# Estimate of User Taxes Paid by Vehicles in Different Type and Weight Groups 

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In this article an estimate is made of the amounts of state highway-user taxes paid by vehicles of different types and general size groups. Of the total of $\$ 3,088$ million of state motor-vehicle-tax payments made in 1952, fuel-tax payments accounted for $\$ 1,968$ million or 64 percent; registration-fee payments, $\$ 910$ million or 29 percent; motor-carrier-tax contributions, $\$ 64$ million or 2 percent; and drivers licenses, miscellaneous fees, etc., $\$ 146$ million or 5 percent.

Comparisons established in this study show that passenger cars represented 83 percent of all motor vehicles registered, accounted for 81 percent of the traffic on our highways, and contributed 65 percent of total state road-user-tax payments. If panel, pickup, and other light trucks are combined with passenger cars, the percentages become 93,89 , and 74 , respectively. Medium and heavy trucks and combinations accounted for 6 percent of the registrations, 10 percent of the traffic, and contributed 24 percent of the road-user payments. Tractor-semi-trailer and truck-trailer combinations included in the preceding group accounted for 1 percent of the registrations, 3 percent of the travel, and 12 percent of user-tax payments. Buses accounted for less than 1 percent of the registrations and travel, and 2 percent of the user-tax payments.

On the basis of user-tax payments per mile of travel, passenger cars and light trucks paid 0.5 cent per mile, buses paid 1.6 cents, and medium and heavy trucks and combinations paid 1.5 cents. The rate for truck combinations alone is slightly more than 2 cents per mile öf travel, tractor-semitrailer combinations paying 2.1 cents and truck-trailer combinations 2.7.

LAST year, there was presented before the Highway Research Board a comparison of the taxes imposed in different states on a selected group of vehicles. The sole purpose of that study was to compare the tax rates of the states, and no effort was made to compute the total or average tax payments of any group.

An entirely different, though related, matter is the total highway-user-tax payments on the different major groups of vehicles. Information on this subject is of considerable importance to highway authorities, legislatures, and vehicle operators in determining the equitability of the total tax burden on various groups of vehicles and in weighing the tax burden on the group against the costs of providing the service and the benefits derived from the service.

It cannot be overemphasized that the work presented here constitutes a series of estimates, and it is fully recognized that some may disagree with these methods or findiugs. Furthermore, it is possible, even probable, that given better basic data, or
more time for intensive study of individual phases of the estimates, it might be found necessary to modify or to revise them. But it is believed that the findings are sufficiently within the areas of reasonableness and general validity to be useful.

Although the principal value of this study lies in the findings, an outline of the data on which the study is based, together with a brief review of some of the problems encountered and the assumptions that were made, should be useful to those who may have occasion to evaluate or apply the findings.

In 1952 the states collected a net total of $\$ 1,967,831,000$ in motor-fuel taxes and related fees. The total registration fees and associated revenues amounted to $\$ 1,069,439,000$, but for practical purposes, the $\$ 12,859,000$ of fines and penalties received have been eliminated, leaving a remainder of $\$ 1,056,580,000$. This was done on the theory that fines and penalties are not actually road-user revenues, even though they are miscellaneous re-
ceipts of the highway departments in some states. State motor-carrier taxes collected during the year amounted to $\$ 64,036,000$. The total of the state road-user taxes considered in this study is, therefore, $\$ 3,088,477,000$.

Precise information is available on the amounts of state registration fees that were paid by automobiles, the amounts that were paid by trucks, and the amounts paid by busses. Various related fees, such as drivers' and chauffeurs' hicenses, title fees, etc., can be allocated to various classes of vehicles without fear of substantial error. Motor-carrier taxes can also be allocated with some degree of confidence. Their payment is accounted for, primarily, by busses and heavier trucks.

At first glance it might seem that the allocation of gasoline-tax payments to the various groups of vehicles should be fairly easy; but this is not the case. To assign gasoline-tax payments to the various groups of vehicles requires the determination of the amounts of travel of each group of vehicles; and this is particularly important among the groups of trucks, since different rates of fuel consumption are assigned to each group. The formulation of an acceptable fuel-consumption curve is, in it-
self, no small task, and relatively minor changes in the rates of fuel consumption assigned would make substantial changes in the computed tax payments. The yield from fuel taxes accounts for approximately two thirds of all road-user-tax payments. According to the results of this study, motor-fuel taxes constitute 68.1 percent of the total state road-user taxes on automobiles, 63.7 percent of the taxes on busses, and 56.1 percent of the taxes on trucks.

Wherever reference is made in this study to state motor-fuel-tax receipts, motorfuel usage, highway use of special fuels, and state motor-vehicle receipts, the data are taken from the Bureau of Public Roads' publication "Highway Statistics 1952". Such information is given therein in tables G-1, G-21, G-25, and MV-2, respectively.

## DETERMINATION OF VEHCLE CLASSIFICATIONS

## Gross-Weight Distribution

Although registrations and fee payments are segregated in state records by major types of vehicles, the further task of distributing numbers and fees among various


Figure 1. Basis of truck registration fees.

TABLE 1
estimated distribution of trucks and combinations by visual classification AND REGISTERED GROSS WeIghts 1952
(tn thousander of vehicles)

| Regletered Gross Welght | Single-unlt Trucks |  |  |  |  |  |  |  | Vehicle Combinations |  |  |  | Total |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Two axles, Four lires |  |  |  | Two axies, 8ix tires |  | Three axles |  | Tractor-semitraller |  | Truck-trailer |  |  |  |
|  | $\begin{array}{\|c\|} \hline \text { Ninber } \\ \text { of } \\ \text { vehicles } \end{array}$ | $\begin{aligned} & \text { Percentage } \\ & \text { of Total } \\ & \text { vehicles } \end{aligned}$ | $\left\|\begin{array}{c} \text { Number } \\ \text { of } \\ \text { Vehicles } \end{array}\right\|$ | Percentage of Total Vehnclas | $\begin{array}{\|c\|} \text { Number } \\ \text { of } \\ \text { Vehicles } \end{array}$ | $\begin{aligned} & \text { Percentage } \\ & \text { of Total } \\ & \text { Vahicles } \end{aligned}$ | $\begin{array}{\|c\|} \hline \text { Number } \\ \text { of } \\ \text { Vehicles } \end{array}$ | $\left[\begin{array}{c} \text { Percentage } \\ \text { of Total } \\ \text { vehicles } \end{array}\right]$ | $\begin{aligned} & \text { Number } \\ & \text { of } \\ & \text { venticies } \end{aligned}$ | Percentage of Total Vehicles | $\begin{gathered} \text { Nomber } \\ \text { of } \\ \text { Vehiclea } \end{gathered}$ | Percentarge <br> of Total <br> Vehicles | Number of Vehicles | $\begin{gathered} \text { Percentage } \\ \text { of Total } \\ \text { vehiclea } \end{gathered}$ |
| $8,000 \mathrm{lb}$ and under | 4,497 | 51000 | 708 | 8000 | 476 | 5400 | - | - | - | - | - | - | 5,679 | 84.400 |
| 8,001 to 10,000 lb | 132 | 1500 | 88 | 1000 | 424 | 4800 | - | - | - | - |  |  | 644 | 7300 |
| 10,001 to 12,000 lb, | - | - | 88 | 1000 | 441 | 5000 | - | - | - | - |  | - | 529 | 8000 |
| 12,001 to 16,000 lb . | - | - | - | - | 656 | 7410 | 17 | 0200 | 29 | 0330 | 2 | 0030 | 704 | 8000 |
| 16,001 to 20,000 lb. | - | - | - | - | 385 | 4360 | 88 | 0300 | 39 | 0330 | 1 | 0010 | 441 | 5000 |
| 20,001 to 24,000 lb. | - | - | - | - | 142 | 1815 | 18 | 0200 | 73 | 0825 | 5 | 0080 | 238 | 2700 |
| 24,001 to 30,000 lb. | - | - | - | - | 60 | 0685 | 26 | 0300 | 37 | 0415 | 9 | 0100 | 132 | 1500 |
| 30,001 to 40,000 lb. | - | - | - | - | 62 | 0700 | 65 | 0735 | 83 | 0825 | 4 | 0040 | 213 | 2400 |
| Dver $40,000 \mathrm{lb}$ | - | - | - | - | - | - | 23 | 0285 | 192 | 2175 | 23 | 0280 | 238 | 2700 |
| Total | 4,629 | 52500 | 882 | 10000 | 2,646 | 30000 | 175 | 2000 | 442 | 5000 | 44 | 0500 | 8,818 | 100000 |

groups of trucks is a complex matter. The difference among the various state bases of registration had to be reconciled, and to do this, factors were developed for converting the available data that the states had supplied to a gross-weight basis. Thirtyone states had supplied, for 1952, data on weight or capacity groupings according to their own registration bases. In a few states this was the unrealistic manufacturers' rated capacity. In some, it was on variations of net or empty weight, but for the majority, it was gross vehicle weight. Some use a combination of factors. Although more than half of the states now register trucks and combinations on the basis of gross weight, it can be seen in Figure 1 that quite a few, including some of the larger ones, register on different bases. Conversion factors were estimated, and for each state for which data were available on some basis other than gross vehicle weight, the conversion factors were applied to obtain an approximation of the state's registration according to the groups in which they would have fallen if all states required registration on a basis of gross vehicle weight.

While there is no need at this point to outline those conversion factors in detail, here are some examples: Single-unit trucks of $4,500 \mathrm{lb}$. or less empty weight in states registering on empty weight were considered to be in the gross-vehicleweight class of 1.8 times their empty weight. Single-unit trucks in the group 4,501 to $8,000 \mathrm{lb}$. empty weight were considered to belong with vehicles of exactly twice their weight when registered on a gross-weight basis, and vehicles with an empty weight of more than $8,000 \mathrm{lb}$. were converted to gross-weight values of 2.5 times their
empty weight. In states where tractor trucks are registered on an empty weight basis they were considered to represent combinations of five times the empty weight of the tractor alone; and tractors registered on a gross-weight basis were converted to gross combination weights of 1.8 times the gross registered weight of the tractor alone.

All in all, there were 18 states for which data were available on a gross-ve-hicle-weight basis, and it was possible to convert the data from an additional 12 states registering on other bases. However, in order to obtain balance, and because of questionable factors in the original material, data for 15 states were selected as representative. These 15 states registered more than 44.2 percent of all trucks in the United States in 1952. The percentages thus obtained from this sample were applied to national totals of trucks registered. This distribution is shown in Table 1 and Figure 2.

In 1952, the year on which this study is based, there were $8,818,000$ trucks registered, excluding publicly owned vehicles. Of these, after converting to a gross-ve-hicle-weight basis, as described above, there were $5,679,000$ in the $8,000-\mathrm{lb}$. -andunder group, or 64.4 percent. An additional 26.3 percent, or $2,318,000$ were in the groups from 8,001 to $20,000 \mathrm{lb}$. Only 370,000 , or 4.2 percent, of the trucks were in the 20,001 -to $-30,000-\mathrm{lb}$. range; and another 212,000 , or 2.4 percent, were between 30,001 and $40,000 \mathrm{lb}$. The trucks and combinations of over $40,000 \mathrm{lb}$. accounted for 2.7 percent of the total, or 238, 000 vehicles and combinations. Thus, only 9.3 percent of all trucks were more than $20,000 \mathrm{lb}$. in gross weight.

## Visual Classification of Vehicles

The previous discussion concerns the distribution of vehicles on registration bases, and some of the difficulties encountered in computing a uniform distribution on the basis of vehicle or combination gross weights. An entirely different problem arises in adapting the computed gross-vehicle-weight basis to the actual vehicles operating on the highway as they are observed from counting or weighing stations. Determination of the taxes paid by various vehicles requires considerable knowledge of the mileages they travel; and these must be computed primarily from observation. Registration fees do not vary with the amount of travel. Motor-carrier taxes do vary to a considerable degree with the amount of travel, and fuel taxes paid vary in direct proportion as travel varies.


Figure 2. Commercial vehicles by gross-wexght-registration classes.

The visual classification of vehicles shown in Table 1 and Figure 3 is that ordinarily used in recording and publishing traffic-volume information. This was the principal reason dictating its adoption for this study, although another factor prompting its use was that this classification is more meaningful than is a classification based solely upon gross weight.

Although the visual classification is so commonly used in presenting traffic data, vehicles in use or registered cannot readily be classified on this basis. In spite of the fact that tractor trucks or panels and pickups are registered separately in a few states, there is none in which the visual classification has been adopted in a general way as a basis for vehicle registration. Manufacturers' and trade-association statistics are no more helpful; manufacturers'
gross-vehicle-weight rating has understandably become the basis upon which these groups publish most of their statistics on production and sales.

As a consequence, it became necessary in preparing the visual distribution of vehicles shown in Table 1 and Figure 3 to resort to other sources of information. One of these was the findings of the motor-vehicle-use studies conducted in five states as presented in the project reports made on those studies. Another was the distribution of vehicles for seven urban areas reported in the home-interview samples taken in origin-and-destination studies. A third was a report prepared on an analysis of the 1952 truck registrations in North Carolina made by the Division of Statistics and Planning of the North Carolina State Highway and Public Works Commission (1). Although none of these sources provided all of the information desired, it was possible by piecing this information together with that which was available from registration records in a few states to develop the distribution shown in Table 1 and Figure 3.

Some of these sources also provided gross-vehicle-weight distributions of individual visual classifications. With the help of these it was possible to calculate a cross-classification of vehicles by both visual and gross-weight classifications. This tabulation, Table 1, provided a means of allocating registration and related fees and taxes according to both classifications. A comparison of the percentage distribution by both classifications is shown in Figure 4.

## DETERMINATION OF REGISTRATIONFEE AND CARRIER-TAX PAYMENTS

## Registration Fees and Related Imposts

Total revenue from state registration fees and associated imposts amounted to $\$ 1,069,439,000$, or $\$ 1,056,580,000$ if the $\$ 12,859,000$ of fines and penalties are excluded. Of this net amount $\$ 910,211,000$ were registration fees and the remainder of $\$ 146,369,000$ was accounted for by title fees and taxes, transfer and reregistration fees, operators' and chauffeurs' licenses, and other miscellaneous allied revenue. Operators' and chauffeurs' licenses alone accounted for $\$ 57,088,000$.

Registration Fees. In order to allocate registration fees between the various prin-


Figure 3. Commercial vehicles by visual classification.
cipal groups of vehicles, average registration fees were computed from the basic data on which the study, "State Road-User and Property Taxes on Selected Motor Vehicles, 1953," was based (2). Although this present study deals in national totals, it is well to remember that there are great differences among the states in their taxation of motor vehicles. A good visual measurэment of these differences appears
in Figures 5 and 6.
Property taxes on motor vehicles are not within the scope of this study, but it is of interest to note that there is considerable variation in their imposition and magnitude as shown in Figures 5 and 6.

The average registration fee for automobiles, derived by simple division, is $\$ 11.81$. The computed truck-registration fees derived by multiplying the numbers of vehicles in each group by the estimated average fees, yielded a total of $\$ 368,605,000$, or not quite 0.9 percent more than the known total of $\$ 365,404,000$. The average fees were therefore reduced the 0.9 percent to arrive at the $\$ 365,404,000$ total.

The amount of truck and tractor registration fees, for 1952, as shown in Table MV-2, is $\$ 320,251,000$. To this amount was added the $\$ 59,270,000$ of fees paid on various types of trailers and semitrailers, from which was deducted $\$ 14,116,000$ estimated to have been paid on house trailers, light car trailers, etc. The resulting amount, $\$ 365,404,000$, makes allowance for the fact that semitrailers and trailers are registered separately in many states


Reglstered Gross
Weight Classification


Figure 4. Comparison of trucks and combinations by registered gross weight and visual classifications.


Figure 5. Road-user and personal-property taxes on a " $11 / 2$-ton" (12,500-1b. G.V.W.) stake truck in private use, ranied according to road-user taxes.
and that there are considerably greater numbers of semitrailers than tractors.

There were 5,679,000 trucks in the weight group of $8,000 \mathrm{lb}$. or less. When converted to the visual classification, 4,497, 000 fell into the panel-and-pickup group with four tires, 706,000 were other single-unit trucks with four tires, and 476,000 were two-axle, six-tire, singleunit trucks. The total registration fees of these groups amounted to $\$ 103,417,000$. It seems probable that the panels and pickups pay slightly smaller fees than the other vehicles in this group.

In this respect, it is interesting to note that a great many states impose lower registration fees on farm trucks than on vehicles not qualifying for that classification. These reductions are very substantial, as can be seen in Figure 7. The vast majority of farm trucks are in the pickup and other light groups. To make allowance for this difference in fees, it was assumed that the average registration fee of the

706,000 four-tire single-unit trucks other than panels and pickups had a value of $\mathbf{X}$ and that the registration fee of the panels and pickups had an average value of $X$ minus 5 percent and that the two-axle, six-tire vehicles in the group had a registration fee with the value of $X$ plus 5 percent. The same technique was applied to the fees of the vehicles in the 8,001-to-$10,000-\mathrm{lb}$. group. For the 529,000 trucks in the 10,001 -to $-12,000-\mathrm{lb}$. group, it was assumed that the 88,000 four-tire trucks had an average registration fee of 5 percent less than the 441,000 six-tire, single-unit trucks in the group. A similar method was followed in distributing the registration fees of each of the weight classes to the visual classifications. In each instance, however a heavier weighting factor was given to the registration fees for combinations when they fell in the same gross-weight group as single-unit trucks.

Operators' and Chauffeurs' Licenses and Miscellaneous Imposts. The allocation
of operators' and chauffeurs' licenses had to be arbitrary. Some states do not require chauffeurs' licenses and others do not require ordinary operators' licenses of those who hold chauffeurs' licenses. The total chauffeurs' license fees attributed to truck operators was $\$ 9,229,000$. It was assumed that one chauffeur's license at an average fee of $\$ 1.80$ should be attributed to each vehicle in the gross-weight classes of 20,000 to $40,000 \mathrm{lb}$. and 1.5 chauffeurs licenses should be attributed to each vehicle over $40,000 \mathrm{lb}$. The remainder of the chauffeurs' licenses and the fees derived therefrom were attributed to trucks in the various groups under $20,000 \mathrm{lb}$. Chauffeurlicense payments attributed to bus operators were computed as approximately two per vehicle or 290,000 , and at $\$ 1.80$ each these amounted to $\$ 522,000$. Motorcycle operators' licenses were estimated at $\$ 0.25$ per registered motorcycle, and amounted to $\$ 102,000$. The remainder of operators' and chauffeurs' license pay-
ments, $\$ 47,235,000$, was allocated to passenger-car operators.

After allocating operators' and chauffeurs' license revenues to various groups of vehicles there remained $\$ 89,281,000$ of miscellaneous fees to be assigned. This was done insofar as possible by examination of the individual state reports and allocating the fees to individual groups where possible. As a result of this examination of state reports, $\$ 17,571,000$ was assigned to trucks. . This amounted to $\$ 1.99$ each. In this distribution, however, consideration was given to size and value of the vehicles, since these factors affected the receipts. Title fees, transfer fees, and issuance fees were distributed to trucks on a numerical basis. Nonresident tag fees and a small amount of other miscellaneous fees were distributed between trucks on the basis of a five-state sample drawn from the individual reports of the states in the Bureau of Public Roads files. The truck share of special titling taxes, amounting to


Figure 6. Road-user and personal-property taxes on a 40,000-1b. three-axle tractor-semitrailer combination in private use in each state, ranked according to road-user taxes.


Figure 7. Reduced registration fees for farm trucks ( $11 / 2$-ton stake).
$\$ 32,489,000$, was distributed on the basis of gross vehicle weights, since these are ad-valorem taxes and it seemed that there should be a high degree of correlation between value and weight. Undoubtedly this is susceptible of refinement, but it is probable that no great violence is done by this approach.

It was assumed that the miscellaneous revenues to be assigned to busses averaged the same as those assigned to trucks, i. e. , $\$ 1.99$ each, or a total of $\$ 289,000$. Miscellaneous revenues of $\$ 1$ each were attributed to the 407,000 registered motorcycles. The remaining miscellaneous fees, $\$ 71,014,000$, were attributed to automobiles, and amounted to $\$ 1.63$ per automobile when the amount is divided by the number of registered vehicles.

## Carrier Taxes

The prior discussion has outlined the major phases of assigning registration and associated fees. The assignment of the $\$ 64,036,000$ in motor-carrier tax revenues was made by study of the individual reports of the states. This indicated that $\$ 7,268,000$ might be assigned to busses and the remaining $\$ 56,768,000$ assigned
to trucks. Undoubtedly there are some instances of certain carrier taxes or pub-lic-service permit fees and related revenues that may be attributed to taxicabs, but insufficient evidence was found of such payments to make any allocation. In any case, it is improbable that a substantial amount would be involved.

For the purpose of this study it was also assumed that carrier taxes can be assigned entirely to busses and to trucks of more than $12,000 \mathrm{lb}$. in gross-vehicle-weight rating. Since the individual state records did not distinguish between the classes of vehicles upon which carrier taxes were levied, an arbitrary procedure was adopted in assigning them to the various groups. By taking the average amount of motor-carrier tax that would be paid by a vehicle of over $40,000 \mathrm{lb}$. as the quantity X , it was assumed, in computing carrier taxes, that vehicles in the group from 30,001 lb. to $40,000 \mathrm{lb}$. could be assigned a value of 0.75 X ; that trucks and combinations in the group from $24,001 \mathrm{lb}$. through $30,000 \mathrm{lb}$. could be assigneda value of 0.5 X ; vehicles in the group from $20,001 \mathrm{lb}$. through 24,000 lb. were assigned a value of 0.25 X ; vehicles in the group from $16,001 \mathrm{lb}$. through $20,000 \mathrm{lb}$. were assigned 0.1 X ; and ve-
hicles of 12,001 to $16,000 \mathrm{lb}$. had a value of 0.05 X . The value of X was found to be $\$ 94.32$. It might be said that this is reducing guessing to a system, and there would be more than a grain of truth to it. Yet, in the absence of detalled basic data any assignment of motor-carrier taxes to various groups of vehicles must necessarily be on an arbitrary basis, and regardless of the complexity of any formula adopted, it would be reasonably certain to contain many of the properties of the estimate made here.

## ASSIGNMENT OF TRAVEL AND FUELTAX PAYMENTS

Although much is known about the character and extent of motor-vehicle use, there is a present lack of complete information about the distribution of highway travel in rural and urban areas, especially that pertaining to the subdivision of this travel among the classes of vehicles for which it was desired to make estimates in this study. Nevertheless, such an estimate of travel during 1952, classified according to these vehicle types, had to be made if the fuel use and fuel-tax payments of the individual types of vehicles were to be calculated.

## Assignment of Motor-Vehicle Travel

Estimates of passenger-car, bus, and truck travel in the continental United States were issued by the Bureau of Public Roads for each of the years from 1936 through 1948 (3). The principal factors controlling the calculations made for 1936 were the traffic volumes, characteristics and relationships as determined from rural traffic counts, and from the studies of motorvehicle allocation and road use conducted between 1935 and 1939, covering both rural and urban travel.

These projects were included in the program of basic highway-planning studies undertaken jointly by the state highway departments and the Bureau of Public Roads. Estimates for the succeeding years were based upon the calculations made for 1936, such modifications being made as were necessary to reflect known trends in motorvehicle registrations, fuel consumption, and vehicle use. The principal factors controlling the calculations for the individual years were: (1) annual estimates of
rural-road traffic made by Public Roads from traffic counts obtained by the high-way-planning surveys; (2) annual reports of the highway use of motor fuel made by state authorities to Public Roads; and (3) reports of motor-vehicle registrations, also made by state authorities to Public Roads. Publication of these estimates was discontmued after 1948 because it was felt that some of the basic relationships existing in 1936, and upon which the entire structure of the estimates was predicated, might have changed considerably. Since that time only estimates of rural travel have been published.

The same basic procedures employed in preparing the estimates for 1936 through 1948 were used in developing the estımate of the total passenger-car, bus, and truck travel for 1952 as presented in Table 2. For purposes of this study, however, it was necessary to subdivide the estimate of total truck travel into the various visual classifications shown in the table. In rural areas, classification counts have been made regularly by the state highway departments as a part of the highway-planning-survey operations, and the percentage distribution shown by these counts was used in subdividing the total rural vehicle mileage of trucks. In urban areas, comprehensive classification-count data are not available. Two other sources of information are available from the planning-survey operations conducted by the states, however, and these were used in subdividing the total urban vehicle mileage of trucks. Estimates of travel by the various visual classifications of trucks were developed for the large cities from information collected in origin-and-destination traffic studies of the homeinterview type, and for the smaller cities from information obtained in motor-ve-hicle-use studies.

In the home-interview origin-and-destination studies, it is standard practice to collect data concerning the type of truck, the licensed gross weight, and the daily mileage traveled in the urban area, as well as the origin and destination of each trip. Information is also available in these studies concerning the number, type, origin, and destination of all trucks entering and leaving urban areas. Twelve cities (Camden, Dallas, Duluth, Houston, Madison, Minneapolis, Philadelphia, Racine, St. Paul, Seattle, Superior, and Washington, D. C.) were selected from those in

TABLE 2 .
ESTIMATED TRAVEL DURING 1952 IN THE UNITED STATES CLASSIFIED BY PLACE OF TRAVEL AND BY VEHICLE TYPE
(Travel in millions of vehicle miles)

| Type and class of vehicle | Amount of travel m - |  |  | Percentage of travel in - |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Rural areas ${ }^{2}$ | Urban places ${ }^{2}$ | All <br> places | Rural areas ${ }^{1}$ | Urban places ${ }^{1}$ | $\begin{gathered} \text { All } \\ \text { places } \\ \hline \end{gathered}$ |
| Passenger cars (including taxicabs) | 213,464 | 197,404 | 410,868 | 77.01 | 83.98 | 8021 |
| Busses ${ }^{\text {a }}$ |  |  |  |  |  |  |
| Commercial | 1,444 1,026 | 1,750 114 | 3,194 1,140 | 0.52 <br> 0.37 | 0.74 <br> 0.05 | 0.62 <br> 0.22 <br> 0.81 |
| Other Subtotal | 1,026 | 1,864 | 4,334 | 0.89 | 0.79 | 0.84 |
| Trucks and combunations* |  |  |  |  |  |  |
| Single-unit trucks -Two-axle Four tire trucks- |  |  |  |  |  |  |
| Panels and pickups | 22,075 | 13,324 | 35,399 | 797 | 5.67 | 691 |
| Others | 2,083 | 5,834 | 7,912 | 0.75 | 2.48 | 155 |
| Subtotal | 24,158 | 19,158 | 43,316 | 872 | 815 | 8.46 |
| Two-axle Six-tire trucks | 20,453 | 13,600 | 34,053 | 738 | 579 | 6.65 |
|  | $1,557$ | -388 | 1,945 | 0.56 | 0.16 | 038 |
| Subtotal | $46,168$ | 33,146 | 79,314 | 1666 | 14.10 | 1549 |
| Vehicle combinations -Tractor-semitranler | 14,013 | 2,465 | 16,478 | 506 | 1.05 | 322 |
| Combinations involving full trailers | 1, ${ }^{1,061}$ | 2, 187 | 1,248 | 038 | 08 | 0.24 |
| Subtotal | 15,074 | 2,652 | 17,126 | 5.44 | 113 | 346 |
| Total trucks and combinations | 61,242 | 35,798 | 97,040 | 2210 | 1523 | 1895 |
| rotal all vehicles | 277,176 | 235, 066 | 512, 242 | 100.00 | 10000 | 10000 |

${ }^{1}$ "Urban areas" uncludes all incorporated places and other urban places, the remainder is included in "rural areas "
which home-nterview studies have been made and special tabulations of the urban travel by type of truck were made for these cities. Some of these tabulations were made by the state highway departments and some by the Bureau of Public Roads. Percentages and factors developed from these data were used in estimating the urban vehicle mileage of trucks by visual types in the larger cities for the country as a whole.

The motor-vehicle-use studies are also home-interview studies designed to obtain on a statewide basis much the same types of information as are obtained for a single city or urban area in the home-interview origin-and-destination studies. Because of their statewide, rather than local emphasis, the sampling rates employed within cities in the motor-vehicle-use studies are much lower than those used in the origin-and-destination studies; therefore, the stability and reliability of the motor-ve-hicle-use samples are lower when only a single city or size group of cities is considered. However, the data available from these studies could be used to good advantage in estimating the travel of various classes of trucks and combinations in the smaller-sized cities and villages as a whole. Data obtained in seven states, the only ones in which motor-vehicle-use
studies have been completed up to the present, were used in making these estimates. In addition to the travel data applied, information obtained through these studies relative to the distributions of dwelling units, population, and motor vehicles was also used in refining the calculations.

Other sources of information used included estimates of travel by commercial and other busses reported by the industry in the 1953 statistical issue of "Bus Transportation" (4), and estimates of automobile use reported by the Automobile Manufacturers Association in "Automobile Facts and Figures" (5).

Total motor-vehicle travel on all roads and streets during 1952 was calculated to be 512 billion vehicle-miles, of which 411 billion (about 80 percent) was estimated to have been performed by passenger cars, 79 billion (nearly 16 percent) by singleunit trucks, 18 billion (somewhat more than 3 percent) by tractor-semitrailer and trucktrailer combinations, and 4 billion (nearly 1 percent) by busses.

This tabulation includes the travel of publicly owned non-military vehicles. It was desired to limit the calculation of fuel consumption and fuel-tax payments to the classifications of private and commercial vehicles shown in Table 1 and Figure 3.

Consequently, the travel of publicly owned vehicles had to be eliminated from the estimated travel of all vehicles shown in Table 2.

Estimates of the travel and fuel consumption of federal civilian vehicles were determined from statıstics compiled by the United States Bureau of the Budget, while estimates of the travel and fuel consumption of motor vehicles owned by state, county, and local government agencies were developed from reports made by most of the state highway departments to the Bureau of Public Roads.

The travel of publicly owned vehicles was determined to be 6 billion vehiclemiles, of which the amounts contributed by the individual vehicle types were as shown in the second column of Table 3. The total travel of private and commercial motor vehicles, after deduction of public-vehicle travel, was 506 billion vehicle-miles, of which 409 billion was performed by passenger cars, 76 billion by single-unit trucks, 17 billion by combinations of freight-carrying vehicles, and nearly 4 billion by busses. The percentage distribution of this travel by vehicle groups was practically the same as for the total travel of all public, private, and commercial vehicles. This distribution is shown in Figure 8.


Figure 8. Percentage distribution of travel by private and commercial motor vehicles in the continental United States during 1952.

## Operating Characteristics of Various Types of Vehicles

In order to estimate the fuel consumption and fuel-tax payments for the individual classes of vehicles used in this study, it was necessary to determine certain of their operating characteristics, such as average gross weights, percentages of vehicles using fuel other than gasoline, and rates of fuel consumption.

Average Operating Gross Weights. The calculated average operating gross weights used in this study for each type of vehicle are shown in Table 4 and Figure 9. Different methods were employed in arriving

TABLE 3
ESTMMATED TRAVEL DURING 1952 IN THE UNITED STATES CLABSIFIED BY OWNERSHIP AND BY VEHICLE TYPE
(Travel in millions of vehicle miles)

| Type and class of vehicle | Amount of travel by - |  |  | Percentage of travel by - |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\begin{gathered} \text { All } \\ \text { vehicles } \end{gathered}$ | Government owned vehicles | Private and commercial vehicles | All vehicles | Government owned vehicles | Private and commercial vehicles |
| Passenger cars: (including taxtcabs) | 410,868 | 1,597 | 409, 271 | 80.21 | 25.42 | 80.89 |
| Busses |  |  |  |  |  |  |
| Commercial | 3,194 | $\overline{7}$ | 3,194 | 062 | - | 0.63 |
| Other | 1,140 | 770 | 370 | 0.22 | 12.26 | 0.07 |
| Subtotal | 4,334 | 770 | 3,564 | 0.84 | 12.26 | 070 |
| Trucks and combinations: |  |  |  |  |  |  |
| Single-unit trucks - |  |  |  |  |  |  |
| Two-axle Four-tire trucks - |  |  |  |  |  |  |
| Panels and pickups | 35,399 7,917 | 1,428 319 | 33,971 7,598 | 6.91 155 | 2273 5.08 | 6.71 150 |
| Subtotal | 43,316 | 1,747 | 41,569 | 8.46 | 27.81 | 8.21 |
| Two-axle Six-tire trucks | 34,053 | 1,374 | 32,679 | 6.65 | 21.87 | 646 |
| Three-axle trucks | 1,945 | 79 | 1,866 | 0.38 | 126 | 0.37 |
| Subtotal | 79,314 | 3,200 | 76,114 | 1549 | 50.94 | 15.04 |
| Vehicle combinations - |  |  |  |  |  |  |
| Tractor-semitraller |  | 664 |  | 3.22 | 10.57 | 3.13 |
| Combinations involving full trailers | $\begin{array}{r} 1,248 \\ \hline \end{array}$ | 51 | 1,187 | 0.24 | 0.81 | 0.24 |
| Subtotal | 17,726 | 715 | 17,011 | 3.46 | 11.38 | 3.37 |
| Total trucks and combinations | 97,040 | 3,915 | 93,125 | 1895 | 62.32 | 1841 |
| Total all vehicles | 512, 242 | 6,282 | 505,960 | 100.00 | 100.00 | 100.00 |

at the weights adopted for the various classes of vehicles.

The average operating gross weight of passenger cars was determined by a complex method of calculation in which these vehicles were divided by makes roughly into four groups, according to the weight of the most-popular four-door sedan of each make. An average operating road weight was calculated for each make by adding to the shipping weight of the fourdoor sedan an allowance to cover nonstandard equipment, such as radios and heaters, fuel, water, two passengers, and baggage. The allowances varied from 600 lb. in the case of the vehicles in the lightest group to 900 lb . in the case of the heaviest vehicles. It was assumed that vehicles of all weight groups would have the same average travel. The average operating gross weight for all passenger cars was calculated to be $3,965 \mathrm{lb}$.

The weights shown for the various classes of trucks and combinations are averages obtained from loadometer studies conducted in 1952 by the state highwayplanning organizations. A total of 134,564 vehicles was weighed as found in the traffic stream on main rural roads. Some were empty, some overloaded, and some only


Figure 9. Operating characteristics of various types of motor vehicles.

TABLE 4
OPERATING CHARACTERISTICS OF VARIOUS TYPES OF MOTOR VEHICLES

| Type and class of vehrcle | ```Average operating gross werght``` | Distribution of travel according to type of fuel used |  |  | Rates of fuel consumption, by type of fuel used |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Gasoline | Diesel | Other | Gasoline | Diesel | Other |
|  | (pounds) | (percent) | (percent) | (percent) | (g p.m.) | (g p m.) | (g p m.) |
| Passenger cars: | 3,965 | 1000 | (a) | (a) | 0.06704 | - | - |
| Busses: |  |  |  |  |  | 0.18590 | 0. 26690 |
| Commercial | 23,000 11,600 | 391 100.0 | ${ }_{\text {(a) }} 5$ | (a) | $\begin{aligned} & 0.26870 \\ & 0.12540 \end{aligned}$ | 0.18590 | 0.26090 |
| Trucks and combinations |  |  |  |  |  |  |  |
| single-ünit trucks -Two-axles, Four tires - |  |  |  |  |  |  |  |
| Panels and pickups | 4,639 | 100.0 | (a) | (a) | 0.07350 | - | - |
| Others | 5,834 | 1000 | (a) | (a) | 0.08420 | - | - |
| Two axles, Stx tires | 11,684 | 100.0 | (a) | (a) | 0.12590 | - | - |
| Three axles | 23,611 | 100.0 | (a) | (a) | 0. 18980 | - | - |
| Combinations -Tractor-semitratler | 35,602 | 86.5 | 126 | 0.9 | 0.24120 | 017230 | 0. 26800 |
| Truck-traler | 46,885 | 86.5 | 12.6 | 09 | 0.28320 | 0.20230 | 0.31470 |

${ }^{\text {a }}$ Percentage negligible.

The operating characteristics of commercial busses differed so greatly from those of other types of busses, that these were treated separately from the other types, such as privately owned busses operated by schools or institutions. The operating gross weight of $23,000 \mathrm{lb}$. assigned to commercial busses was determined by adding to the curb weight of a typical 42 -passenger bus, such as used in either city or suburban service, the weight of a load of 21 passengers. The operating gross weight of $11,600 \mathrm{lb}$. assigned to "other" busses represents the combination of the curb weight of a typical mediumsized school bus and the weight of an average load of 20 children.
partially loaded. The weights reported reflect these conditions. Since no data were available on weights of vehicles operating in cities, the rural road weights had to be applied to all traffic.

Use of Fuels Other Than Gasoline. Although the use of fuels other than gasoline in the propulsion of motor vehicles is increasing rapidly, the amount of such socalled special fuels used is still a relatively small percentage of the total fuel consumed on the highways. In 1952 the total of all motor fuel so used in the United States was 40 billion gallons (Public Roads Table G-21), while the total amount of special fuels used for highway purposes was only 805 million gallons (Public Roads

Table G-25). This relatively small segment of motor-fuel consumption assumes greater importance, however, when it is considered that nearly all of this fuel is consumed by the larger commercial vehicles.

Information reported by the commercial bus industry indicates that large portions of its operations are now carried on with busses propelled by diesel fuel, liquefied petroleum gas, and other nongasoline fuels. The specific percentage relationships used in this analysis are based upon reports from 24 intercity, intracity, and suburban operators reported by "Bus Transportation' magazine (6). These data, which appear to be supported by other reliable information, indicate that more than 50 percent of the fuel now used in commoncarrier busses is diesel fuel, while the use of liquefied petroleum gas has become an important factor in some instances. On the other hand, although there is undoubtedly some use of these fuels in busses engaged in other types of operations, available information seems to indicate that up to the present such use is insignificant.

Nongasoline fuels are alsoused to some extent in single-unit trucks, but inasmuch as the achievement of significant savings from the use of these fuels requires largescale operations, such use is thought to be negligıble and all of the consumption of these fuels in freight-carrying vehicles was assigned to combinations rather than single vehicles.

Estimates of Fuel-Consumption Rates. The rate at which a certain motor vehicle or combination of vehicles will consume fuel in its operations over the highways is affected at any given time by a number of factors, among which the following are of major importance: type and grade of fuel used, characteristics of the engine, gear ratios, frequency of stops, condition of the vehicle, gradients encountered, types and conditions of roads traveled, weather, operating gross weight of vehicle (or combination) and contents, and driving techniques employed.

When the universe of all motor vehicles in service, operating throughout the year under widely varying conditions, is being considered, and if only a broad and general analysis is undertaken, as was the case in this instance, the effects of such factors as frequency of stops, topography, weather, condition of the vehicle, and driving techniques employed tend to be-
come compensating and have little effect upon the determination of average rates of fuel consumption. Consequently, in the analysis undertaken for this study no attempt was made to take any factor other than gross vehicle weight into account, except in a very limited way as noted subsequently.

Figure 10 shows the compromise curve indicating the relationship between gross weight and gasoline consumption plotted from the equation developed for this paper and the other fuel-consumption data that were considered in developing it. This equation is intended to indicate approximate gasoline-consumption rates for gross vehicle weights up to at least $72,000 \mathrm{lb}$. operating under average conditions.

This gasoline-consumption equation was not statistically developed in the ordinary sense. Rather, it is a composite of values for numerous gross-weight groups obtained from each of several previous determinations by other investigators. Since it was beyond the scope of this study to assemble original data on the fuel-consumption rates of motor vehicles, it was necessary to draw on the work of others. Although many sources of data were investigated, none was found which appeared to meet present needs in all respects.

Some, like the determinations of the Federal Coordinator of Transportation (7), were developed from information that is now so old that it does not reflect conditions now known to prevail especially in the higher gross-weight brackets. Others, like the fuel-consumption rates developed from the Ford data reported upon by Robley Winfrey (see p. 36 of this bulletin) are based upon limited coverage of engines, vehicle types, or loadings, and so tend to give values, for certain weight ranges, that deviate rather widely from the consensus of findings.

After plotting all of this information, as shown in Figure 10, it became evident that a new curve, or set of curves, should be developed. Some students of the problem contend that a single fuel-consumption curve cannot be develoned to fit all types of vehicles from passenger cars through the heaviest combinations. When the gasolineconsumption equation adopted for use in this study was developed, it had not been predetermined that a single curve could be applied to all gross weaghts. However, when average fuel-consumption rates for


Figure 10. Estimated variation of fuel consumption of gasolinepowered vehicles with average operating gross weight.
each of numerous values of operating gross weights, ranging from 3,000 to $50,000 \mathrm{lb}$. had been calculated and plotted to logarithmic scales, it was found that they closely fitted a straight line having the following cquation:

Let $\quad$ GPM $=$ gallons per mile W = average operating gross weight of vehicle

Then $G P M=0.000534 W^{0.583}$
Consequently, it was decided that, for purposes of the present analysis, this fuelconsumption equation could be applied throughout the entire range of gross weights for which gasoline consumption would need to be calculated.

As stated previously, this equation applies only to gasoline-powered vehicles. It is known that different rates of fuel consumption will apply to diesel-powered vehicles, but there are not sufficient data at hand to permit the calculation of an equation for them. After consultation with representatives of the trucking industry, it was decided to assume that, for operating gross weights above $20,000 \mathrm{lb}$., diesel vehicles will consume on the average, about 30 percent less fuel than will gasolinepowered vehicles of equal weight. No special allowance was made for vehicles using other fuels, such as liquefied petroleum gas, partly because of their negligible importance in the nationwide picture and partly because available data seemed to indicate that such vehicles generally have
fuel-consumption rates closely approximating those of similar gasoline-powered vehicles.

All of the gasoline-consumption rates shown in Table 4 and Figure 9 were developed by applying the derived equation to the average operating gross weights shown, except in the case of commercial busses. Available overating data indicate that relationships between the gasoline-consumption rates and average operating weights of intercity busses are almost in line with the corresponding relationships calculated by use of the equation, but that in the case of intracity and suburban busses the rates are much higher, probably because of the combined effects of frequent stops, urban congestion, and other factors peculiar to such operations. The composite gasolineconsumption rate shown was developed from operating statistics of the 24 companies previously cited.

Fuel Consumption and Fuel-Tax Payments
Table 5 presents the calculated fuel consumption and fuel-tax payments of each
of the various classes of vehicles indicated in the visual classification adopted for this study. Figure 11 shows the percentage distribution of indicated total fuel consumption.

Fuel consumption. The fuel-consumption data shown were calculated by multiplying the total mileages indicated in Table 5 by the corresponding rates shown in Table 4 and Figure 9. Separate calculations of gasoline, diesel, and other fuel used were made on the basis of the percentages of total use there indicated.

The total calculated consumption of 39,807 million gallons of fuel of all kinds is 91 million gallons, or 0.225 percent, below the 39,898 million gallons of fuel used by private and commercial vehicles for highway purposes in 1952 reported in Public Roads Table G-21. However, the analysis made for this paper did not take into account fuel consumed by motorcycles, motorscooters, and other similar vehicles, nor did it give consideration to the use of fuel on which highway-user taxes were paid and no refunds claimed for such nonhighway purposes as the operation of

TABLE 5
FUEL CONSUMPTION AND TAX PAYMENTS IN 1952 CLASSIFIED BY VARIOUS TYPES OF PRIVATE AND COMMERCIAL MOTOR VEHICLES

| Vehicle type | Total miles traveled | Gasoline powered vehicles |  | Diesel powered vehicles |  | Vehicles powered by other fuels. |  | Fuel consumed |  | $\begin{gathered} \text { Total } \\ \text { tax } \\ \text { pand } \end{gathered}$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Mileage | Fuel | Mileage | $\begin{gathered} \text { Fuel } \\ \text { consumed } \end{gathered}$ | Mileage | $\begin{gathered} \text { Fuel } \\ \text { consumed } \\ \hline \end{gathered}$ | $\begin{array}{\|r} \hline \text { Total } \\ \text { gallons } \\ \hline \end{array}$ | Percent |  |
|  | Millions | Mallions | Million gallons | Millions | Million gallons | Millions | Mallion gallons | Millions |  | Million dollars |
| Passenger cars | 409,271 | 409,271 | 27,438 | - | - | - | - | 27,438 | 68.771 | 1,353.3 |
| Busses |  |  |  |  |  |  |  |  |  |  |
| Commercial | 3,194 | 1,249 | 336 | 1,785 | 332 | 160 | 43 | 711 | 1782 | 35.0 |
| Other | 370 | 370 | 46 | - | - | - | $\underline{-}$ | 46 | 0115 | 2.3 |
| Subtotal | 3,564 | 1,619 | 382 | 1,785 | 332 | 160 | 43 | 757 | 1897 | 373 |
| Trucks and combinations |  |  |  |  |  |  |  |  |  |  |
| Single-unit trucks -Two-axles, Four-tires |  |  |  |  |  |  |  |  |  |  |
| Panels and pickups | 33,971 | 33,971 | 2,497 | - | - | - | - | 2,497 | 6.259 | 123.2 |
| Other | 7,598 | 7,598 | 2,640 | - | - | - | - | $\begin{array}{r}2,640 \\ \hline\end{array}$ | 1.604 | $\begin{array}{r}123.5 \\ \hline 1.5\end{array}$ |
| Subtotal | 41,569 | 41,569 | 3,137 | - | - | - | - | 3,137 | 7.863 | 154.7 |
| Two-axles, Six-tires | 32,679 | 32,679 | 4,114 | - | - | - | - | 4,114 | 10311 | 2029 |
| Two-axles | 1,866 | 1,866 | 354 | - | - | - | - | 354 | 0. 887 | 175 |
| Subtotal | 76,114 | 76,114 | 7,605 | - | - | - | - | 7,605 | 19061 | 3751 |
| Combinations -Tractor-semitrailer | 15,814 | 13,679 | 3,299 | 1,993 | 343 | 142 | 38 | 3,680 | 9.223 | 1815 |
| Truck-traller | 1,187 | 1,035 | 293 | 151 | 31 | 11 | 3 | 327 | 0820 | 16.1 |
| Subtotal | 17,011 | 14,714 | 3,592 | 2,144 | 374 | 153 | 41 | 4,007 | 10.043 | 197.6 |
| Total trucks and combunations | 93,125 | 90,828 | 11,197 | 2,144 | 374 | 153 | 41 | 11,612 | 29,104 | 572.7 |
| Total all vehicles | 505,960 | 501,718 | 39,017 | 3,929 | 706 | 313 | 84 | 39,807 | 99.772 | 1,963.3 |
| Difference (consumption by motorcycles, etc.) |  |  |  |  |  |  |  | 91 | 0.228 | 4.5 |
| Total fuel consumed and tax payments |  |  |  |  |  |  |  | 39,898 | 100.000 | 1,967.8 |

gasoline- Dowered lawnmowers, garden tractors, or small boats.


Figure 11. Percentage distribution of motor-fuel consumption by private and commercial motor vehicles in the continental United States during 1952.

There were about 408,000 private and commercial motorcycles, motorscooters, and similar vehicles registered in 1952. If it can be assumed that these vehicles consumed an average of 200 gallons of fuel each during the year, their total consumption would have been nearly 82 million gallons, a not-unlikely figure. Other investigators have averaged the annual consumption of motorcycles at 250 gallons, or even more. (The Federal Coordinator of Transportation used a fuel-consumption rate of 0.027041 gallons der mile and an average annual mileage of 15,000 in estımating motorcycle fuel consumption in 1932; see "Public Aids to Transportation," Vol. IV, D. 143.)

Fuel - Tax Payments. Public Roads Table $\mathrm{G}-1$ indicates that $\$ 1.97$ billion was collected during 1952 from state taxes upon motor fuel used for highway purdoses. This total excludes taxes refunded upon nonhighway use of motor fuel and allowance made in a few states to taxpayers for costs of tax collection. It includes the incomes from certain miscellaneous recerpts, such as distributors' and retailers' license fees, inspection fees, etc.

The total motor-fuel consumption covered by these tax payments is not exactly the same as the total of highway motor-fuel consumption by private and commercial vehicles of almost 40 billion gallons shown
in Table G-21. The reason is that Table G-1 shows tax collections during 1952, regardless of when the fuel was used, while G-21 is designed to present actual fuel consumption during the year. Although there may not be much time lag between the payment of the fuel tax and the actual use of motor fuel in most instances, the procedures used in the various states for handling tax refunds for nonhighway use may result in a considerable imbalance between net collections and highway use during any calendar year. Thus, taxrefund claims for nonhighway use in the fall of one year may not be paid and be deducted from collections until after the first of the following year.

For this reason it was decided not to attempt to calculate tax payments directly from the gallonage distribution shown in Table 5. Instead, a percentage distribution was calculated from these data and applied to the total collections of $\$ 1.97$ billion shown in Table G-1, on the assumption that the percentages of use reflected by the collections would be essentially the same as those reflecting actual use during 1952. The results of this calculation are shown in the last column of Table 5 and in Figure 11.

## FINDINGS OF THE STUDY

In this paper, the attempt has been made to develop the amounts of state roaduser taxes paid by vehicles of different types and general size groups. Because the problem is a comolex one and the estimates are necessarily approximate, much time has been devoted to describing the procedures and techniques used. It is time now to ask and to answer the question, "What does it all amount to ?"

The answer is found in the summary figures given in Tables 6 and 7 and in Figures 12 and 13, which portray the results graphically. The summary data compare the numbers of vehicles in each visual classification, the user taxes paid, vehicle-miles travelled, average payments per vehicle, and average payments per mile of travel.

Table 6 brings together the classufied estimates of tax payments that were described individually in previous sections of this paper. It will be observed that fuel-tax payments accounted for $\$ 1.968$ billion (or 63.7 percent) of the total of $\$ 3.088$ billion of state motor-vehicle-tax

TABLE 6
ESTIMATE OF STATE ROAD-USER-TAX PAYMENTS BY MAJOR GROUPS OF VEHICLES 1952
(In thousands of dollars)

| Vehicle group | Registration fees | Motor carrier taxes | Oper. \& Chauff. hcenses | Mise. fees | Motor fuel taxes | Total |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  | Amount | Percent |
| Automobiles . - | 515,750 | - | 47,235 | 11,014 | 1,353,280 | 1,987, 279 | 64.34 |
| Busses . . | 13,171 | 7,268 | 522 | 289 | 37,337 | 58,587 | 1.90 |
| Motorcycles . . . . . . | 1,769 | - | 102 | 407 | 4,488 | 6,766 | . 22 |
| Camp \& other light tranlers. . | 14,117 | - | - | - | - | 14,117 | . 46 |
| Trucks and combinations. |  |  |  |  |  |  |  |
| Single unit |  |  |  |  |  |  |  |
| Two axles, Four tires- |  |  |  |  |  |  |  |
| panels and pickups | 83,804 | - | 4,436 | 5,966 | 123, 156 | 217, 362 | 7.04 |
| Other . . . . | 18,729 | - | 836 | 1,186 | 31,567 | 52, 318 | 1.69 |
| Two axles, Six tires | 129,887 | 2,613 | 2,647 | 5,417 | 202,909 | 343,473 | 11.12 |
| Three axles . . . | 27,309 | 225 | 297 | 1,083 | 17,461 | 46,375 | 1.50 |
| Subtotal | 259,729 | 2,838 | 8,216 | 13,652 | 375,093 | 659,528 | 21.35 |
| Vehicle combinations: |  |  |  |  |  |  |  |
| Tractor-semitraler | 94,307 | 49,529 | 917 | 3,533 | 181,504 | 329,790 | 10.68 |
| Truck-trailer . . | 11,368 | 4,401 | 96 | 386 | 16,129 | 32,380 | 105 |
| Subtotal . | 105, 675 | 53,930 | 1,013 | 3,919 | 197,633 | 362,170 | 1173 |
| Total trucks and combinations | 365,404 | 56,768 | 9, 229 | 17,571 | 572,726 | 1,021,698 | 33.08 |
| Total vehicles - - | 910, 211 | 64,036 | 57,088 | 89,281 | 1,967,831 | 3,088,447 | 10000 |

payments made during 1952. Registrationfee payments totaling $\$ 910$ million brought in 29.5 percent; motor-carrier tax contributions of $\$ 64$ million provided 2.1 percent; operators' and chauffeurs' license incomes provided $\$ 57$ million ( 1.8 percent; and miscellaneous fees totaled $\$ 89$ million ( 2.9 percent).

The most-natural comparison of total payments is that between passenger cars and other types of vehicle. Of the $\$ 3.088$ billion in state road-user taxes paid by all vehicles in 1952, $\$ 1.987$ billion was paid by passenger cars; $\mathbf{\$ 1 . 0 2 2}$ billion was contributed by trucks and combinations; $\$ 59$ million by busses. The remainder is accounted for by nearly $\$ 7$ million assigned to motorcycles and $\$ 14$ million assigned to camp, farm, and other light trailers.

Table 7 and Figure 12 indıcate that automobiles constituted 83.0 percent of motorvehicle registrations in 1952 and accounted for 64.8 percent of the user taxes. Busses, relatively negligible in the gross totals, were approximately 0.3 percent of the numbers registered and contributed 1.9 percent of the user-tax revenues. Trucks and combinations accounted for 16.8 percent of the vehicles and 33.3 percent of the revenues.

A different grouping of vehicles brings out the relation of numbers and payments
more clearly. If the values for panels and pickups and other four-tired trucks are added to ihose for automobiles, we have what may be called the light-vehicle group. With this grouping it is found that automobiles and light trucks formed 93.4 percent of the registered vehicles in 1952 and contributed 73.6 percent of the road-usertax payments. Medium and heavy trucks and combinations accounted for 6.3 percent of the vehicles and 24.5 percent of the usertax payments. This finding is two-edged, in a sense. By the act of putting light trucks with passenger cars, the total of the truck contribution is diminished, but the weighting of payments in relation to numbers is increased from less than two to one to nearly four to one.

Some of the figures for individual types in the visual classification are revealing. Two-axle, six-tired trucks amounted to 5.0 dercent of the vehicles, and the tax contribution was 11.2 percent of the total. Three-axle trucks, constituting 0.3 dercent of the vehicles, contributed 1.5 percent of the revenues. Tractor-semitrailer combinations, which added only 0.84 percent to the vehicle total, paid 10.8 percent of the user-tax revenues. Truck-trailer combinations constituted 0.08 percent of the vehicles and contributed 1.1 percent of the tax payments. Combinations, as a
group thus amounted to less than 1 percent of the vehicles and contributed nearly 12 percent of the revenues.

In average payments per vehicle during 1952, it is found that the value for automobiles was approximately $\$ 45.50$; that for busses was \$404; and that for trucks and combinations was slightly less than $\$ 116$. Within the truck and combination group, there is found an average payment of $\$ 47$ by panels and pickups and $\$ 59$ by other two-axle, four-tire trucks; the general average for two-axle, four-tire trucks was $\$ 49$. Two-axle, six-tire trucks paid, on the average, $\$ 130$, and three-axle trucks about $\$ 265$. The average oayment for combinations as a groud was $\$ 745, \$ 746$ being the average for tractor semitrailers and $\$ 736$ that for truck trailers. Too much should not be made of the comparison between the two types of combinations, because of the wide difference in both numbers and geographical distribution.

In the regrouping of vehicles, automobiles and light trucks are found to have made an average payment per vehicle of $\$ 46$; the average for medium and heavy trucks and combinations was $\$ 227$.

Comparisons on a vehicle-mile basis are also given in Table 7 and illustrated in Figure 13. Here it is found that automobiles, which constituted 83.0 percent of the registrations in 1952, accounted for 80.9 percent of the traffic volume. This may be compared with their contribution of 64.8 percent to the total road-user revenues. If again automobiles and light trucks are combined, it is found that this group contributed 89.1 percent of the vehicle-miles and 73.6 percent of the revenues. Medium and heavy trucks and combinations accounted for 10.2 percent of the traffic volume and 24.5 percent of the revenues. Combinations taken alone provide an interesting comparison. They constituted 0.92 percent of the vehicles, travelled 3.4 percent of the vehicle-miles and provided 11.8 percent of the revenues.

The final comparison shown in Table 7 and Figure 13 is that made on the basis of average road-user-tax payments per mile of travel. The average payment by automobiles was 0.49 cents per vehicle-mile, or almost exactly $1 / 2$ cent. Busses paid 1.64 cents der mile of travel and trucks and combinations, as a group, paid 1.1C

TABLE 7
estimate of state higway-user taxes paid in 1952 by vehicles in different type and weight groups

| Vehicle group | Motor vehicles registered ${ }^{\text {a }}$ |  | Vehicle-miles travelled |  | State highway user taxes paid |  | Average rates of user-tax payments |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | Number | ```Per- centage dis- tribution``` | Amount | Percentage distribution | Amount ${ }^{\text {b }}$ | Percentage distribution | Per vehicle | $\begin{gathered} \text { Per } \\ \text { vehicle- }- \\ \text { mule } \end{gathered}$ |
|  | Thousands |  | Millions |  | \$1,000 |  |  | Cents |
| Pabsenger cars | 43,654 | 82.96 | 409, 271 | 80.89 | 1,987, 279 | 6478 | \$45.52 | 0.49 |
| Busses | 145 | 28 | 3,564 | 70 | 58,587 | 191 | 40405 | 1.64 |
| Trucks and combunations. Single units: |  |  |  |  |  |  |  |  |
| Two-axle, Four-ture |  |  |  |  |  |  |  |  |
| Panel and pickup | 4,629 | 8.80 | 33,971 | 672 | 217,362 | 708 | 46.96 | . 64 |
| Other | 882 | 1.68 | 7,598 | 150 | 52,318 | 171 | 59.32 | 69 |
| Two-axle, Six-tire | 2,646 | 5.03 | 32,679 | 6.46 | 343, 473 | 11.20 | 129.81 | 105 |
| Three-axle | 175 | 033 | 1,866 | . 37 | 46,375 | 151 | $\underline{26500}$ | 249 |
| Subtotal | 8,332 | 1584 | 76,114 | 1505 | 659,528 | 21.50 | 79.16 | . 87 |
| Vehicle combinations |  |  |  |  |  |  |  |  |
| Tractor-semitrailer | 442 | . 84 | 15,814 | 312 | 329,790 | 10.75 | 74613 | 2.09 |
| Truck-traler | 44 | 08 | 1,197 | 24 | 32,380 | 1.06 | 735.91 | 2.71 |
| Subtotal | 486 | . 92 | 17,011 | 3.36 | 362,170 | 1181 | 745.21 | 2.13 |
| All trucks and combinations | 8,818 | 16.76 | 93,125 | 1841 | 1,021,698 | 33.31 | 11587 | 110 |
| All motor vehicles | 52,617 | 100.00 | 505,960 | 100.00 | 3, 067, 564 | 100.00 | 58.30 | . 61 |
| Regrouping of vehicle types ${ }^{\text {c }}$ |  |  |  |  |  |  |  |  |
| Automobiles and light trucks Medium and heavy trucks | 49,165 | 93.44 | 450,840 | 89.11 | 2,256,959 | 73.57 | 4591 | 50 |
| and combinations | 3,307 | 6.28 | 51,556 | 1019 | 752, 018 | 2452 | 22740 | 1.46 |

[^0]

Figure 12. Comparison of registrations and tax payments by vehicle groups.
cents. The average for all vehicles was 0.61 cents per mile of travel. When automobiles and light trucks are combined, the average payment per mile comes out exactly at $1 / 2$ cent. Medium and heavy trucks and combinations, taken as a group, contributed 1.46 cents per vehicle-mile.

Among the general group of trucks and
combinations, it is found that two-axie, four-tire trucks paid between 0.6 and 0.7 cents per mile of travel. Two-axle, sixtire trucks paid 1.05 cents per vehiclemile, and three-axle trucks 2.49 cents, the average for single-unit trucks being 0.87 cents. The rate ner vehicle-mile for combinations as a group was 2.13 , tractor-


Figure 13. Comparison of travel, tax payments, and payments per vehicle mile.
semitrailer combinations paying 2.09 cents per mile and truck-trailer combinations 2.71 cents.

In the interoretation of these figures it should be borne in mind that they are nationwide totals and averages derived by processing in various ways the data reported by 48 states and the District of Columbia, each of which has its own schedule of user taxes, with the rates of payment differing
widely from state to state. The vehicles of each type and size group may contribute relatively more in one state and relatively less in another. The findings of this study summarize the situation as a whole, giving apmroximate values of the aggregate and average payments by each vehicle group, and thereby affording comparisons of the extent to which each group shares in the total burden of state road-user taxation.

## References

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2. "Public Roads", Vol. 27, No. 7, April 1953.
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6. "Bus Transportation", Vol. 32, No. 11, McGraw-Hill Publishing Co., New York, N. Y.
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[^0]:    ${ }_{b}$ Private and commercial motor vehicles only Publicly owned vehicles, motorcycles, and light trailers omitted.
    bublic Roads table DF, 1952, gives $\$ 3,101,306,000$ as the amount of State imposts on highway users collected in 1952
    Omitted from the amounts given in this column are $\$ 12,859,000$ in fines and penalties, $\$ 14,117,000$ assigned to light
    ctrailers, and \$6, 766,000 assigned to motorcycles
    C Panels and pickups and other Two-axle Four-tire trucks grouped wnth passenger cars

