MEASUREMENT OF AUTOMATIC
SPRINKLER DISTRIBUTION

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Investigation of the Design of Apparatus for the Measurement of Automatic Sprinkler Distribution

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C O N T E N T S.

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PREFACE.

Previous to this time the problem of de-signing apparatus for the determination of the distribution of water from an automatic sprinkler has been worked out on two occasions.

Both times apparatus has been designed by means of which this distribution could be accurate-ly obtained. The first apparatus consisted of 144 pans, each one foot square at the top and one foot in depth, a device for exposing the pans to the water from the sprinkler head for a definite length of time, and a calibrated tank for measuring water to one-twentieth of a gallon.

The second design consisted of a series of 12 pans mounted on a sector of a circle, 7.5" in radius and sub-tending an angle of 45 degrees, and a device for exposing each pan for a definite length of time. In place of measuring the water in each pan the weight of each pan empty was known, and after the test the amount of water in each pan was ascertained by weighing.

Time has shown that neither of these methods is feasible, inasmuch as neither method is in use at present.   The reason for this is because both sets of apparatus are such that the measuring of the distribution of water from an automatic sprinkler is a very cumbersome and tedious test, requiring at least 1-1/2 to 2 hours time for a single run.

The need of some apparatus by means of which the distribution can be obtained in a much shorter time and with much less tedious work is very evident.   The design of such apparatus is the object of this investigation.

C H A P T E R   I.

INTRODUCTION.

At the beginning of this investigation it was decided that, if apparatus could be designed which could eliminate the necessity of having to handle each pan after each run, the tedious and cumbersome part of the test would be eliminated. This would require two designs: first, an instrument for measuring the amount of water in each pan; second, some means of draining the water from each pan other than by dumping each one individually.

Owing to the fact that the first design of apparatus with the 144 pans required that the actual run of water from the sprinkler head be only 1/8 the length of time that the sector method required, it was decided to try to design apparatus to use with these pans.

In all, three pieces of apparatus were designed and tried out before obtaining a device which would give accurate and satisfactory results.

The base A Fig. I of the first instrument was designed to sit on the tops of the pans. A hole, 3/4" in diameter was based in the middle of the base to take a wooden upright 22" long. A semi-circular wooden arc "B" was nailed to this upright as shown. A cork float "C" 2" in diameter was fastened by means of a stiff wire to a movable member "D" 12" long. This member was pivoted to the upright to give a 3 to 1 ratio.
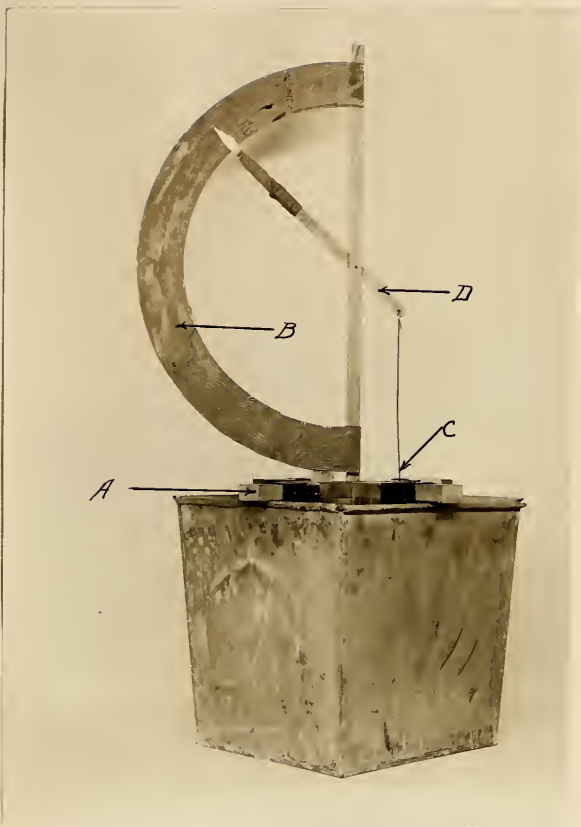
Fig. I
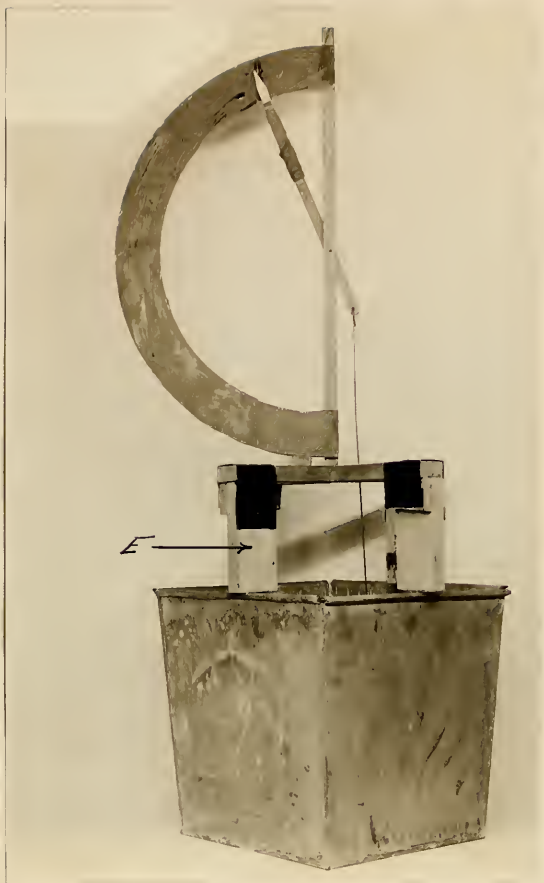
Fig. I'

Owing to the fact that the instrument as first designed would measure depths of water in the pans up to only 5-1/2", it was necessary to design some means of measuring larger quantities. Movable block SE, Fig. I¦,3"x1"x5" long were fastened to each of the four pieces of the base in such a way that, when not in use, they could be moved in so that they would be inside the pan. When it was necessary to use them, they could be moved out to the edge of the base so that the instrument would set on them.   The pointer was then redesigned so that it could be read on either side of the arc.   The other side would be calibrated to read the quantity of water in the pans from 5-1/2 to 10-1/2".

The question then arose as to whether or not the pans were made with sufficient uniformity for one instrument to give accurate readings on all pans.   In order to investigate this question ten pans were picked at random and the instrument was calibrated in 1/2 gallon increments from 1/2 gallon

up to 5-1/2 gallons. The amount of water necessary to make up the difference between the minimum and maximum position of the pointer for corresponding increments was obtained by actual test on a set of scales. Working under the supposition that a mark half way between the minimum and maximum would be taken in the final calibration, the maximum percentage error that would result by doing this was worked out for each increment. (Table I)

This error for the lower readings was too large. It was noticed, however, that the error was not due as much to the non-uniformity of the body of the pans as it was to the un-evenness of the top edge.

T A B L E   I.

Reading.	Maximum		Minimum		Diff.	Average.	% Error.
	Lbs.	Ozs.	Lbs.	Ozs.			
.5	12	14.5	12	5	8.5	4.25	6.4
1.0	17	3	16	10	9	4.5	3.4
1.5	21	5	20	13	8	4.0	2.0
2.0	25	10.25	25	0	10	5.0	1.9
2.5	29	11	29	2.5	8.5	4.25	1.28
3.0	33	15.5	33	8	7.5	3.75	.95
3.5	38	1	37	4.5	12	6	1.29
4.0	42	6.5	41	8.5	14	7	1.31
4.5	46	6.5	45	8.5	14	7	1.17
5.0	50	10.5	49	12.5	14	7	1.05
5.5	54	7	53	9	14	7	.96

N O T E:

"Reading"- The instrument reading in gallons.

"Maximum"- The gross weight in lbs. and ounces of pan, instrument and water to give the maximum reading as given by any pan for this increment.

"Minimum"- The gross weight in lbs. and ounces of pan, instrument and water to give the minimum reading as given by any pan for this increment.

"Difference"- The difference in ounces between the maximum and minimum reading.

"Average"- The difference in ounces between a point taken half-way between the maximum and minimum reading and either the maximum or minimum reading.

C H A P T E R III.

The primary idea in the second design was
to make an instrument working on the same
principle as the first one with sufficient changes
to eliminate the undesirable features.

The base of this instrument was made so that
it would set on the bottom of the pan.   This
necessitated that the length of the upright member
(A Fig. 2) be increased $12''$.   The arc (B Fig. 2)
on which the reading would be obtained was made of
No. 20 galvanized iron with paper fastened on each
side to allow marking.   The indicator (C Fig. 2)
or pointer was made of much heavier material.   The
indicating end was cut in such a way that readings
could be obtained on both sides of the arc.   The
float and wire connection were the ones used in
the first design.

In making the first tests it was observed
that in placing the instrument in the water, the
water was distrubed to such an extent that it was
impossible to obtain an instantaneous reading.
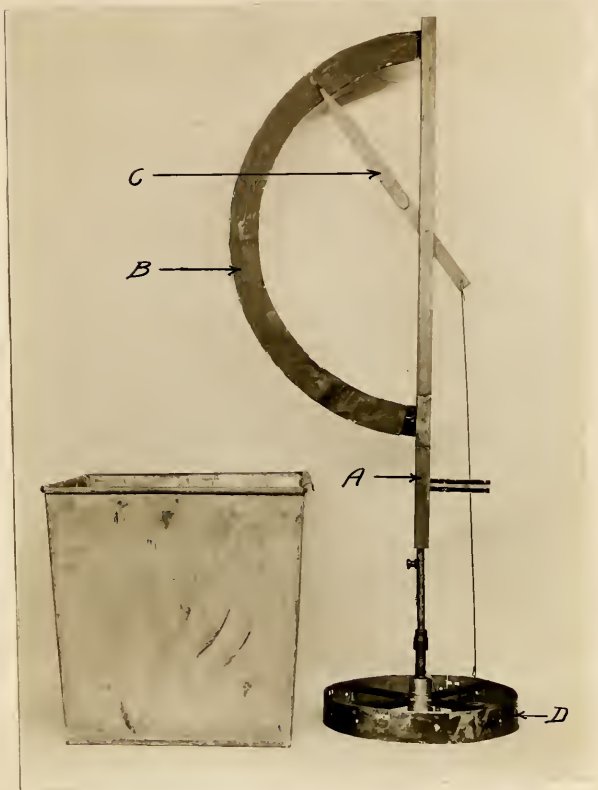For that reason the base was redesigned in the form

Fig. II

of a wheel. (D Fig. 2)   With this arrangement
there was a minimum amount of disturbance.

It was now necessary to design some attach-
ment whereby depths greater than 5-1/2" of water
could be measured.   A design for a telescoping
base was first worked out and tried.   This proved
a failure, due to the fact that it slowed up the
process to a marked extent and that it made the
instrument very awkward to handle.   The following
arrangement, however, was worked out, tried, and
proved a success.   The wooden upright was re-
moved from the hub, the hub was tapped and a piece
of 1/4" pipe (E Fig. 2) 8" long was screwed into it.
Eight inches was cut off the bottom of the upright,
the end was bored to a depth of 2" to take a piece
of Bessemer steel rod (F Fig.2') 1/4" in diameter.
A piece of 1/4" Bessemer steel rod 9" long was
taken and two small holes bored through it 5" apart,
the first one being 2-1/2" from one end.   A groove
1/8"x3/32" was then cut in the rod running from hole
to hole.   The piece of 1/4" pipe mentioned before
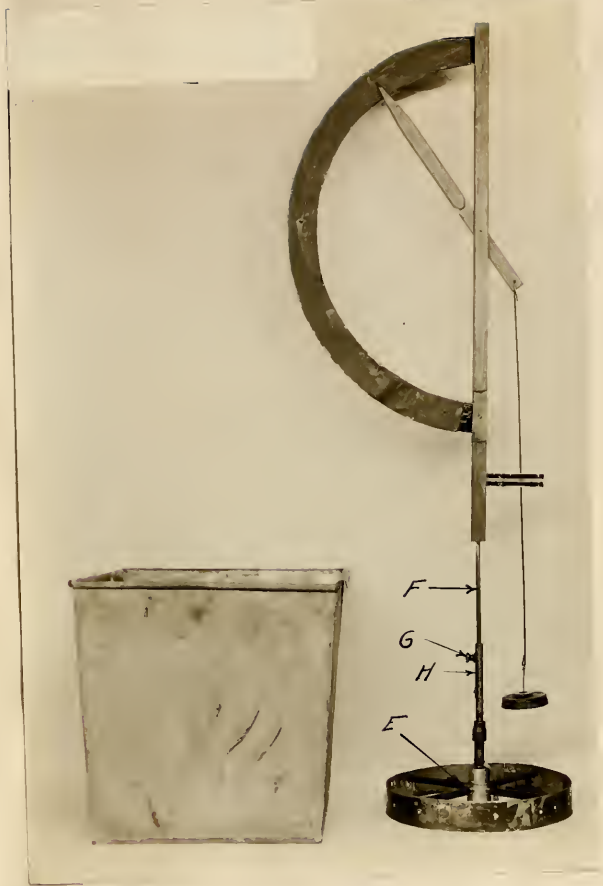was bored 1/2" from the upper end with a 1/16" hole

Fig. 2'

in which a pin, (G Fig. 2) which extended 3/16"
into the pipe was held in place by a flat spring.
(H Fig. 2).   One end of the rod made a tight fit
into the end of the upright, the other end fits
into the 1/4" pipe.

By this means, when the pin was in the top
hole in the rod, quantities of water up to 5-1/2"
in the pan could be measured, the readings being
taken on one side of the arc.   To measure
quantities between 5-1/2" and 10-1/2", the pin
would be pulled out far enough to permit the rod
to move.   The pin, following the groove would
allow the upright member to be raised until the end
of the groove was reached when the pin would drop
into position in the other hole, thus fastening
the upright in this position.

The same procedure as described with the
first design to test for the uniformity of the pans
was repeated.   This time, however, the calibra-
tion of the ten pans was only carried up to 2-1/2
gallons, inasmuch as the previous test had shown
that from this point on the percentage error was
decreasing.   (Table II)

T A B L E II.

Reading.	Maximum Lbs.	Maximum Ozs.	Minimum Lbs.	Minimum Ozs.	Diff.	Average.	% Error
.5	12	3.5	12	0	3.5	1.75	2.5
1.0	16	5.5	16	1	4.5	2.25	1.65
1.5	20	9	20	5	4.0	2.0	1.05
2.0	24	13.5	24	8.5	5.5	2.5	1.03
2.5	28	15	28	8.5	5.5	2.75	.8

This instrument, although workable, and
fairly accurate, had some bad features which it
was thought would interfere with the speed at
which it was desired to run the test. For in-
stance,- the float from time to time became
caught on the base and would not function. The
fact that the instrument was such that two settings
were necessary added to its complications, and
increased the time element of the test. For
these reasons it was decided to try to work out a
third design which would have all the good points
of the previous instrument, but none of the points
which added to its complication, or the time of
the test.

In the third design a wooden disc (A Fig.3) 15" in diameter and 1/2" thick was supported on its edge by three legs (B Fig. 3) of 1/4" iron rods spaced so that they would rest in the bottom of the pan.   A double bearing (C Fig. 3) was mounted at the center of (A) at the back.   A wooden pulley (D Fig. 3) fastened to a small shaft was mounted here and kept so that it would not move horizontally by means of a block and pin (E Fig. 3)   This pulley was flanged and was constructed to give a 11-1/2" circumference in- side the flange.   A pointer (F) was fastened to the rim of the pulley.   This was of sufficient length to give a 4 to 1 ratio in the readings. It was found necessary to counterbalance the pulley on the side opposite the pointer.   This was done by drilling a hole in the face of the pulley and filling it with solder. (K Fig. 3)

Two strands of No. 30 enameled copper wire, twisted together for added strength, were passed around the pulley 1-1/2 turns.   A cork float
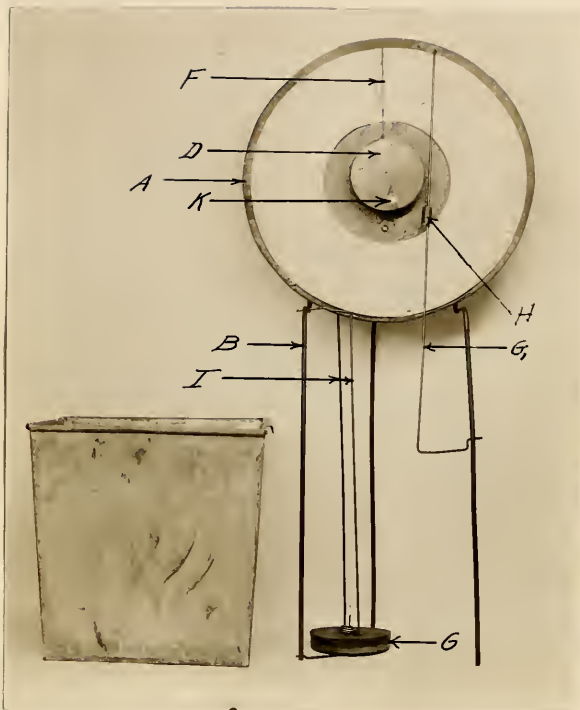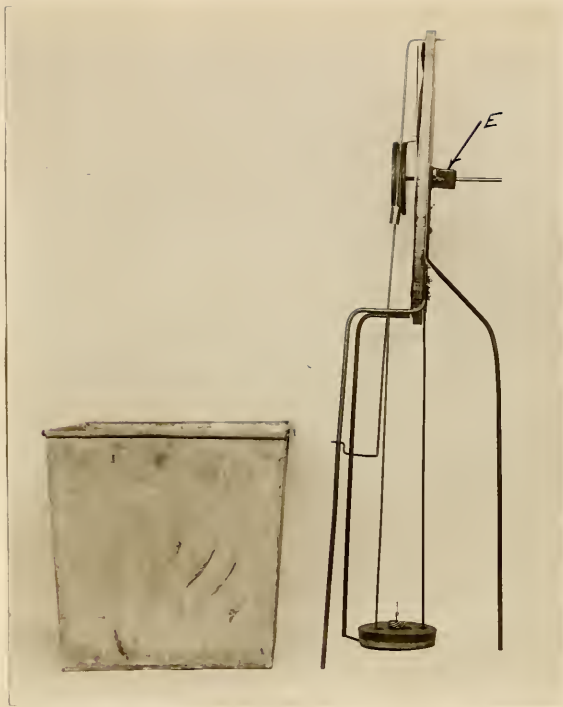
Fig. 3

Fig. 3

(G Fig. 3) was fastened to one end of the wire and a counterweight (H Fig. 3) was fastened to the other. The cork float, as it functions, is guided by two small rods (I Fig. 3) of Bessemer steel each of which passes through a hole in the cork. The counterweight is also guided by a similar rod (G1). The wire is fastened to the pulley by a small nail so as to prevent slipping of the wire on the pulley.

The same proceeding as described with the first design to test for the uniformity of the pans was repeated. The results and the action of the instrument were such that it was decided to proceed with its calibration. (Table III)

A paper dial was cut out and fastened to the frame (A) by means of thumb tacks. It was decided that owing to the fact that all pans did not give the same reading on the instrument for corresponding half-gallon increments, the calibration would have to be done with two pans, one which gave the maximum reading, and the one which

T A B L E   III.

Read-	Maximum		Minimum				
ing.	Lbs.	Ozs.	Lbs.	Ozs.	Diff.	Average.	% Error.
.5	14	3.5	13	15.5	4	2	3.0
1.0	18	9.0	18	4.5	4.5	2.25	1.65
1.5,	23	6.5	23	0	6.5	3.25	1.62
2.0	27	15	27	11	4.0	2.0	.8
2.5	32	3	31	13.5	5.5	2.75	.9
3.0	36	6	35	15	7	3.5	.82

gave the minimum reading. Then the final
calibration taken would be a point midway be-
tween the readings given by these pans. The
pans were first weighed, and then the instru-
ment was calibrated in 1/10th gallon increments
up to 6 gallons. The calibration dial was
definitely marked with regard to its position
on the frame. It was then removed and a scale
drawn in ink to read to .01 of a gallon. The
scale was then replaced.

Twentyfour pans were selected at random,
weighed,and marked. An unknown quantity of
water was placed in each pan. This quantity
was measured by means of the instrument and
tabulated. Each pan was again weighed and
the actual amount of water in it calculated
and tabulated. The maximum error made by the
instrument was.037 gallon, the minimum .001
gallon, and the average error .016 gallon.
(Table No. 4)

This last instrument showed a great im-
provement over the previous ones, inasmuch as

T A B L E   IV.

Pan No.	Weight Empty Ozs.	Weight With Water Ozs.	Amount of Water Gals.	Instrument Reading	Gals. Error.
1	101.25	356.25	1.913	1.924	.011
2	105.75	186.5	605	60	.005
3	96.5	317.0	1.654	.672	.018
4	103	324.5	1.662	1.641	.021
5	101	334.0	1.748	1.759	.011
6	99	223	.931	.915	.016
7	98.5	239.5	1.058	1.032	.036
8	100.5	437.0	2.524	2.56	.036
9	99	423.0	2.468	2.457	.011
10	99.5	261.0	1.204	1.228	.024
11	96.5	355.0	1.939	1.923	.016
12	100.0	234.5	1.008	.978	.03
13	100.0	232.5	.997	.987	.01
14	98.0	391.0	2.19	2.153	.037
15	101.5	315.5	1.605	1.63	.025
16	100.0	419.0	2.393	2.407	.014
17	103.5	168.0	.483	.488	.005
18	99.0	169.0	.525	.512	.013
19	102.0	175.5	.551	.555	.004
20	99.0	155.0	.420	.417	.003
21	101.0	244.5	1.076	1.075	.001
22	101.5	275.5	1.305	1.307	.002
23	100.0	324.5	1.684	1.662	.022
24	100.5	224.0	.926	.928	.002

it practically gave an instantaneous reading, only one scale was necessary, and a larger ratio was obtainable on the scale.

The results obtained with this last instrument were such as to convince the writers that they had finally arrived at the goal which they had been seeking as far as the first problem of design was concerned.   The last problem of design, that of apparatus for expeditiously disposing of the water in the pans, was worked out only on paper, owing to the lack of time.   No apparatus of this kind has been made up and the writers are only submitting the design as a suggestion that may prove worthy of further consideration by others who take up the work.

C H A P T E R   V.

Owing to the fact that it was desirable that future sprinkler distribution tests be run in the hydraulic laboratory, a piece of apparatus was designed which required for its working the drainage pit running between the Quimby pump and the pressure tanks in this laboratory.

This apparatus is such that 72 pans will be dumped in one operation.   In other words it is really made up of two similar pieces of apparatus, each of which will take care of 72 pans.

The frame work is as shown in the enclosed drawing, made up of tees, angle irons, and stay rods, the whole being covered with No. 16 gauge galvanized iron.   The flanges of the tees are so located that they will fit in between two rows of pans which have a clearance of 1-1/2" at the bottom.   The part (A Fig. 4) on the drawing is the means by which the pans are kept from sliding off the frame during the dumping opera-

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tion.   The part marked clamping frame
(Fig.5) is also used only during the dumping
operation.   After the test, this piece of
apparatus is laid on top of the pans and
fastened securely to the frame by means of the
clamping rods (B Fig. 4), and the posts (C Fig.4)
so that the pans are held securely to the frame.

Another piece of the apparatus required
with this design is the piece shown on the draw=
ings as the "joining strip".   It is merely a
piece of galvanized iron bent and cut in such a
manner as to make a tight connection between the
two sets of 72 pans. Fig. 6.

The preferable place for the location of
the sprinkler will be at the point directly over
the middle of the pit so that at the end of a
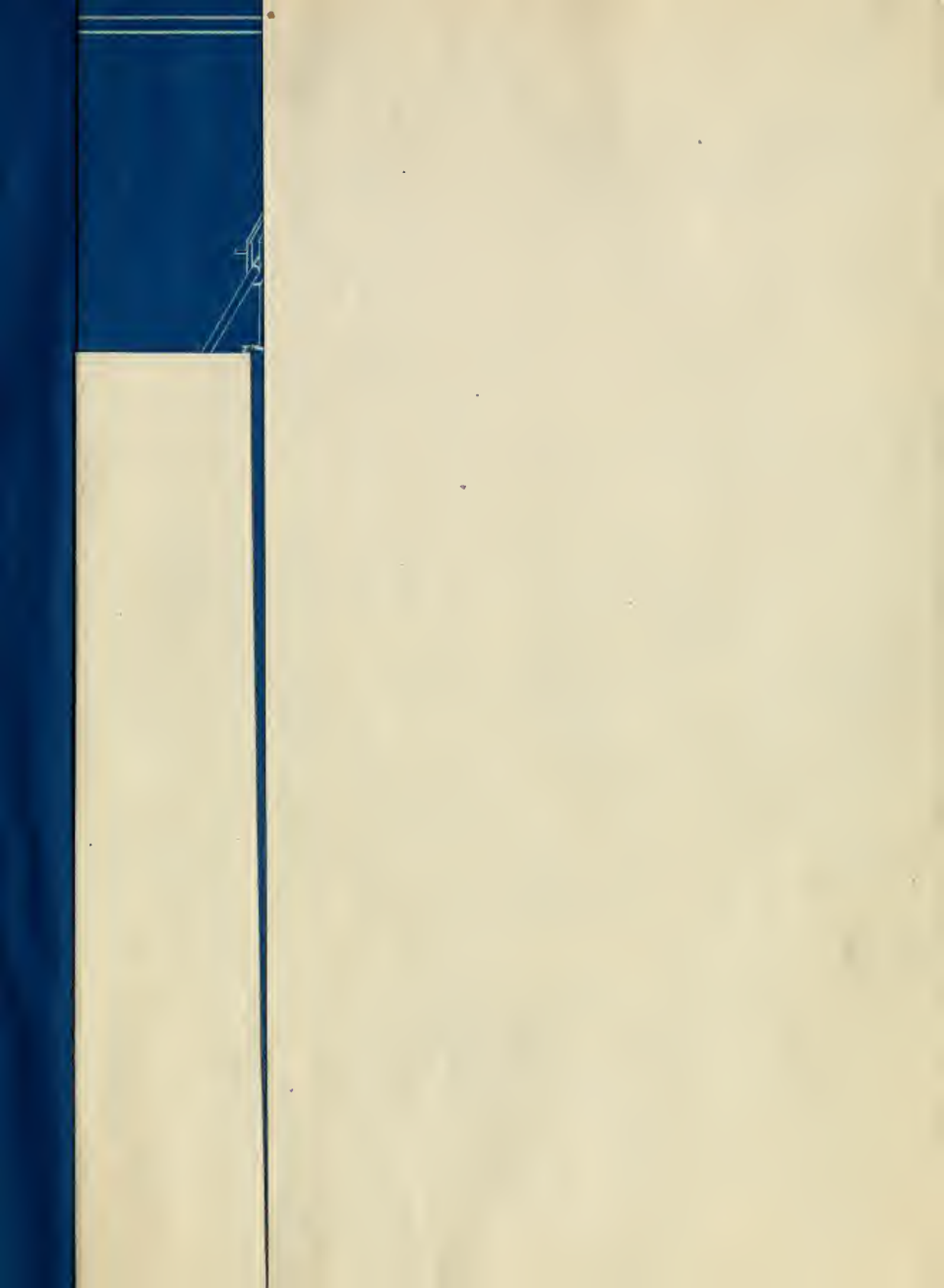test each set of pans may be rolled back to its
own side of the pit.

P.28

Climbing frame

SCALE ½"=1'-0"
Fig 5

3'   3'

Inlay strip

1'-0"
12'-0"
1'-0"

SCALE 3"=1'-0"
Fig 6

SCALE 1"=1'-0"   Fig. 4

6'-4"

6'-5"   2

6

6'-6"

6

3
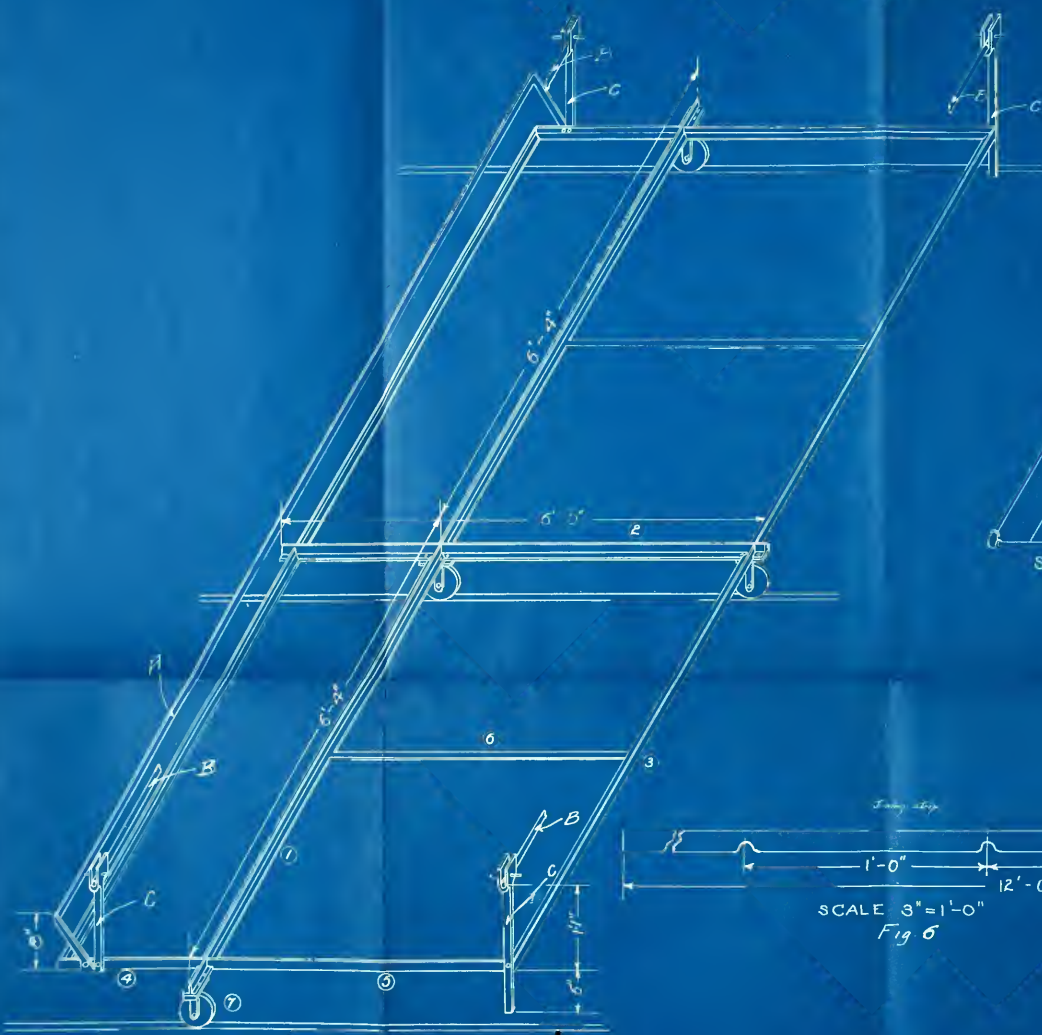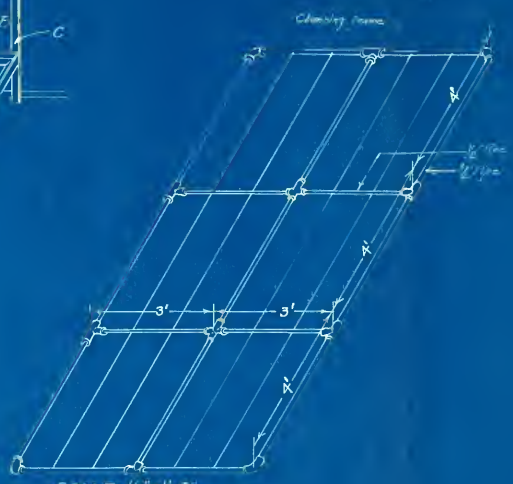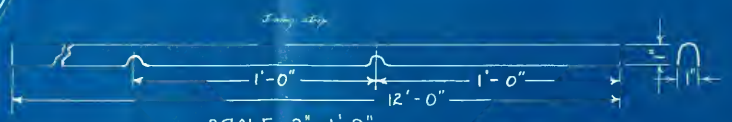
DUMPING APPARATUS

BILL OF MATERIAL   No.
1 Tees-2"x½'- 6'4"Long   2
2 Tee-2"x½'-6'0" "   1
3 Angles-1½"x1¼"x½"-5'10½"   4
4   "   "   "   " -1'-10½"   2
5   "   "   "   " -5'-10½"   2
6 Supporting Rods 1"x1¼"x5'-10"   2
7 Wheels-as shown   4

All pipes to be cut with a
running thread on one end.

MAY 15. 1920

H.M.SABISTON   T.KINGSLEY.Jr

Assuming that the sprinkler discharge
is completed, the following are the details of
the procedure to obtain the amount of discharge
per square foot and to get the apparatus ready
for the next test.

The "joining strip" is removed and the
two sets of pans run back from the pit. By
means of the measuring instrument the amount
of water in each pan is obtained to .01 of a
gallon.   After the amount of water in each of
the 72 pans has been measured by this means,
the clamping frame is fastened securely in place
and the set of pans run up on the track to a
position where the edge of the inner row of
pans will just clear the farther edge of the
pit.   The wheels (E) are blocked and the
outer edge of the frame is raised so that the
whole pivots about the three wheels (E) until
the frame is practically in an upright position,
thus allowing every pan to drain.   After the

pans have drained the frame is brought back
to its original position, and the clamping
frame is removed.   Exactly the same procedure
is carried out with the other section of pans.
Both set of pans are then brought up to the
first position and the joining strip put in
place.

C H A P T E R   VII

Although the apparatus as described here-
in has never been subject to working conditions,
the writers feel that the probability of ap-
paratus of this kind proving a success is un-
questionable.   The main idea of the writers
was to keep the apparatus as simple as conditions
would allow.   They feel that in this apparatus,
they have accomplished that which they set out
to do, inasmuch as the time of the test will be
cut down to at least 1/3 that of former tests
and the amount of manual labor necessary has been
cut down to a minimum.