

1916

# Construction and maintenance of Kansas City boulevard pavements

Ralph Robert Benedict



Department:

# CONSTRUCTION AND MAINTENANCE

# of

# KANSAS CITY BOULEVARD PAVEMENTS

by

Ralph R. Benedict

May 8. 1916

Submitted for
Civil Engineer Degree

Approved:

Edward Harris

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# CONSTRUCTION AND MAINTENANCE
# of
# KANSAS CITY BOULEVARD PAVEMENTS

In the first years of the history of the Park and Boulevard System of this city, road surfaces for boulevards received careful consideration for people were not satisfied with a good earth road well maintained. As the years have passed and the great changes have come in the methods of transportation, the evolution of pavements has had to keep pace with these changes.

The water-bound macadam surface was the first adopted and for the pleasure vehicle traffic at that time gave the highest satisfaction. The water-bound macadam surface was constructed with materials obtainable in this vicinity along the best lines then in practice. That some of these macadam surfaces are still in use after fifteen years of service speaks well of their construction. A number of different classes of materials were used, but the specifications for the building of the road were substantially the same. The first macadam roads were built 13 inches thick on a sub-grade that had been thoroughly rolled and compacted. All soft places were cleaned out and new material added. Such wet places as developed were drained with broken rock drains into

the nearest catch basin or manhole. On this prepared sub-grade was placed 6 inches of stone, either hand-broken in 6 inch cubes or crushed limestone running 2½ to 3¼ inches in size. This was thoroughly rolled with a road roller weighing not less than 10 tons and such depressions as appeared were patched and re-rolled until the cross section was an even gradient 7 inches below and parallel with the finished surface. On this base was placed a second course 4 inches thick constructed of crushed limestone 1½ to 2½ inches in size. This was thoroughly rolled and water finished with limestone screenings 3 inches below and parallel with the finished pavement. On this course was placed 3 inches of Arkansas trap rock of 1½ to 2½ inches in size. Before rolling, sufficient bank gravel was cast over the trap rock to partially fill the voids and provide a softer material to bond and obtain cementatious qualities for the water finish. This Arkansas trap was a very hard Diabase, dark gray in color and very difficult to bond with a roller without the addition of the bank gravel which contained a small amount of other fine material. After the top course had been flooded and rolled until there was no creeping of the surface under the action of the roller, a top dressing of trap rock screenings ½ inch in thick-

WEST PENNWAY-Subgraded and ready for base rock.

ness was added.

This macadam surface was built 36 feet wide with 12 inch crown, which was the standard width and crown of all boulevards. A combined concrete curb and gutter 30 inches wide and 8 inches high was placed just outside of the pavement giving a 40 foot roadway from curb to curb.

The inability to obtain the trap rock in sufficient quantities to keep pace with the rapid growth of the boulevard system necessitated a substitute and native limestone for the top course was chosen. In this construction only two courses were used, the first being 8 inches thick of hand-broken stone and the second 4 inches thick of crushed stone 1½ to 2½ inches in size. The top course was finished with native limestone screenings and water, thoroughly rolled and compacted. Cross walks of red Missouri granite were constructed at each street intersection both across the boulevards and side streets. These were necessary at that time to give the people a dry crossing on account of the excessive sprinkling needed to lay the dust arising from the macadam pavement. The range of prices for the water-bound macadam was from 80¢ to $1.75 a square yard, depending upon the length of haul. Native limestone was worth at the works an average of $1.25 per cubic yard, while the Arkansas

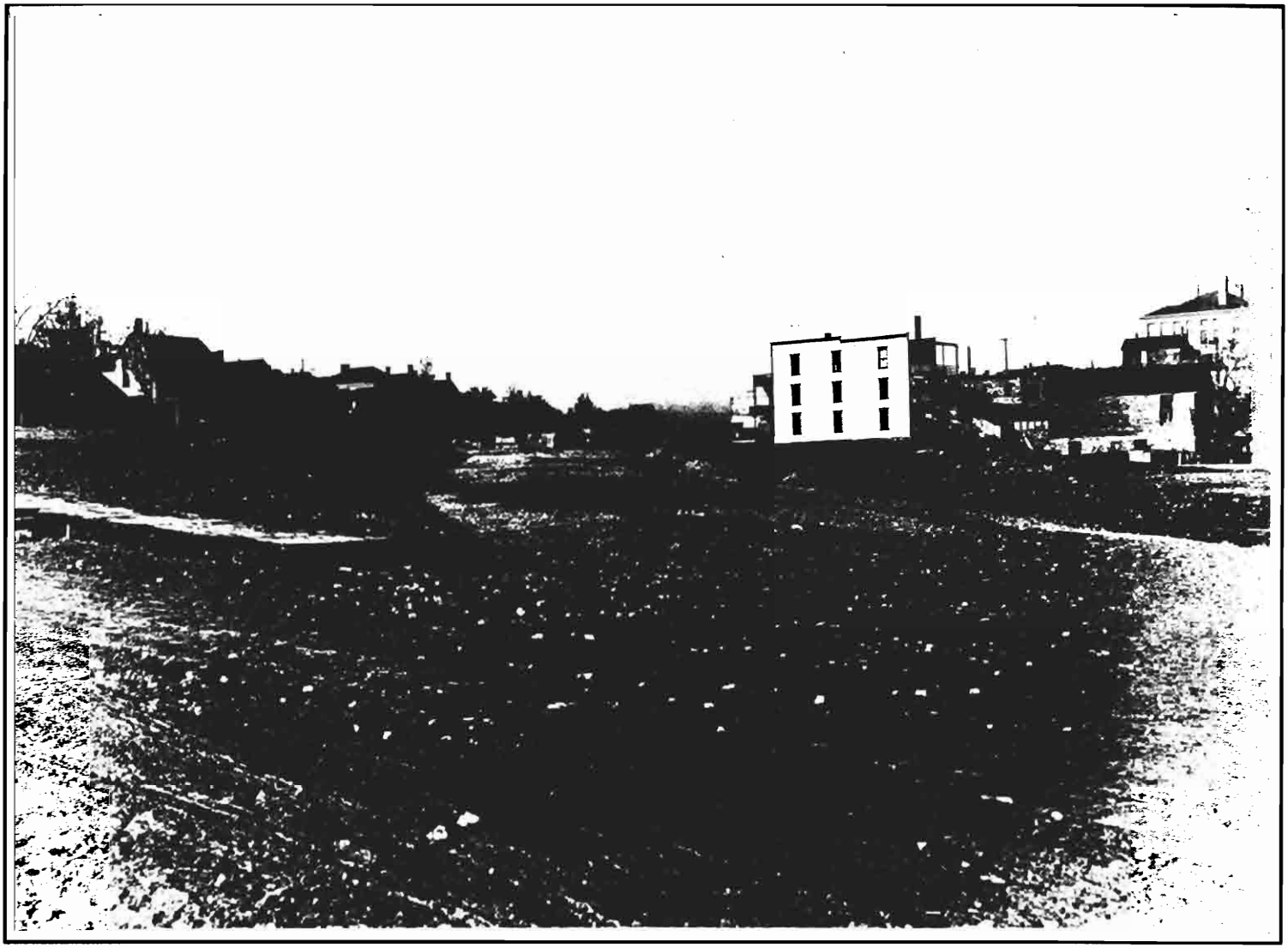
trap rock cost about $2.80 f. o. b. the works.

Owing to the increased automobile traffic and the attending high maintenance due to water sprinkling. which softened the road and allowed a fast disintegration of the surface, the laying of dust with oil fast came into prominence. In the fall of 1906 a small beginning was made, but in the spring and summer of 1907. 650,000 square yards of pavement were covered with oil, some having two applications and others only one. This oil was applied from a regular water sprinkling wagon with a tin trough attached. This trough was perforated with quarter inch holes which allowed a fairly even distribution.

When the macadam was absolutely dry, a section was barricaded and the surface was swept clean of dirt and screenings. These sweepings were left along the edge of the gutter to protect the cement work and also to be handy to cast back over the oil after it had been applied. The entire surface of the pavement was flooded with oil and thoroughly broomed to aid in getting an even distribution. The sweepings and rock dust were cast over the fresh oil to absorb such excess oil and to permit a roller to follow. After thoroughly rolling. the boulevard was opened for use. The first application

of oil was at the rate of ½ gallon per square yard and cost 1½¢ per square yard including the dust and labor of applying. The oil used at this time was a Kansas residuum of 20-21 Baume gravity containing a very small per cent of asphalt and had no bonding qualities. This oil cost 80¢ per barrel, f. o. b. Kansas City.

From the very first the use of oil for laying dust was highly satisfactory for it not only made a saving of 34 per cent the first year over the cost of water sprinkling, but the great advantage was that it kept the roads from raveling under the action of the automobiles. Instead of being harmful to the surface the automobile assisted in rolling and making firmer the oiled cushion. The cost of roadway repairs was lowered from the very beginning by the use of oil. Previous to the use of oil as a dust layer, large damages had to be repaired after each rain because of the washes along the gutters, due to the steep grades. The large stones in the top course of the water-bound macadam is a great advantage over roads constructed of small crushed rock because as soon as the road is swept the large stones are exposed and the layer of fine dust, which is so common on the macadam road built of small stones, is almost totally eliminated. This large stone



WEST PENNWAY- Second course, ready for top.

makes an ideal surface to receive the oil as the adhesion will be perfect due to the absence of fine dust.

The successive applications of the oil and rock dust have formed a mat or cushion on top of the macadam which in places are as much as 3/4 of an inch thick. This mat during the summer months remains flexible and makes an ideal surface for travel, but during the winter season the automobiles with their chains break up this mat. After the mat is broken, water stands in the depressions and before long a deep hole is worn into the macadam itself.

The failure of this oil mat on top of the water-bound macadam made it necessary to adopt some other form of surface that would withstand the enormous automobile travel at all times of the year.

The next surface was constructed of bituminous macadam using the penetration method and the first bitumen used was the Tarvia. This road was built 12 inches thick in 3 layers. The base was 6 inches thick. of large hand-broken limestone and rolled with a 10 ton roller. The next course was 4 inches thick of crushed limestone of $1\frac{1}{2}$ to $2\frac{1}{2}$ inches in size. This course was water sealed with limestone screenings and after it had thoroughly dried out, was covered with a 2 inch course

of crushed limestone of the same size as the second course. Into this was poured 1½ gallons of Tarvia over which was cast limestone grit of ¼ to ⅜ inch in size. Only such amount of grit was used as to thoroughly cover the stone and allow a roller to pass over without picking up the Tarvia. The top course was rolled with a tandem roller weighing 7 tons. The method used in distributing the Tarvia was from tank wagons equipped with a hose connection and with a fire box for maintaining a constant heat. After the surface had been in use for a week or more it was given a light treatment of oil similar to that used in oiling water-bound macadam. This oil was applied by the park maintenance force and was not a part of the contractor's job. The surface was not swept before applying the oil and no dust or screenings were cast over the fresh oil. Just enough oil was used to soften the Tarvia and absorb such dust and grit as remained on the surface. This oil has acted as a weatherproofer so that there has been no coking or disintegrating of the Tarvia surface.

All the pavements laid under this specification have been down a number of years and have given the best of satisfaction. The cost of this class of pavement averages about $1.35 per square yard with the

limestone costing $1.50 f. o. b. the job, Travia 10¢ a gallon, labor $2.00 a day of 8 hours and teams $4.00 a day for 8 hours.

The increased amount of travel on the boulevards during the past four years has caused an increase in the width of the boulevards. The standard boulevards are now being constructed 50 feet wide between the curbs, thus making 46 feet of pavement between the gutters. Also with the use of the bituminous surface the crown has been decreased to less than ½ inch to the foot.

In 1911 the specifications for the construction of boulevard pavements were enlarged upon so as to include the penetration method of constructing bituminous pavements by the use of asphalt products. These specifications provide for 3 courses of rock similar to the construction of the Tarvia road above given. But the treatment of the top course is the important change in the specifications. The following specifications for the asphalt binder is used:

"Asphaltic Cement. The asphaltic cement, considered apart from any mineral matter which it may contain, shall conform to the following analysis:

(1) It shall be free from water or decomposition products.


WEST PENNWAY- Completed.

(2) The various hydrocarbons composing it shall be present in homogeneous solution, no oily or granular constituent being present.

(3) It must be of such consistency that at a temperature of 25° C. a No. 2 needle, weighted with 100 grams, will not in five seconds penetrate more than twelve, and less than eight and one-half millimeters. The No. 2 needle referred to is a common sewing needle about one millimeter in diameter and tapering uniformly to a sharp point for one centimeter of its length.

(4) When fifty grams of the material is maintained at a uniform temperature of 163° C. for five hours in an open cylindrical tin dish five and one-half centimeter in diameter, with vertical sides measuring approximately three and one-half centimeters in depth, the loss in weight shall not exceed two per cent of the original weight of the sample.

The penetration of the residue, when tested as described in clause (3) with a No. 2 needle under a load of 100 grams, for five seconds at 25° C. shall be not less than one-half the penetration of the original material tested under the same conditions.

(5) It shall be soluble in chemically pure carbon disulphide ($CS_2$) at air temperature to the extent of at

least ninety-nine and one-half per cent.

(6) It shall be soluble in 86° to 88° Baume paraffin naptha, of which at least 85 per cent distills between 35° and 65° C. to the extent of not less than 75 per cent nor more than 85 per cent of its bitumen as determined by clause (5).

(7) Its solubility in carbon tetrachloride shall not be more than one per cent less than its solubility in carbon disulphide—both tests being made at air temperature.

(8) It shall show of fixed carbon not more than fifteen per cent.

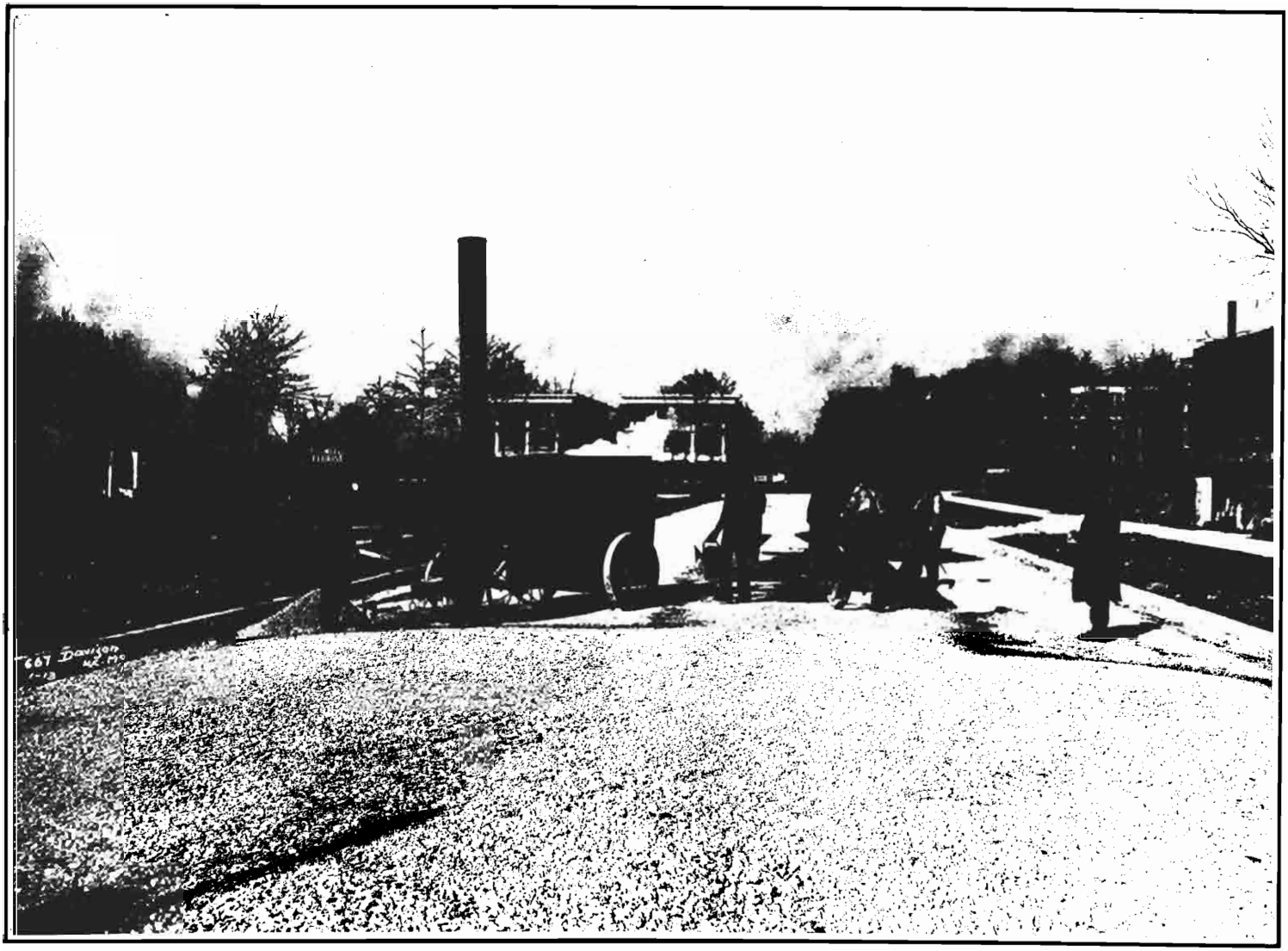
(9) It shall show a flashing point (New York State Closed Oil Tester) of more than 205° C.

(10) Its viscosity at a temperature of 0° C. shall be not less than 0.15 grams. Viscosity of asphaltic cement by the terms of this contract shall mean the number of grams of asphaltic cement that will, in four hours, be forced through a circular orifice one centimeter in diameter, by a pressure equal to that exerted by a column of mercury 150 centimeters high. The asphaltic cement during this test shall be contained in an iron cylinder 42 millimeters in diameter and 100 millimeters high, and the thickness of the plate through

which the orifice is made shall not be more than two millimeters.

(11) Its ductility, at a temperature of 25° C. shall be not less than 20 centimeters or more than 75 centimeters. Ductility, by the terms of this contract, shall be understood to mean the distance in centimeters that a cylinder of asphaltic cement, one centimeter in diameter, can be drawn out at the rate of one centimeter per minute. The drawing out shall be accomplished by means of two similar clips cylindrical in form, of inside diameter of about three centimeters, open at one end and having a concentric orifice one centimeter in diameter through a circular plate, not more than 0.5 millimeters thick and covering the other end. To make a determination, one of the clips is placed on a smooth surface with the open end down. The other clip is then placed on top of the first with the open end up so that the one-centimeter orifices coincide. The hot asphalt cement is poured into the top one slowly so as to fill both clips completely. The temperature of the asphaltic cement in then adjusted to the temperature of 25° C., and the clips pulled apart at the rate of one centimeter per minute."

Into the top course not less than 2½ gallons




THE PASEO-Applying asphaltic cement.

of asphaltic cement at a temperature of 350° Fahrenheit is poured, requiring two operations. The first pouring consisted of 2 gallons per square yard and over this was cast limestone grit of $\frac{1}{4}$ to $\frac{3}{4}$ inch in size. This is rolled with a 7 ton tandem roller, after which the excess grit and dust is swept off by means of hand brooms and the second application of $\frac{1}{2}$ to $\frac{2}{4}$ gallon per square yard of asphaltic cement is added. This asphalt is spread with rubber-lipped squeegees or fibre brooms. Over this is cast the limestone grit and the surface again rolled. This class of pavement costs $1.45 a square yard with asphaltic cement at $21.00 a ton f. o. b. the works, the rock and labor being the same as for the Tarvia specifications.

The equipment for applying the asphaltic cement consists of two 500 gallon portable kettles and several hand pouring pots. This is a crude method of application, but with the squeegee makes a fairly uniform coating. One of the main essentials in constructing this class of pavement is the uniformity of distribution of the bitumen.

From the results of the earlier pavements we learned the important lesson on drainage of the subgrade for most of the failures of the water-bound macadam

primarily started with poor drainage of the subgrade. Instead of draining only the wet places that appear in the subgrade, our method is to lay 2 drains of 4 inch unjointed, unglazed pipe near each gutter and 18 to 24 inches below the finished surface of the pavement. This drain tile is laid to a uniform slope and is connected with the nearest catch basin or manhole.

Under the provisions of the charter. the city is divided into park districts and the money for the maintenance of the boulevards is raised by a levy on the land values of real estate in that district. This gives a constant fund in which to maintain the boulevards without going through the red tape so often encountered in municipal work. Maintenance is by means of the patrol system. This patroling is done by repair crews consisting of four men, one three horse wagon, one small tandem roller, one small portable kettle, which constantly makes the rounds of the boulevards and park roads fixing every break in the road surface no matter how small. These wagons are mounted on low gears and have special beds divided into three compartments, one compartment for the rock and large enough to hold 2700 pounds, one compartment for grit of such size as to hold 5400 pounds and the third for asphalt with a storage

capacity of 3 barrels. The small kettle has a capacity of 150 gallons and is so constructed as to provide for the addition of asphalt from time to time, thus maintaining a constant supply of the hot asphalt. These repair crews also patch all the cuts of the public service corporations made in the roadway of the boulevard. All excavations in the boulevards are controled by permits issued through the Park Board office and when these excavations are ready for backfilling, the office is notified at least four hours in advance of such work in order that an inspector may be sent out to see that the backfilling is properly tamped dry and in such small layers as to insure a cut that will not settle after being repaired. The proper care of excavations is a very important detail in the proper maintenance of boulevard surfaces for there is as much damage caused by these excavations as there is from wear due to traffic.

Before the advent of the patrol system of maintenance, which has only been adopted during the past two years, a number of the boulevards were in such condition that resurfacing was necessary. This resurfacing is accomplished by park forces and consists of placing $2\frac{1}{2}$ inches of crushed limestone on top of the old surface in the following manner: the boulevard

is thoroughly swept with a rotary street broom to remove such fine particles of dust and oil that has accumulated. Along each gutter a strip is excavated to such a width and depth as to permit the application of 2½ inches of stone. This stone is native limestone of 1½ to 2 inches in size and is placed on the old surface at least 2 stones deep, which, after rolling, gives a finished surface of 2½ inches thick. No scarifying or picking is done. After the surface has been sufficiently rolled to thoroughly key the stone, 1½ gallons of asphaltic cement, which conforms to the specifications previously mentioned, is poured by means of hand-pouring pots. Over this is cast limestone grit and thoroughly rolled. The excess grit is then swept off and a seal coat of ½ gallon of asphaltic cement of the same grade is poured and grit used and rolled as before. A good many thousand yards of this resurfacing has been done by the park maintenance force. As an experiment only one pouring of asphaltic cement was used in the first resurfacing work, but after one season it was necessary to go back and apply the seal coat. This work was done at a cost of about 40¢ per square yard for the first treatment and 15¢ for the seal coat with prices the same as above quoted. There are a number of these resurfaced boulevards that have

GLADSTONE BOULEVARD-Showing standard boulevard construction.

been finished for two years and they are in as good condition as when first constructed.

On one boulevard, which is subjected to very heavy traffic on account of the absence of any directly parallel streets, a resurfacing contract was let that called for a different material in the top course. A Wisconsin granite was specified for the wearing course in the hopes of obtaining a stone sufficiently hard to withstand the abrasion of the heavy steel tired traffic. This granite, very dense and closely grained, was 1½ to 2¼ inches in size. The old water-bound macadam was excavated to 3 inches below the finished surface of the pavement. This was rolled, water-sealed and allowed to dry out before the granite was spread. This was again rolled and 2½ gallons of hot asphaltic cement was poured and granite chips of ¼ to ¾ inch in size were cast over the surface. This was rolled, the excess chips swept off and the seal coat of ½ gallon per square yard was poured. More chips were added and rerolled.

After the job had been in progress a week, the first work completed began to show signs of breaking up under traffic. The method was then changed by putting the granite top course down in two layers and adding some limestone grit, causing the granite to bond under

the action of the roller. A layer of 1½ inches of granite was spread over the subgrade as previously prepared and into this was cast limestone grit and 2 gallons of asphaltic cement, more limestone grit used and this layer rolled. The top 1½ inches of granite was then placed, rolled and two additional gallons of asphaltic cement used. Over this was cast the granite grit and rolled, after which the excess grit was swept off and the seal coat of ½ gallon was used. No more trouble was experienced with the surface cracking, but the first work completed had to be entirely removed and reconstructed according to this last method. The pavement gave very good satisfaction the rest of the season and until the hot weather of the next year when the asphaltic cement began to run or bleed. As soon as the bleeding started, limestone grit and binder from ¼ to 1¼ inches was added from time to time in such quantities as to absorb the excess asphalt. This was rolled with a 10 ton roller longitudinally, which prevented waves from forming. The surface has now passed two seasons and is in very good condition.

Another type of resurfacing was built on a park road. The road was originally constructed of 10 inches of crushed limestone in two courses, the first

course being 6 inches thick and using crushed stone of 1½ to 2½ inches and the top course being 4 inches thick using about the same size stone. In the resurfacing. all loose material was swept from the surface with a rotary broom, after which the top crust was broken with a 10 ton roller equipped with spikes. This was followed with a scarifier which thoroughly loosened the surface for a depth of at least 6 inches. The large sized stones were harrowed to the top by means of an heavily weighted "A" shaped harrow. The roadway was reshaped by the use of a common road grader and where necessary new stones added to bring the surface to an even gradient. After this had been thoroughly rolled with a 10 ton roller, 1 gallon of hot asphaltic cement was poured, limestone grit added and rerolled. This construction gave a surface that has been highly satisfactory for the past three years and has not required any maintenance except a light application of oil once a year. The resurfacing work was done at a cost of about 30¢ per square yard.

This method is impractical on the main traveled boulevards. The internal wear of the surface has ground the large stones into such small ones that no amount of harrowing would give a surface suitable for pouring.

With the constant changes in roadway specifica-

tions has come changes in the oiling methods for although the bituminous macadam surface makes a resisting pavement for auto travel, it is not absolutely dustless. The old gravity oil sprinkler has been replaced with a pressure distributor that gives a very even distribution of the oil and the amount of oil used can be controlled to a fractional part of a gallon. This pressure oiler was made in the Park Board shops and consists of a centrifical pump attached to a steel oil tank mounted on the running gears of the former water sprinklers. This pump is driven by sprokets and chains connected to a rear wheel. The pressure is controlled by a pressure valve which is worked by the operator who rides at the rear of the tank. The oil is distributed by means of one-half inch pipes constructed in the shape of a T. Three spray nozzles are connected with this pipe and have a sprinkling range covering 20 feet of the roadway. These nozzles are controlled by a combination of levers or a separate lever so that they may all be put into action or that one or more may be shut off. Limestone dust is still used over the fresh oil, but in very small amounts. In this method only one-half of the roadway is oiled on the same day thereby allowing travel the use of the boulevard at all times.

PENN VALLEY PARK- Showing standard parkway drive.

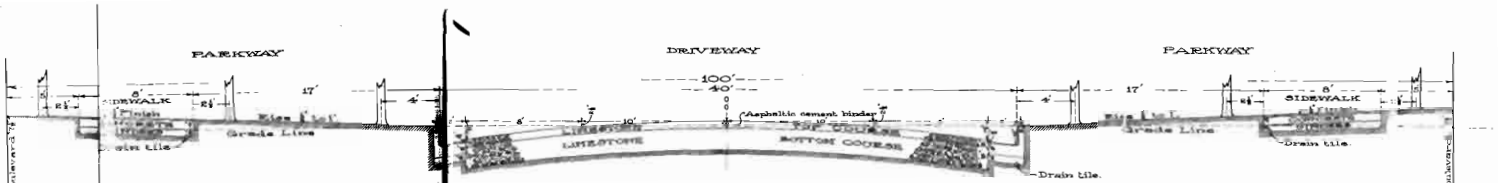
The average oiling is done at the rate of .07 of a gallon per square yard and at a cost of $.004 per square yard, which includes the cost of the oil and the cost of the dust and labor of applying same. The oil used is a Kansas residuum oil of 19 degrees Baume gravity and costs 2¾¢ a gallon loaded into the oil wagon.

The present specification for the bituminous macadam provides for only 2 courses, the base being 9 inches thick and the top 3 inches thick. Large hand-broken limestone in such sizes as not to exceed 9 inches is used in the base and crushed limestone 1½ to 2½ inches in the top course. Over the base course is cast small stone, grit added and rolled until the voids are sealed to prevent the asphalt from penetrating too deep. The top course with the same amount and grade of asphalt is applied similar to the previous specifications.

There is probably no form of engineering work so constantly before the people as road building. That the ideal pavement must be durable, noiseless, easily cleaned, easily and cheaply maintained, have low tractive resistance, low original cost and an aesthetic surface are points that are absolutely without argument, but whether the bituminous macadam pavement now being used will fill the above requirements is still a debated

question and one that time will be able to answer better than the engineers of today.

But with the great development of motor transportation and the advent of the large motor busses, the paving of the future boulevard assumes a place along side of the trafficway problem. That some harder surface is surely to follow this enormous increase of traffic is without question. Just what that surface will finally be is one of conjecture, but the improved method of treating and laying creosoted blocks is fast bringing this class of road surface to the place of fulfilling the requirements of the ideal pavement.




Cross Section of Standard Boulevard


Cross Section of Standard Parkway Drive