786.92	$243,568.93	$19,724.55	$230,783.83	$39,891.33	$12,405.24	$2

* Credit.

NAVAJO COUNTY

July 1, 1920—June 30, 1922

Project	Distribution			Funds		
	Engineering	Construction	Maintenance	25%	75%	S. B. No. 51
Winslow-Coconino County Line	$.....	$ 391.25	$.....	$ 391.25	$.....	$.....
Holbrook-St. Johns (Petrified Forest)	3,949.95	26,683.92	.....	12,053.03	18,580.84	.....
Holbrook-St. Johns 5	1,441.34	.....	.....	1,441.34	.....	.....
Holbrook-Winslow Survey	1,499.27	.....	.....	193.98	1,244.54	60.75
Holbrook-Winslow 1	163.94	583.20	.....	.....	.....	747.14
Holbrook-Winslow 2	152.29	.....	.....	.....	.....	152.29
Holbrook-Winslow 3	103.37	1,248.28	.....	.....	.....	1,351.65
Holbrook-Winslow 4	255.87	1,393.47	.....	.....	.....	1,649.34
Winslow Paving	164.76	.....	.....	164.76	.....	.....
Holbrook-St. Johns	.....	.....	2,421.36	2,421.36	.....	.....
Total County	$7,730.79	$30,300.12	$2,421.36	$14,244.36	$22,246.74	$3,961.17

PIMA COUNTY

July 1, 1920—June 30, 1922

Project	Distribution			Funds			
	Engineering	Construction	Maintenance	25%	75%	S. B. No. 51	
Benson-Vail A	$ 127.91	$ 37,815.75	$.....	$ 37,871.16	$ 72.50	$.....	$
Benson-Vail B	147.39	110,235.25	.....	110,347.94	34.70	.....	1
Benson-Vail C	1,468.69	27,721.79	.....	24,499.78	4,690.70	.....	
Benson-Vail (Mescal Wash Br.)	709.47	12,935.12	.....	13,644.59	.....	.....	
Benson-Vail (Cienega Br.)	1,363.11	38,972.69	.....	40,335.80	.....	.....	
Tucson-Florence	449.38	330.31	11,869.13	1,966.34	10,682.48	.....	
Tucson-Florence Paving	3,492.45	12,776.96	.....	*8,361.45	24,630.86	.....	
Tucson-Nogales Bridges	2,232.96	23,775.39	.....	*899.86	.....	26,908.21	
Tucson-Nogales Paving A	6,227.12	252,074.82	.....	257,782.31	519.63	.....	2
Vail-Empire Contract	.....	85,191.09	.....	85,191.09	.....	.....	
Tucson-Nogales	.....	.....	12,192.72	471.62	11,721.10	.....	
Tucson-Benson	.....	.....	9,073.06	346.36	8,726.70	.....	
Rillito Creek Bridge	.....	.....	10.456.20	143.80	10,312.40	.....	
Total County	$16,218.48	$601,829.17	$43,591.11	$563,339.48	$71.391.07	$26.908.21	$6

* Credit.

PINAL COUNTY

July 1, 1920—June 30, 1922

Project	Distribution			Funds			
	Engineering	Construction	Maintenance	25%	75%	S. B. 51	General
Florence Bridge	$ 3.50	$ 152.63	$ 684.92	$ 841.05	$	$	$
Florence Bridge Extension		9,018.16	1,136.76		10,154.92		
Florence-Superior A & B	711.54	110,357.76	5,644.38	72,458.35	44,255.33		
Florence-Superior C		2,582.08		860.51	1,721.57		
Florence-Superior D	5,574.54	28,457.39		30,077.49	3,954.44		
Florence-Superior E	46.85	3,814.87		2,827.55	1,034.17		
Florence-Superior F	619.45	71.95		691.40			
Mesa-Superior 2B		7,348.92	8,392.63	3,236.07	12,505.48		
Ray-Superior	59.00	32,956.32		29,015.32	4,000.00		
Superior-Miami A B C	31.45	163,694.41	1,158.86	116,727.13		48,157.59	
Superior Miami D	1.72	159,005.97		74,548.22		84,459.47	
Superior-Miami E	499.46	75,821.05		75,456.18		864.33	
Superior-Miami H	47.83	3,544.00		3,567.83		24.00	
Superior-Miami J	22.75					22.75	
Superior-Miami (Prison)		120,000.00		120,000.00			
Superior-Miami (Pilot Road)		146.68		86.22			60.46
Superior-Miami (Concrete Pipe)		1,454.21		1,454.21			
Tucson-Florence	4,198.70	22,701.34	3,012.03	27,678.81	2,233.26		
Total County	$11,816.79	$741,127.74	$20,029.58	$559,526.34	$79,859.17	$133,528.14	$60.46

SANTA CRUZ COUNTY

July 1, 1920--June 30, 1922

Project	Distribution			Funds			
	Engineering	Construction	Maintenance	25%	75%	S. B. No. 51	
Nogales-Fairbank A	$2,298.31	$ 41,781.94		$ 43,959.18	$ 121.07	$	$
Nogales-Fairbank B	119.99	31,575.35		31,695.34			
Nogales-Fairbank 50	393.09	132,657.00		133,050.09			
Nogales-Tucson			20,369.75	3,442.45	16,927.30		
Nogales-Willows Paving	797.81.			797.81			
Nogales-Fairbank			2,096.59	2,092.34	4.25		
Tucson-Nogales Bridges	555.14	13,938.42			30.00	14,463.56	
Vail-Sonoita	987.97			987.97			
Total County	$5,152.31	$219,952.71	$22,466.34	$216,025.18	$17,082.62	$14,463.56	$

YAVAPAI COUNTY

July 1, 1920—June 30, 1922

Project	Distribution			Fund			
	Engineering	Construction	Maintenance	25%	75%	S. B. 51	General
Ash Fork-Chino-Nelson 1-2	$1,791.98	$ 47,611.41	$ 222.63	$ 2,084.99	$		$47,541.03
Ash Fork-Pinevita		30,845.65		30,845.65			
Ash Fork-Seligman	307.03					307.03	
Cottonwood Bridge	474.56	21,112.26		11,347.05		10,239.77	
Prescott-Jerome	186.68	1,408.46				648.80	946.34
Prescott-Jerome 1	785.69	8,482.71		7,068.66		2,199.74	
Prescott-Jerome 2A	431.01	125,698.82		72,713.30		53,324.96	91.57
Prescott-Jerome 2B	249.77	56,197.10		24,081.52		35,801.56	*3,436.21
Prescott-Jerome 4A	66.02	37,381.03		*441.76		17,709.07	20,179.74
Prescodtt-Jerome 4B	43.02	46,612.39		22,546.37		18,509.48	5,599.56
Prescott-Jerome (Granite Creek Bridge)	167.13	14,648.28		9,935.49		3,567.51	1,312.41
Prescott-Jerome 5	2,284.94	23,023.93		25,002.28			306.59
Prescott-Jerome 5 (Granite Creek Crossing)	692.98	8,565.92		9,258.90			
Prescott-Jerome			10,327.95	7,277.59		3,050.36	
Prescott-Flagstaff			873.68	624.00		249.68	
Prescott-Phoenix (Senator Mt.)			570.95	430.95		140.00	
Prescott-Phoenix			1,002.26	598.82		403.44	
Prescott-Ash Fork		10,478.08		24,412.51			
Prescott-Jerome (Yeager Canyon)		24,412.51		10,478.08			
Pineveta-Crookton		25,913.99		25,913.99			
Seligman-Chino		14,061.83		14,061.83			
Seligman-Crookton	76.15	55,173.63		55,249.78			
Wickenburg-Congress Jct.		20,036.51		20,036.51			
Total County	$7,556.96	$571,664.51	$12,997.47	$373,526.51		$146,151.40	$72,541.03

* Credit.

YUMA COUNTY

July 1, 1920—June 30, 1922

Project	Distribution			und				
	Engineering	Construction	Maintenance	25%		75%	S. B. No. 51	
Antelope Hill Bridge	$ 70.66	$ 14,406.27	.....	$ 630.97	$.....	$ 13,845.96	$.....	$
Colorado River Bridge	.....	733.31	.....	.....	733.31	.....	.....	
Parker Highway	.....	30,000.00	121.50	.....	121.50	.....	30,000.00	
Yuma-Wellton B	33.40	129,373.72	2,905.22	26,714.73	36,779.33	68,818.28	.....	
Yuma-Wellton D	1,970.78	22,498.50	.....	7,133.52	.....	17,335.76	.....	
Total County	$2,074.84	$197,011.80	$3,026.72	$34,479.22	$37,634.14	$100,000.00	$30,000.00	$

GENERAL ACCOUNTS

July 1, 1920—June 30, 1922

General Office Expense		
Postage, Freight and Express	$ 2,120.74	
Telephone and Telegraph	3,061.73	
Drafting and Engineering Equipment	1,713.07	
Drafting and Engineering Supplies	7,349.42	
Engineering Office Salaries	91,254.35	
Accounting Office Salaries	73,866.02	
Traveling Expense	2,356.79	
Accounting Office Supplies	5,713.39	
Blue Prints and Photographs	783.58	
Magazines and Newspapers	225.75	
General Office Supplies	2,906.73	191,351.57
General Expense		
Salaries not charged to Projects	63.18	
Expense not charged to Projects	8,922.08	
Auto Expense not charged to Projects	768.23	
Bonding, Premiums and Insurance	1,602.02	
Miscellaneous	204.71	
Explosion Warehouse Yard	1,945.13	13,505.36
Suspense		
Motor Vehicle License Plates	2,500.00	2,500.00
General Equipment		
General Office Equipment	2,219.75	
Federal Equipment	113,284.31	
Auto Cars and Trucks	1,610.71	
Yard, Warehouse, Machine Shop Equipment	*85,870.15	
Field Camp Equipment	164,396.31	
Live Stock—(Horses and Mules)	3,388.48	
Maintenance Equipment	4,670.94	203,700.35
General Equipment Repairs		
Truck and Auto Operation	4,599.84	
Freight Charges a/c Camps, etc	2,991.55	
Federal Equipment (Parts and Accessories)	*7,145.06	
Labor: Warehouse, Yard and Machine Shop	85,605.55	
General Equipment Repairs: Parts	3,601.79	
Warehouse and Machine Shop Expense	2,921.98	
Oil and Gas	12,650.67	
Parts and Accessories Purchased	88,332.74	
Tools	257.86	193,816.92
Plants (General)		
State Screening Plant	2,897.32	
Tempe Crushing Plant	3,627.29	6,524.61
		611,398.80

* Credit.

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