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THE PASSAGE OF SHOCK WAVES OVER OBLIQUE OBSTACLES

REPORT 51-4

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The series of shadowgraphs presented in this report were prepared at the request of the ARMED FORCES SPECIAL WEAPONS PROJECT and THE SANDIA CORPORATION. They are being distributed with the hope that they will be of interest to other investigators. In three previous reports[1,2,3] the passage of shock waves over vertical walls and over rectangular obstacles, all of which were aligned with and at right angles to the flow, were studied. In the present report rectangular walls are placed at certain definite angles to the flow. Due to the complexity of the obstacle no real theoretical interpretation has been attempted, although many details can be understood using standard textbook procedures.

Fig. 46 shows the method of mounting a typical block for this study. The tape along the edge of the false wall and along the edge of the model served primarily to prevent gas leakage between these surfaces and the test section windows. Blocks two inches in width(*) were mounted at an angle of inclination (θ) of 30°, 45°, 60°, and 90° (Figs. 1-20, 30-45). In addition, a model one inch wide was mounted at an angle of inclination of 45° (Figs. 21-29).

Photographs have been taken at three values of primary shock-wave Mach number, 1.1, 1.2, and 1.3 and at several positions of the primary shock wave. Complete data for each photograph are contained in

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1. Uhlenbeck, G., Diffraction of Shock Waves Around Various Obstacles, E.R.I., University of Michigan, Report No. 50-1, 21 March 1950.

2. Hollyer, R. N., and Duff, R. E., Effect of Wall Boundary Layer in the Diffraction of Shock Waves Around Cylindrical and Rectangular Obstacles. E.R.I., University of Michigan, Report No. 50-3, 7 Nov. 1950.

3. Hollyer, R. N., and Duff, R. E., Growth of the Turbulent Region at the Leading Edge of Rectangular Obstacles in Shock Waves Diffraction, E.R.I., University of Michigan, Report 51-2, 18 Jan. 1951.

* Width refers to the dimension across the shock tube, parallel to the direction of observation.

Table I. In all cases the pressure (P_o) ahead of the primary shock wave is one atmosphere. The time (t) for each photograph is the time elapsed after the primary shock wave had reached the leading edge of the model and was computed from the measured position of the primary shock wave. In all cases, the upper edge of the photograph coincides with the plate to which the model has been attached (see Fig. 46). The photographs have been reduced slightly to facilitate publication. The proper scale factor may be determined by noting that the actual thickness of the models was 0.50 inch.

It may be possible to correlate the size of the turbulent region at the tip of the block with the flow speed in a manner similar to that previously reported[3]; however, no such correlation has been attempted at present.

TABLE I

For All Pictures, P_o = 1 Atmosphere

Figure No.	*t [μsec.]	Shock Velocity [mm./μsec.]	Shock Mach No.	Flow Velocity [mm./μsec.]	Flow Mach No.	θ [Degrees]
1	59	0.380	1.08	0.056	0.152	30
2	162	.379	1.08	.054	.148	30
3	292	.383	1.09	.062	.165	30
4	85	.416	1.19	.108	.293	30
5	126	.413	1.18	.104	.283	30
6	175	.417	1.19	.109	.297	30
7	267	.416	1.19	.108	.293	30
8	285	.418	1.20	.1105	.300	30
9	28	.456	1.31	.162	.425	30
10	134	.454	1.30	.160	.420	30
11	189	.443	1.27	.145	.385	30
12	72	.379	1.09	.054	.148	45
13	178	.379	1.09	.054	.148	45
14	237	.380	1.09	.056	.152	45
15	86	.417	1.20	.109	.297	45
16	173	.417	1.20	.109	.297	45
17	213	.415	1.19	.106	.290	45
18	39	.449	1.29	.153	.405	45
19	82	.435	1.25	.134	.335	45
20	184	.450	1.29	.154	.406	45
21	18	.378	1.08	.053	.145	45
22	199	.379	1.09	.054	.148	45
23	305	.380	1.09	.056	.152	45

* t = time in μsec. after passage of shock wave past leading edge of model.

TABLE I (cont'd)

For All Pictures, P_o = 1 Atmosphere

Figure No.	*t [μsec.]	Shock Velocity [mm./μsec.]	Shock Mach No.	Flow Velocity [mm./μsec.]	Flow Mach No.	θ [Degrees]
24	30	.416	1.19	.108	.293	45
25	158	.420	1.20	.113	.308	45
26	244	.420	1.20	.113	.308	45
27	49	.445	1.28	.148	.391	45
28	155	.445	1.28	.148	.391	45
29	184	.445	1.28	.148	.391	45
30	35	.380	1.09	.056	.152	60
31	126	.381	1.09	.057	.157	60
32	240	.380	1.09	.056	.153	60
33	39	.416	1.20	.108	.293	60
34	104	.415	1.19	.106	.290	60
35	221	.416	1.20	.108	.293	60
36	51	.450	1.29	.154	.406	60
37	110	.450	1.29	.154	.406	60
38	229	.454	1.30	.160	.420	60
39	49	.380	1.09	.056	.152	90
40	159	.378	1.09	.053	.145	90
41	19	.415	1.19	.106	.290	90
42	121	.415	1.19	.106	.290	90
43	37	.458	1.32	.165	.432	90
44	89	.460	1.32	.167	.438	90
45	106	.461	1.33	.168	.441	90

* t = time in μsec. after passage of shock wave past leading edge of model.

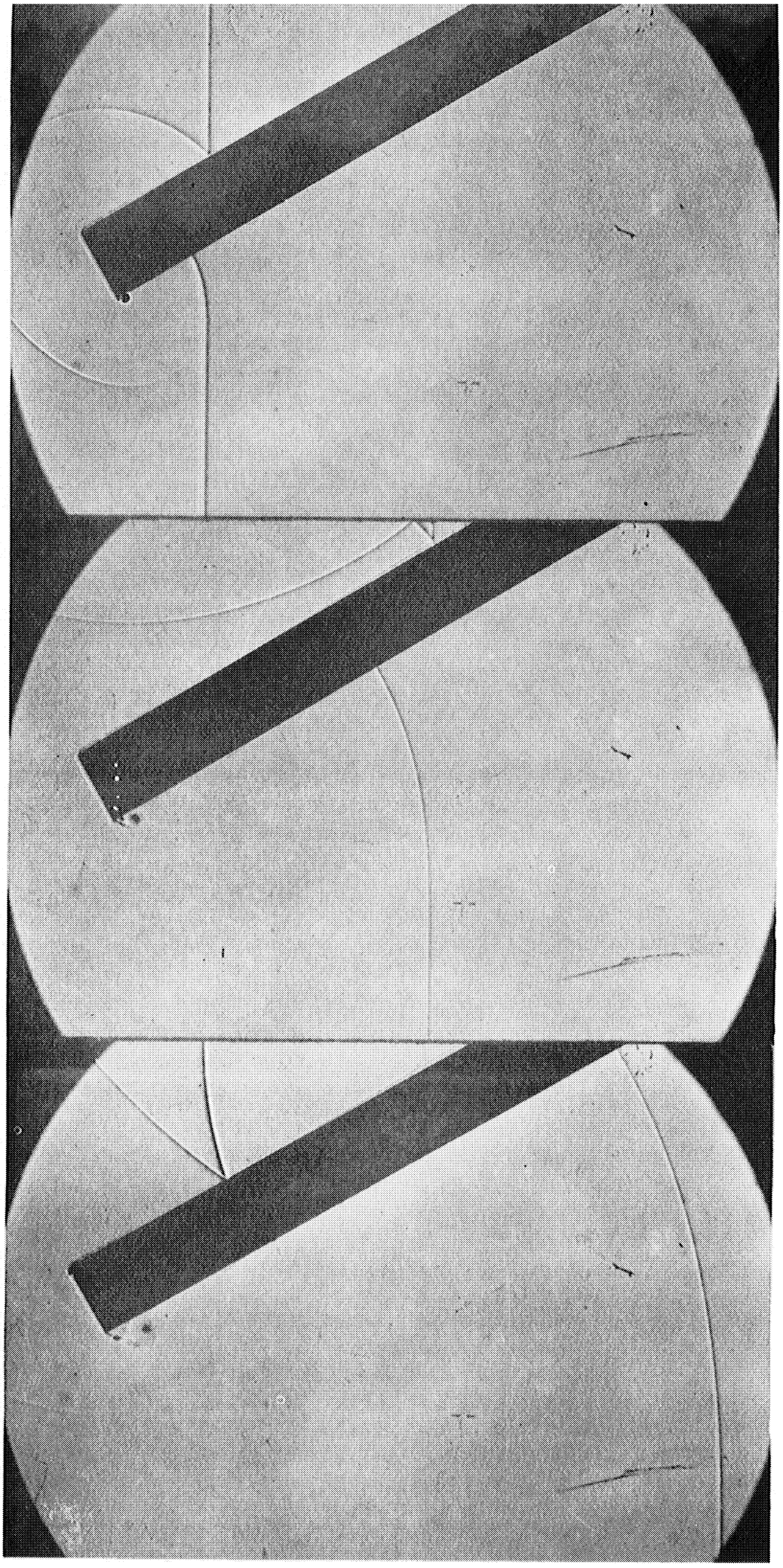

Fig. 1

M = 1.1
t = 59

Fig. 2

M = 1.1
t = 162

Fig. 3

M = 1.1
t = 292

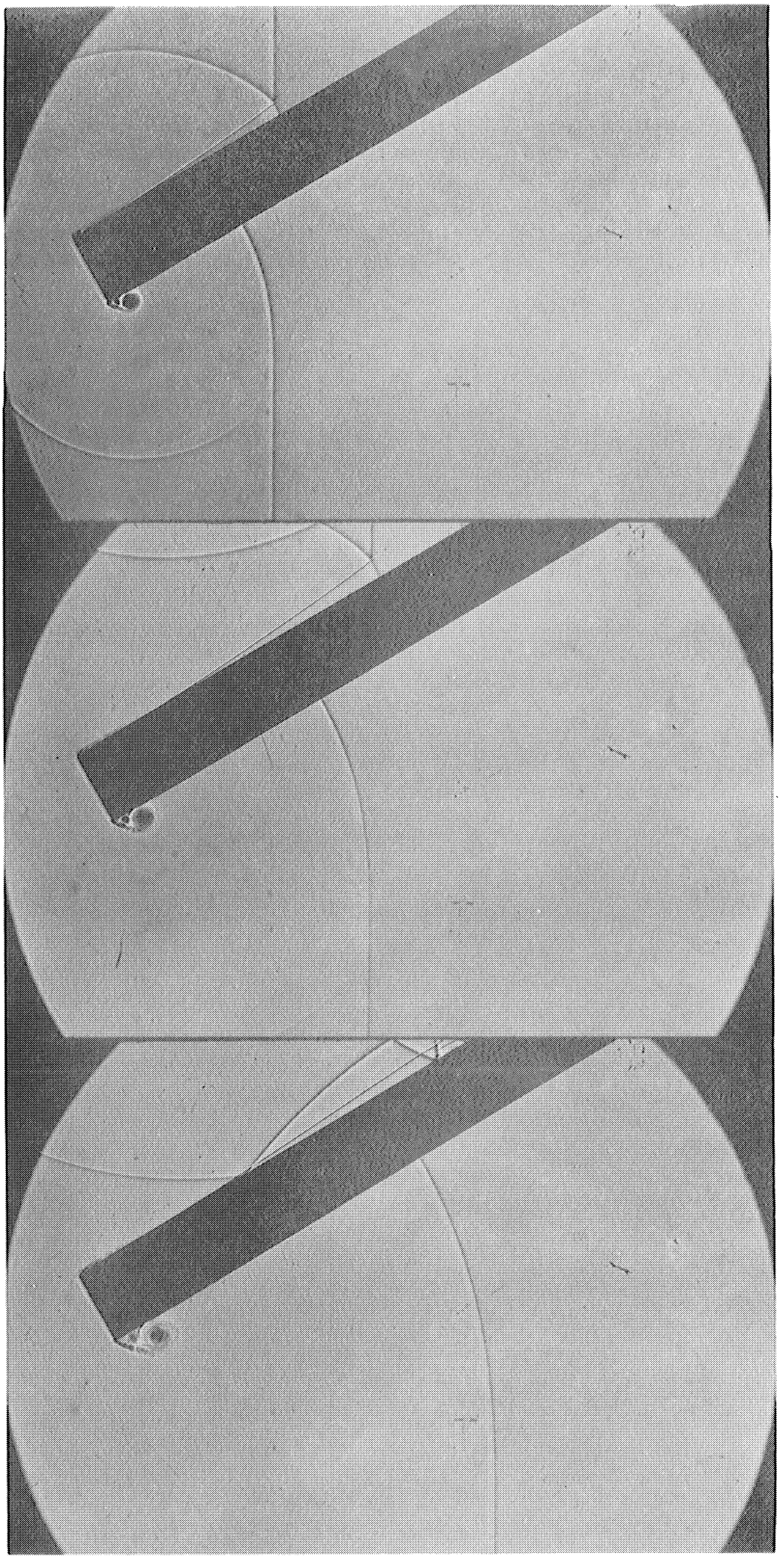

Fig. 4

M = 1.2
t = 85

Fig. 5

M = 1.2
t = 126

Fig. 6

M = 1.2
t = 175

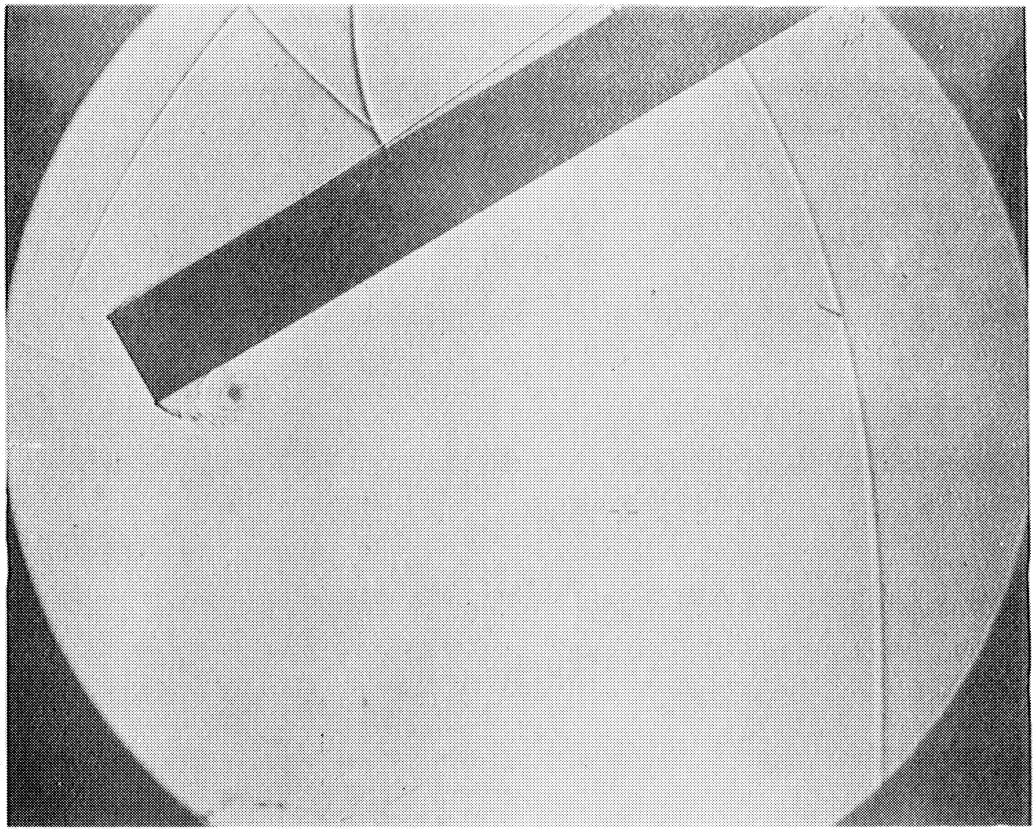

Fig. 7

M = 1.2
t = 267

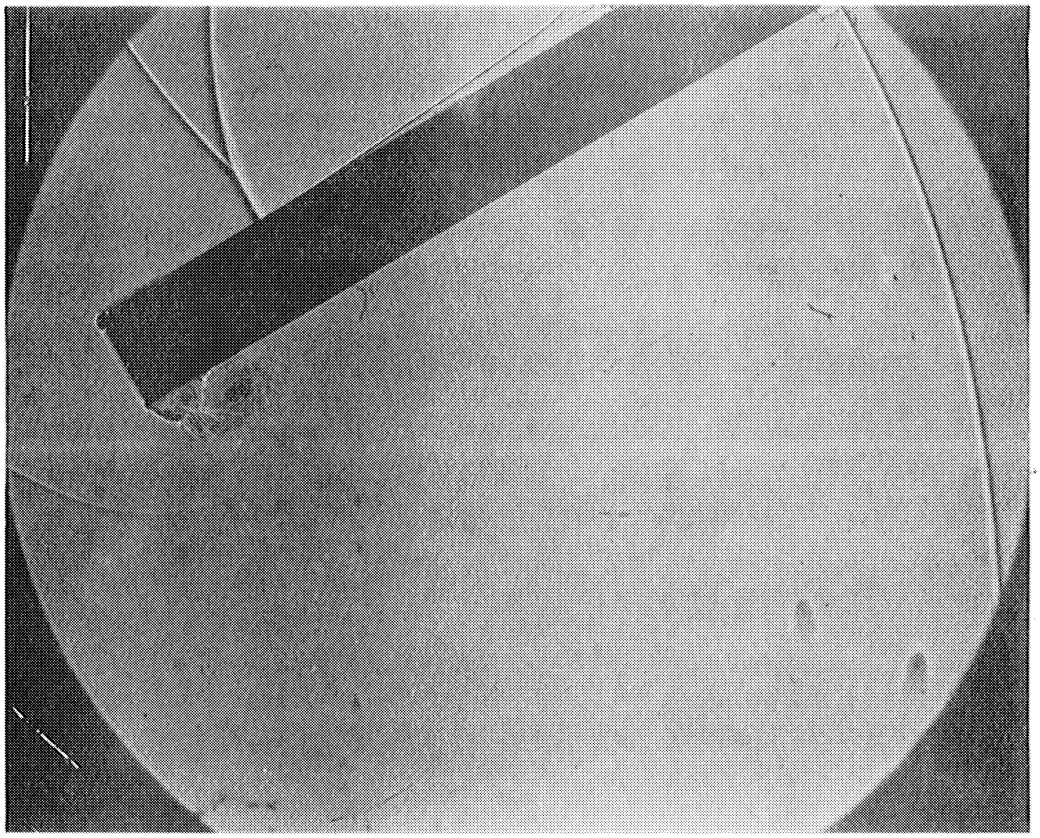

Fig. 8

M = 1.2
t = 285

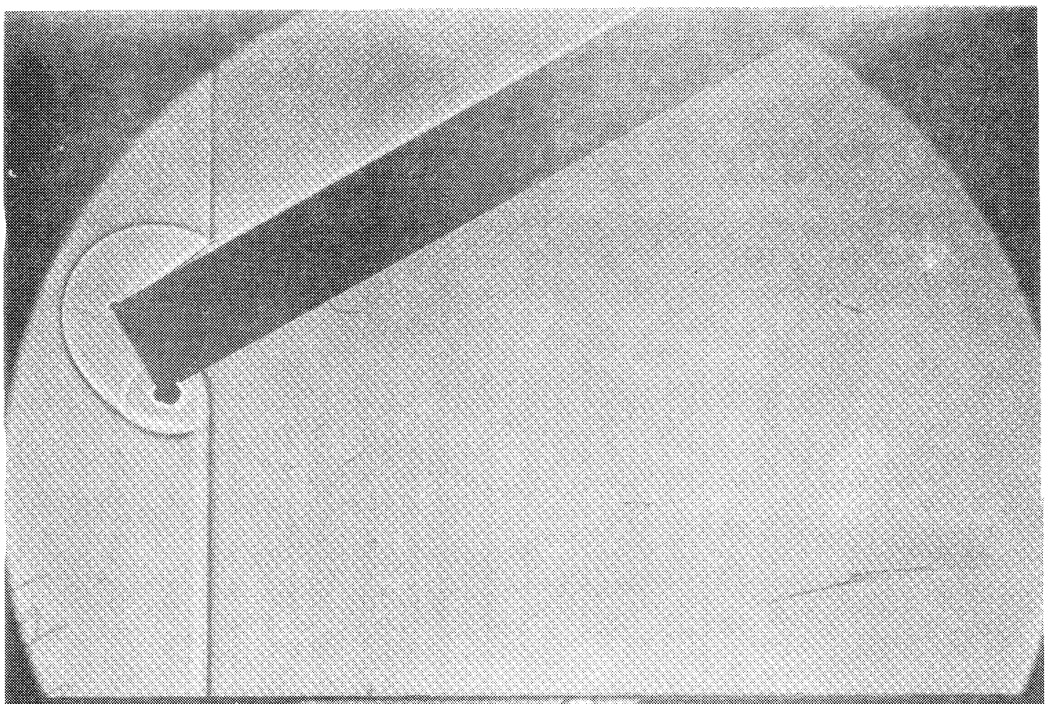

Fig. 9

M = 1.3
t = 28

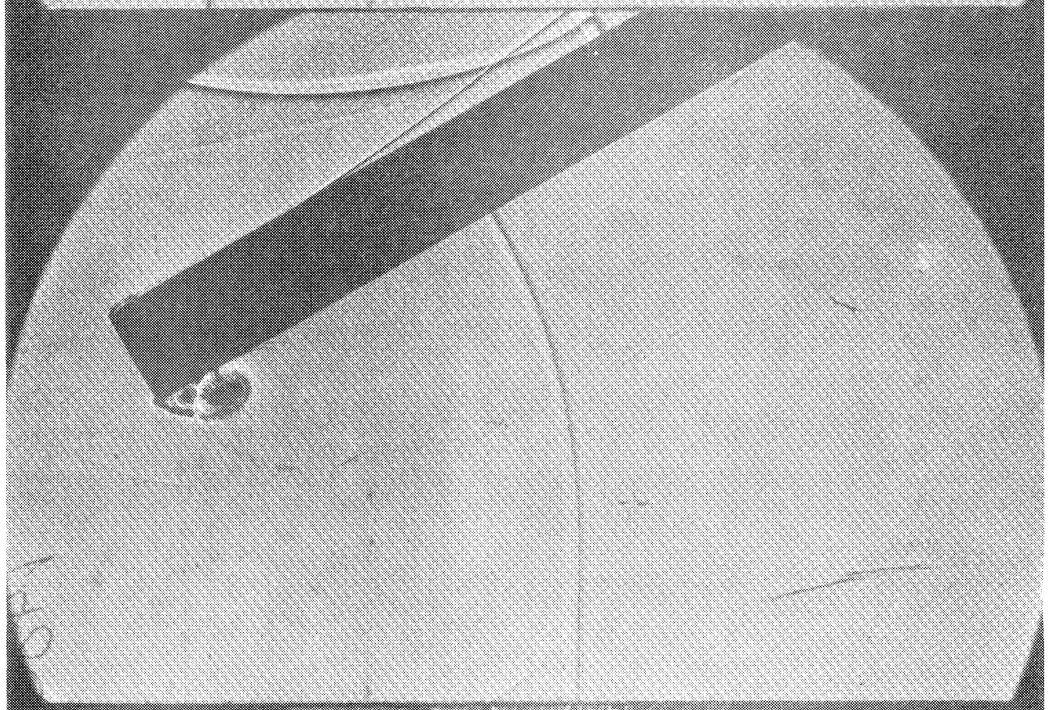

Fig. 10

M = 1.3
t = 134

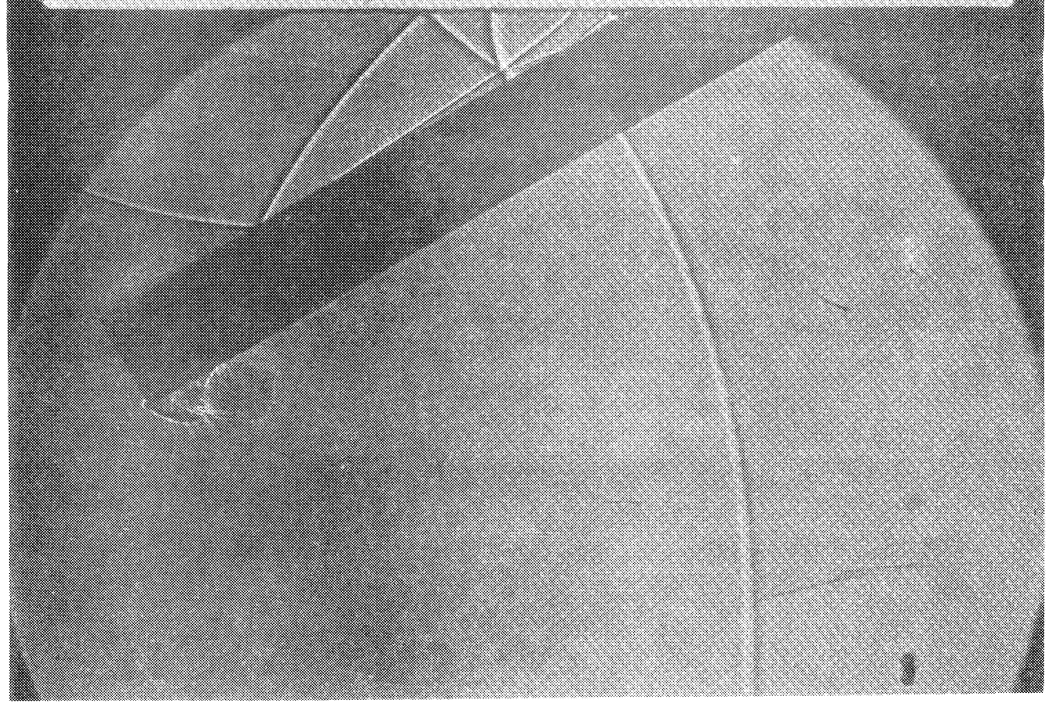

Fig. 11

M = 1.3
t = 189

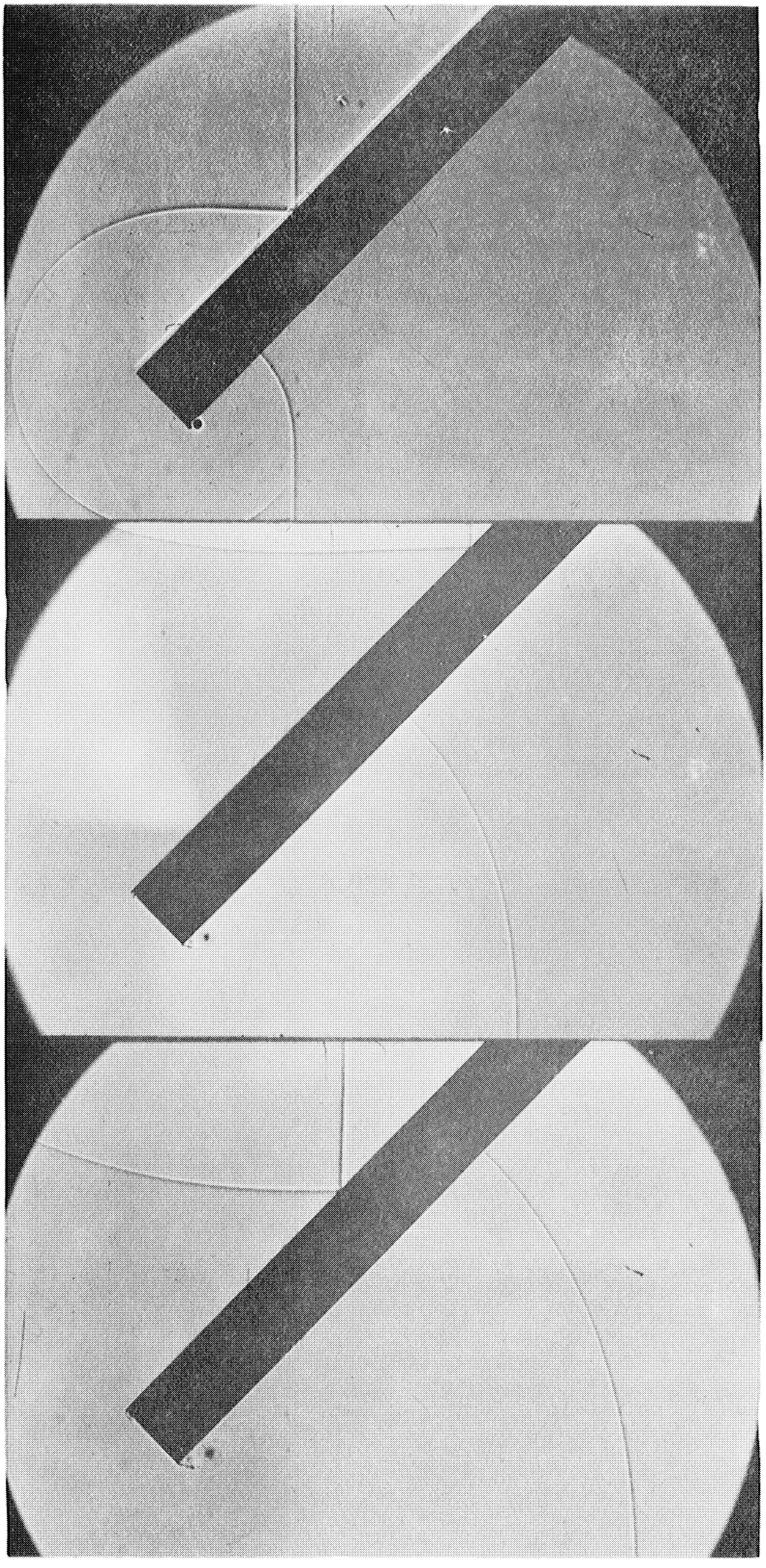

Fig. 12

M = 1.1
t = 72

Fig. 13

M = 1.1
t = 178

Fig. 14

M = 1.1
t = 237

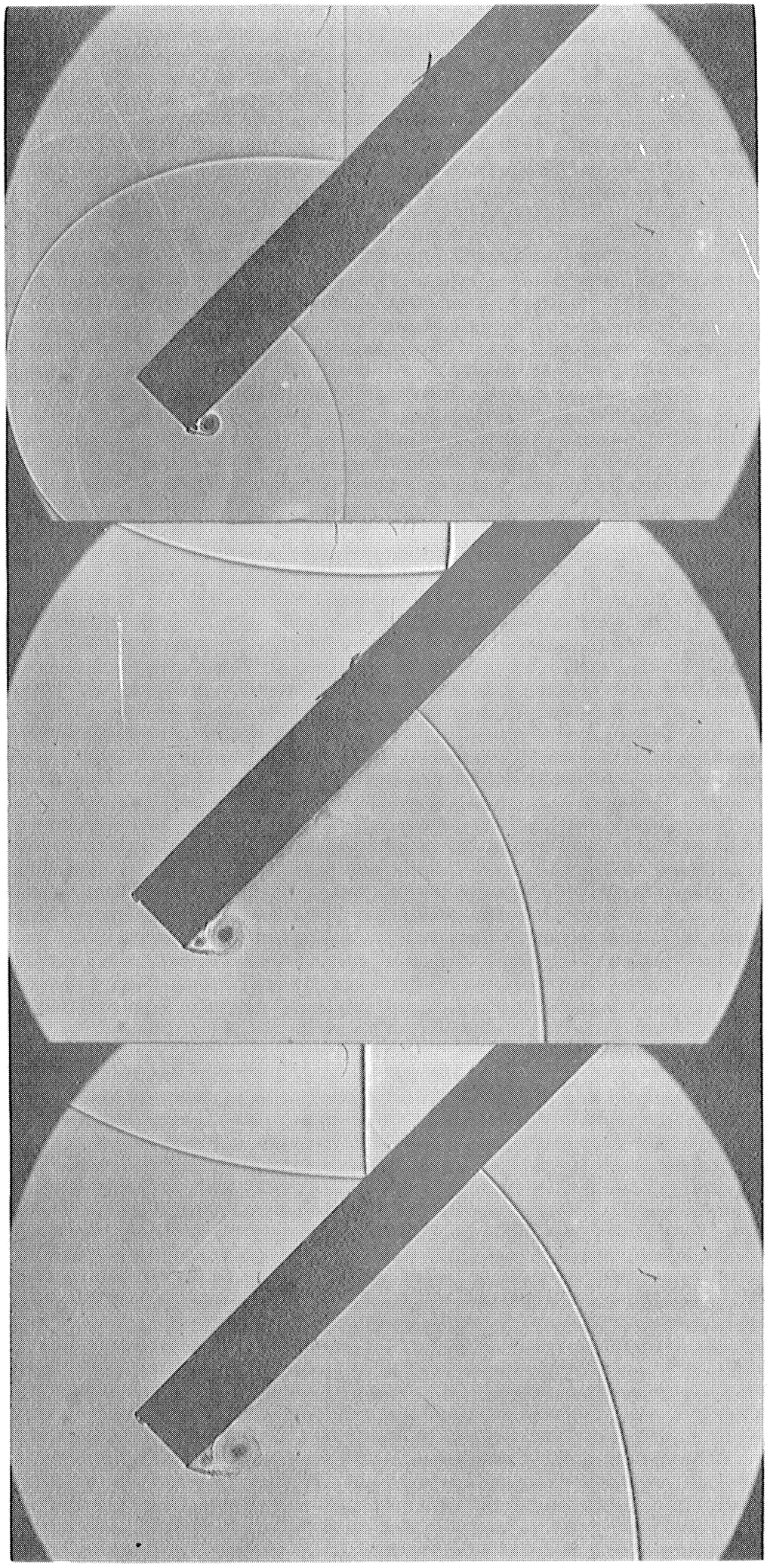

Fig. 15

M = 1.2
t = 86

Fig. 16

M = 1.2
t = 173

Fig. 17

M = 1.2
t = 213

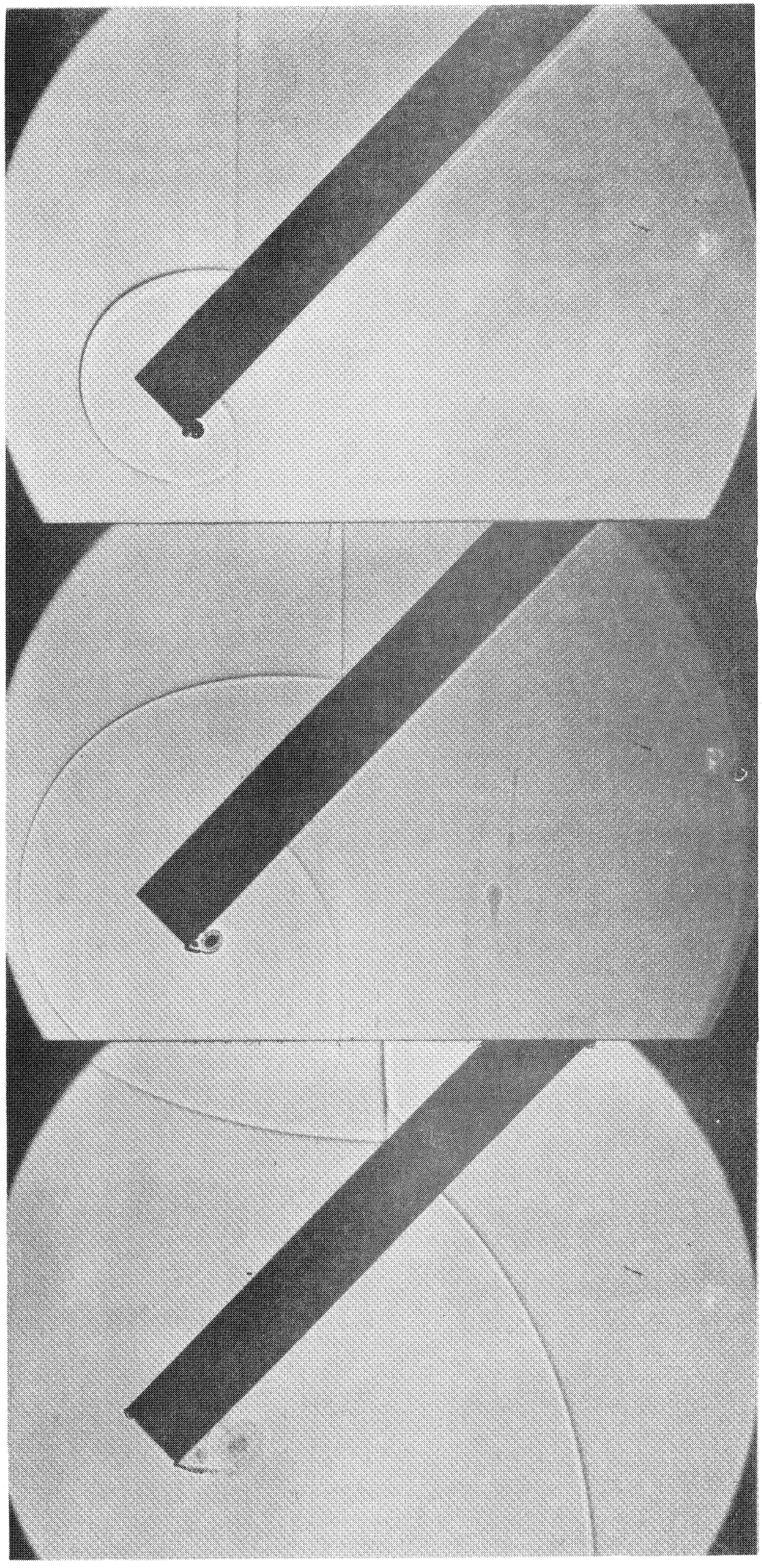

Fig. 18

M = 1.3
t = 39

Fig. 19

M = 1.3
t = 82

Fig. 20

M = 1.29
t = 184

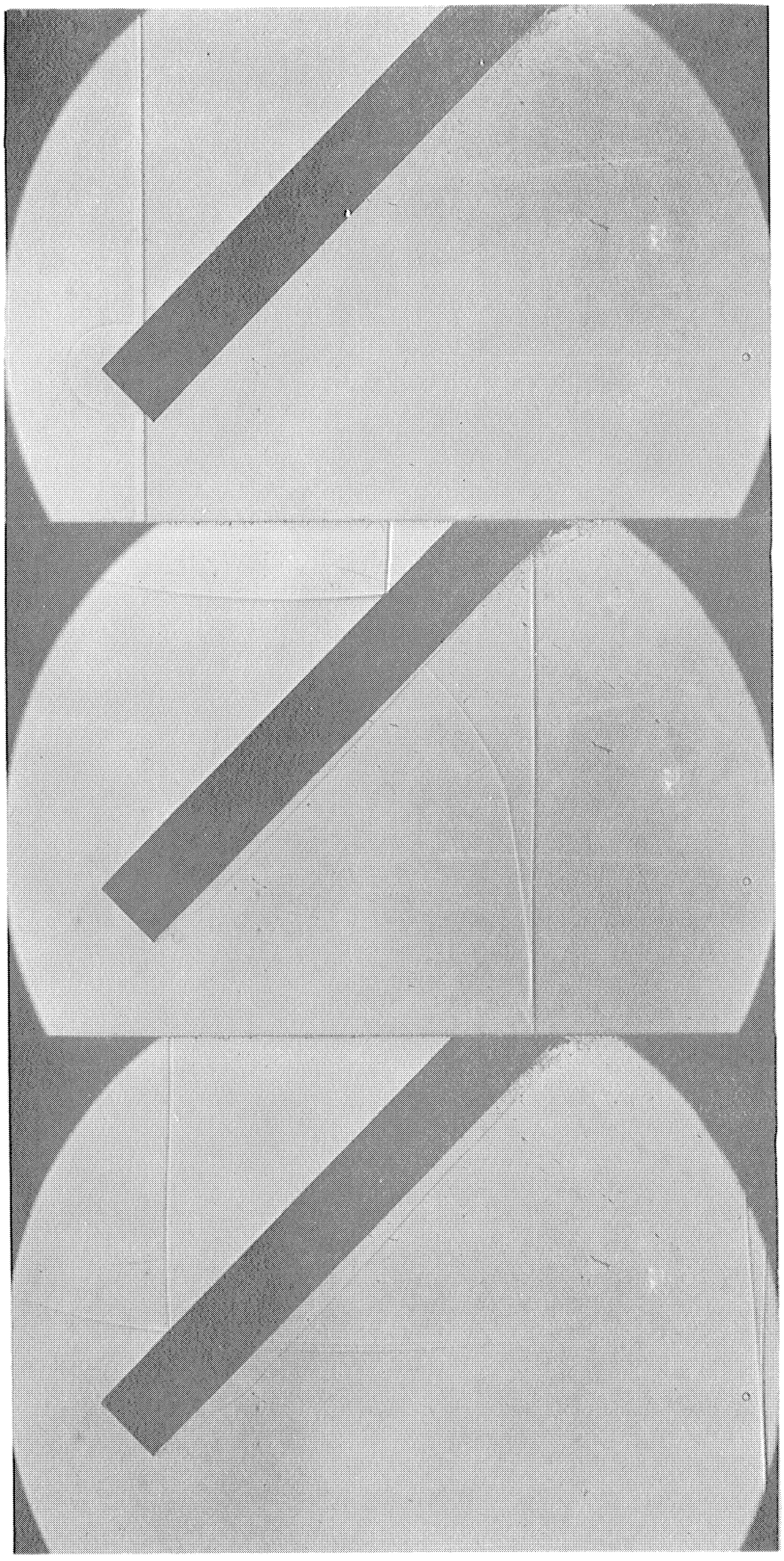

Fig. 21

M = 1.1
t = 18

Fig. 22

M = 1.1
t = 199

Fig. 23

M = 1.1
t = 305

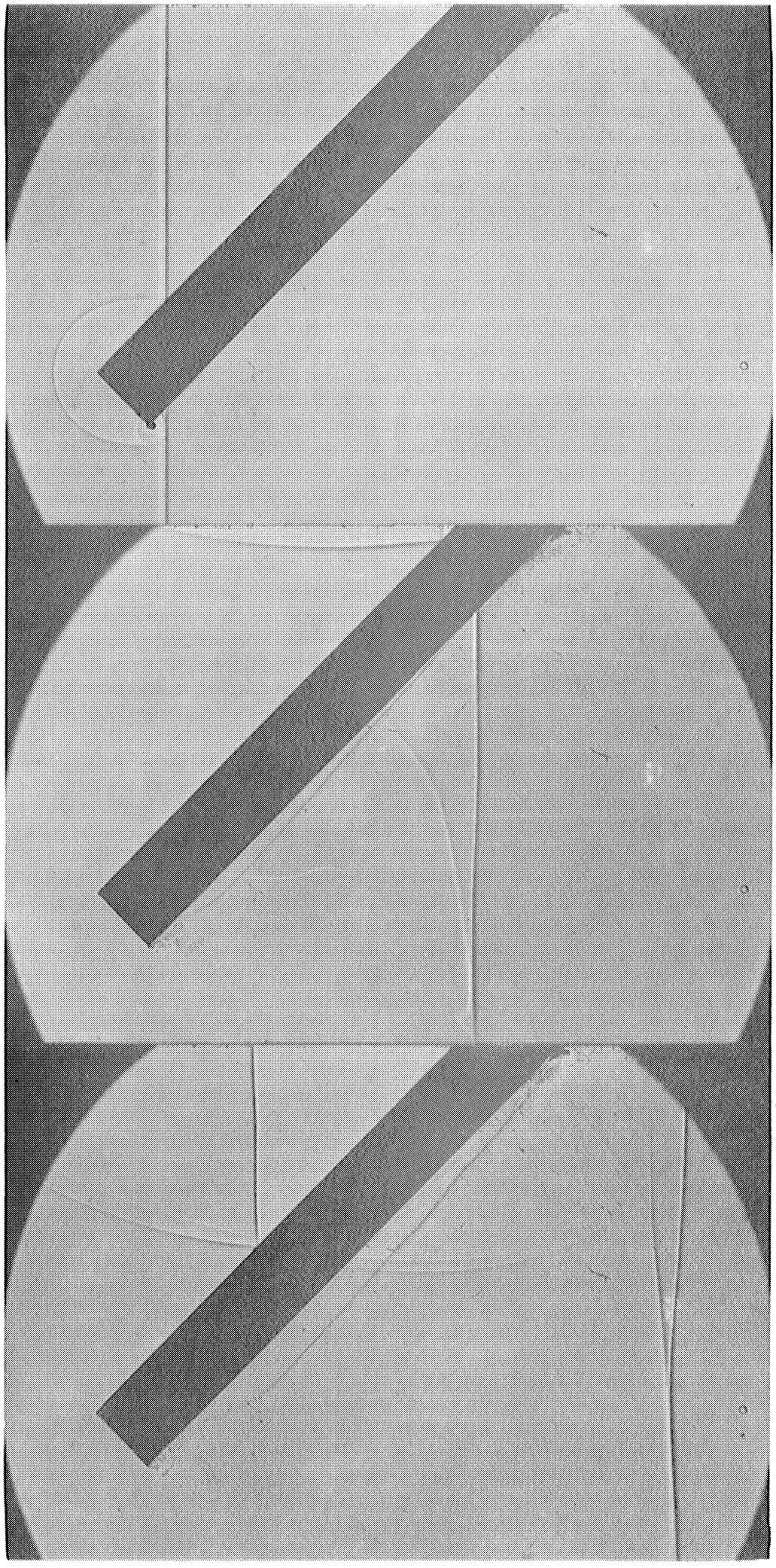

Fig. 24

M = 1.2
t = 30

Fig. 25

M = 1.2
t = 158

Fig. 26

M = 1.2
t = 244

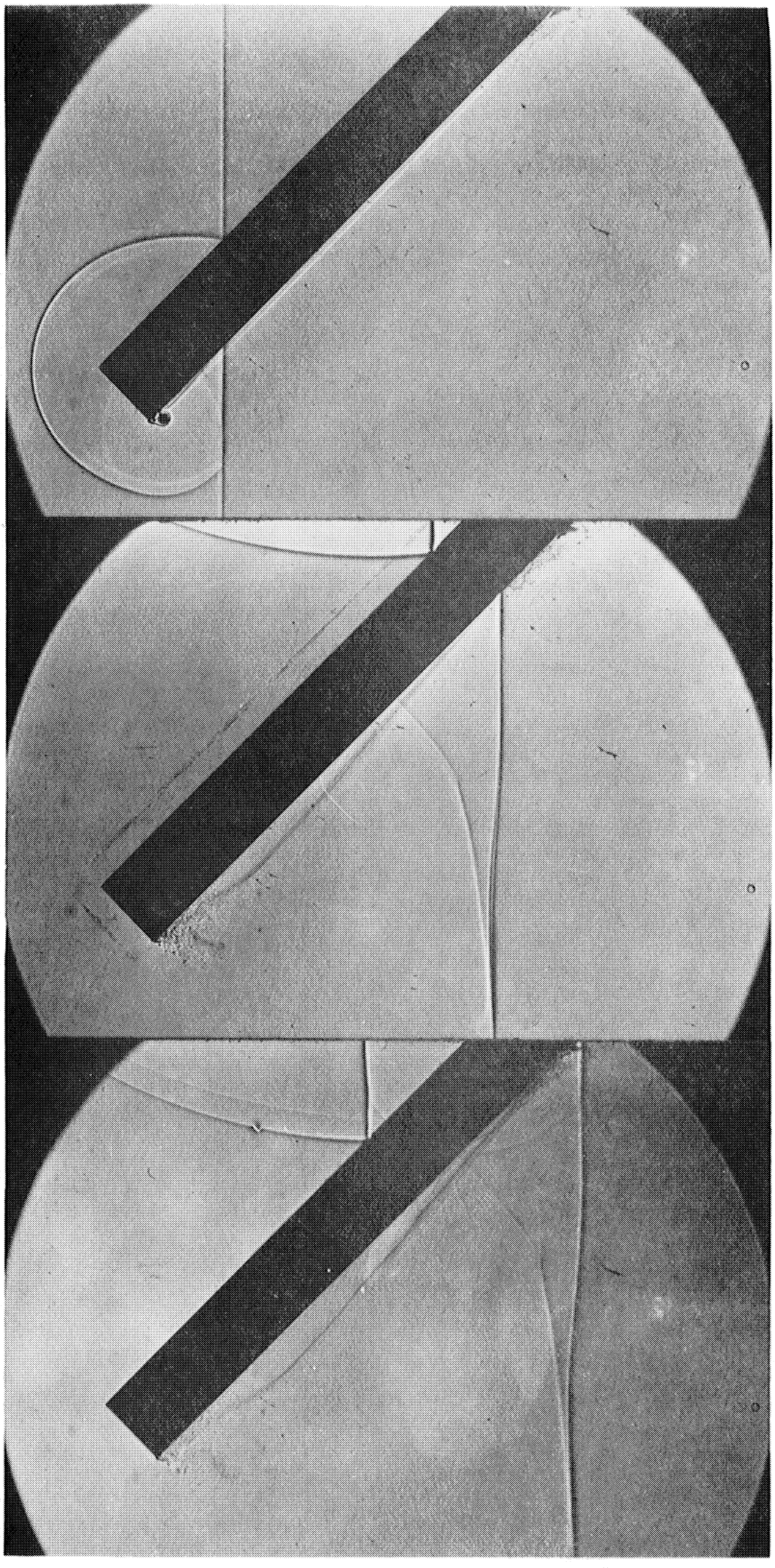

Fig. 27

M = 1.3
t = 49

Fig. 28

M = 1.3
t = 155

Fig. 29

M = 1.3
t = 184

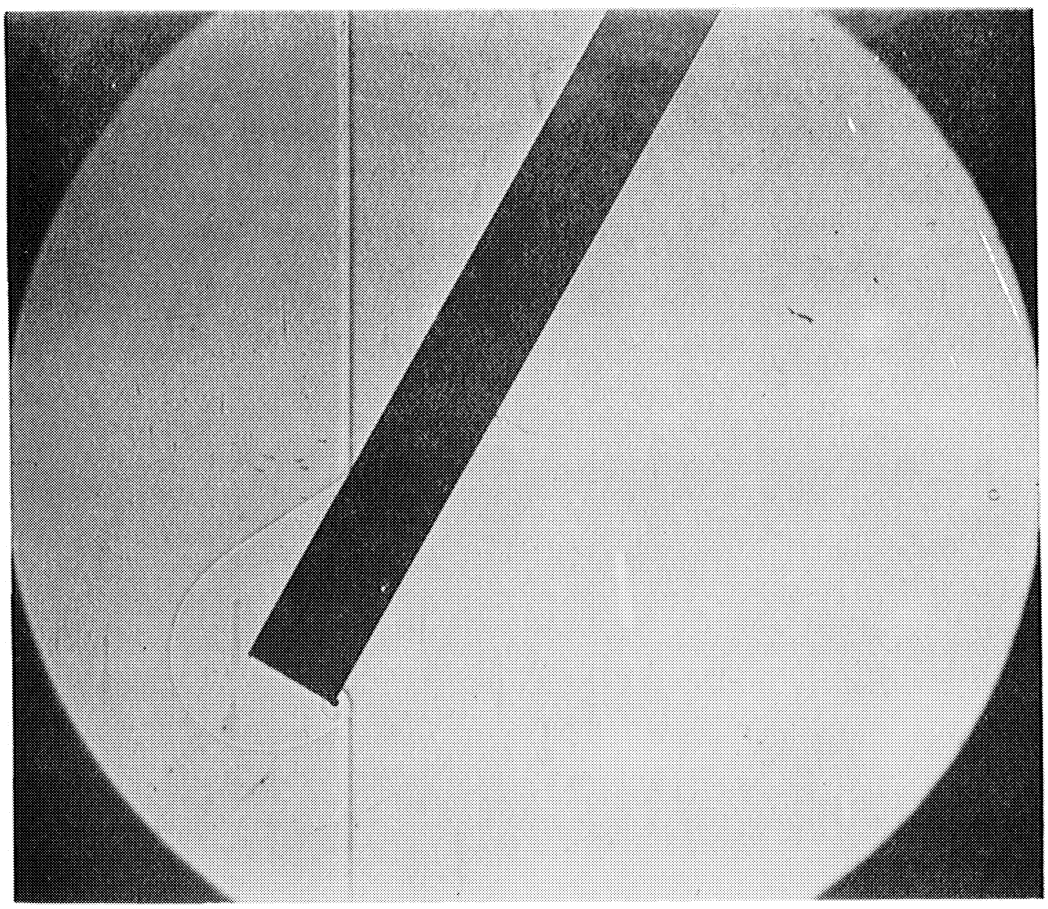

Fig. 30

M = 1.1
t = 35

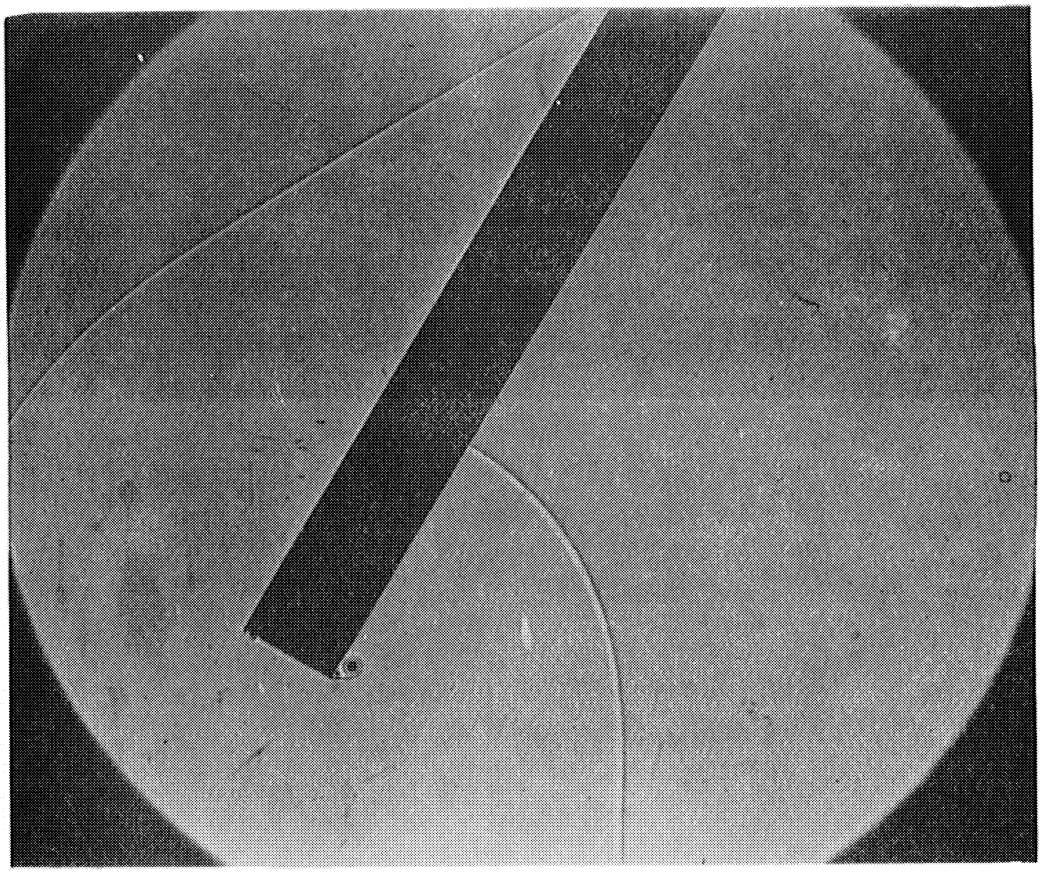

Fig. 31

M = 1.1
t = 126

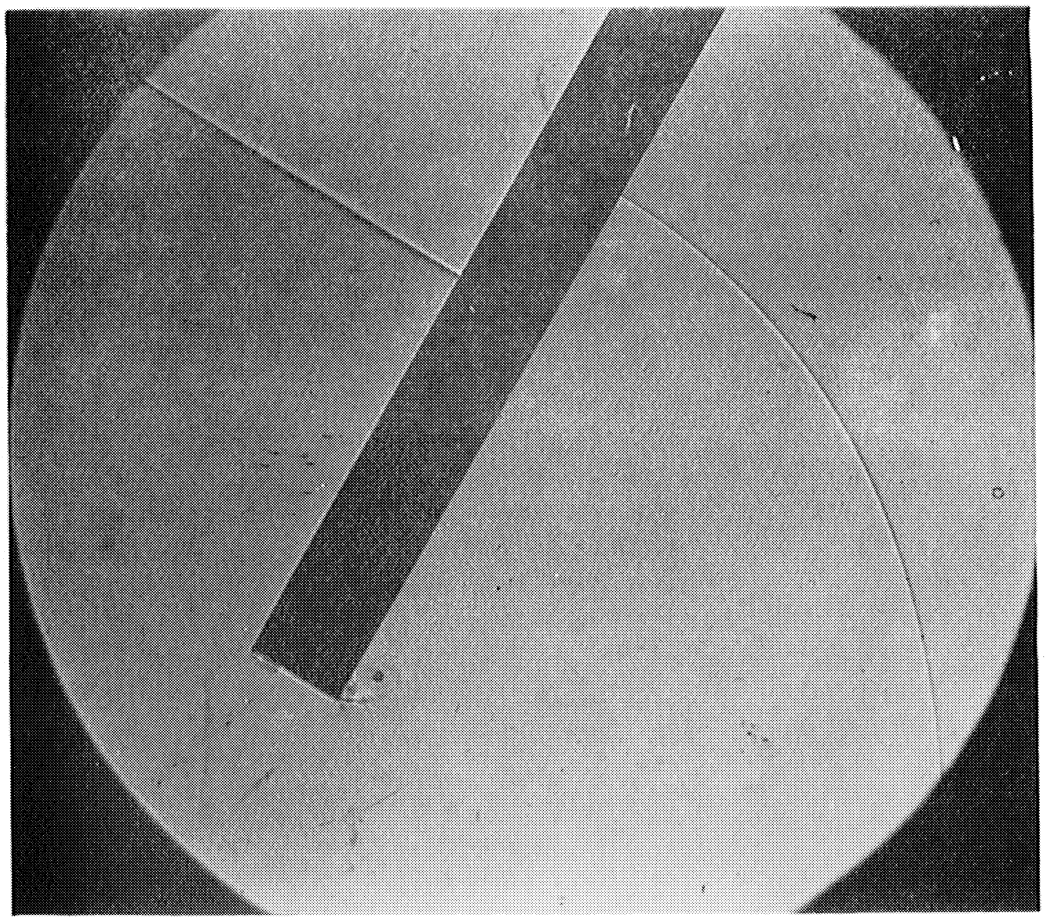

Fig. 32

M = 1.1
t = 240

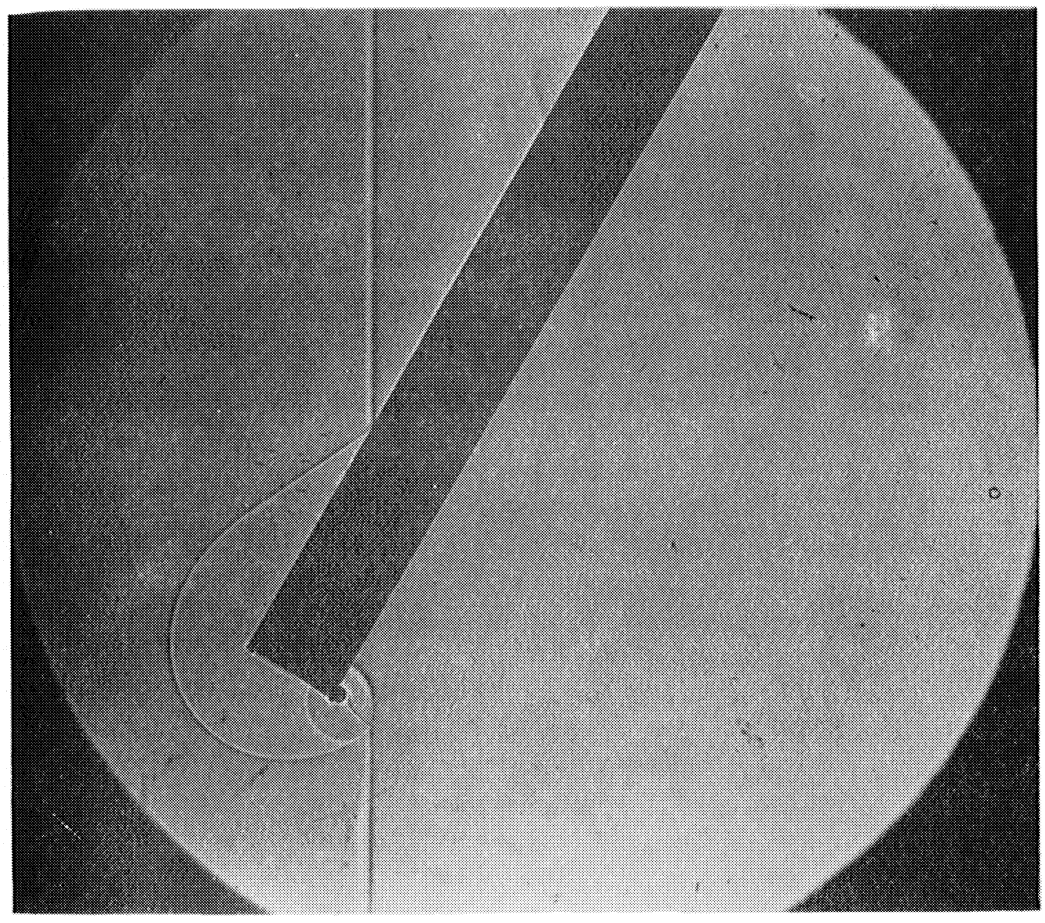

Fig. 33

M = 1.2
t = 39

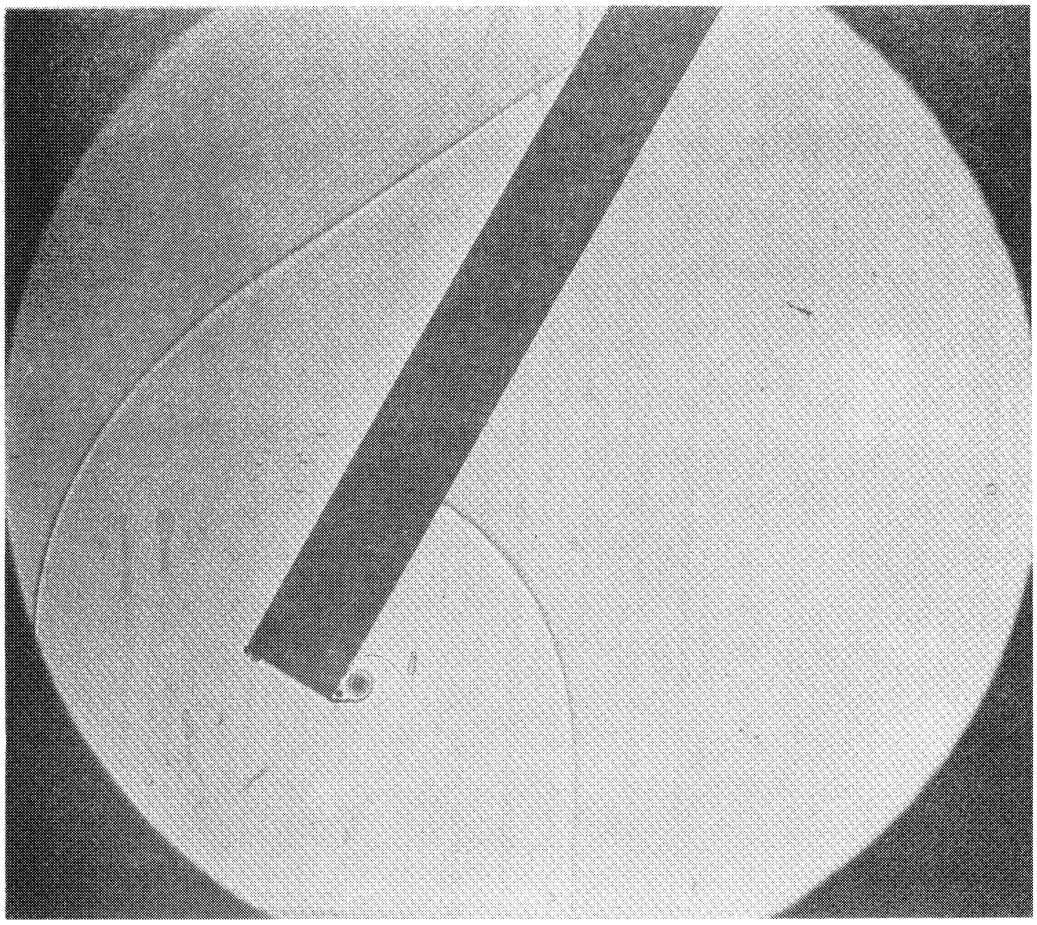

Fig. 34

M = 1.2
t = 104

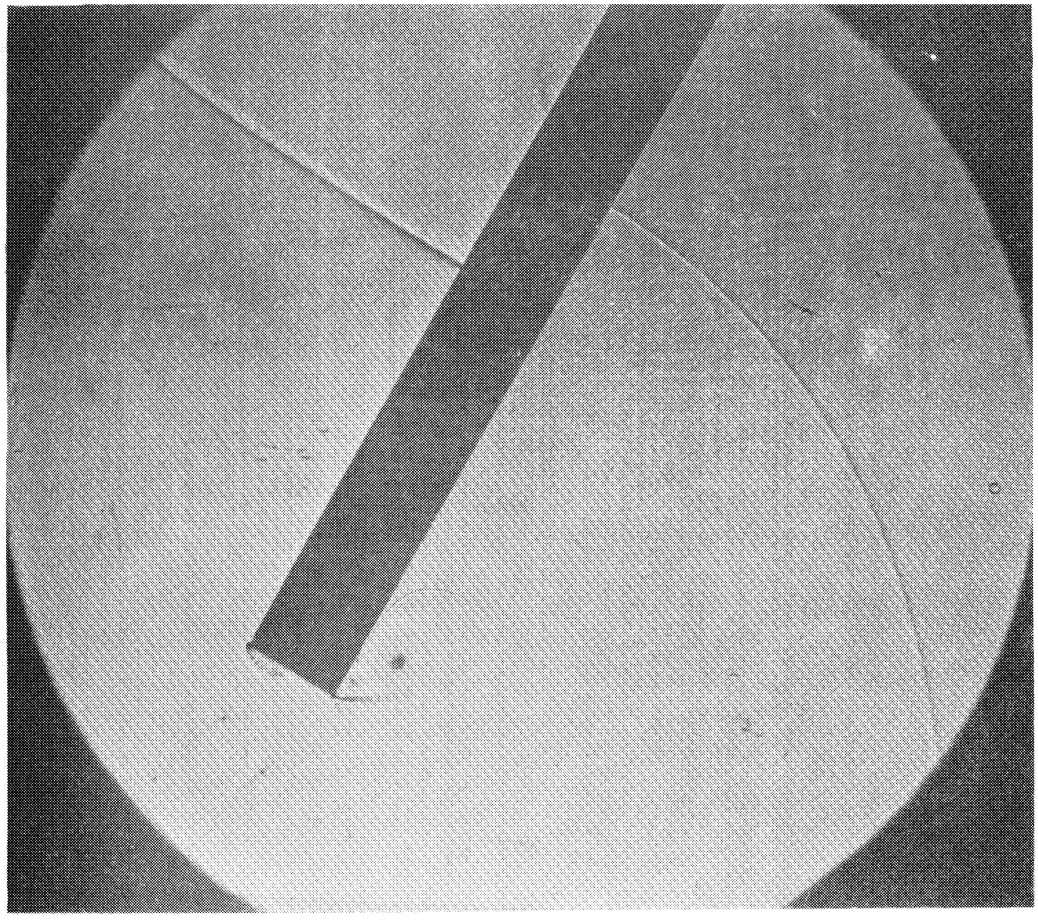

Fig. 35

M = 1.2
t = 221

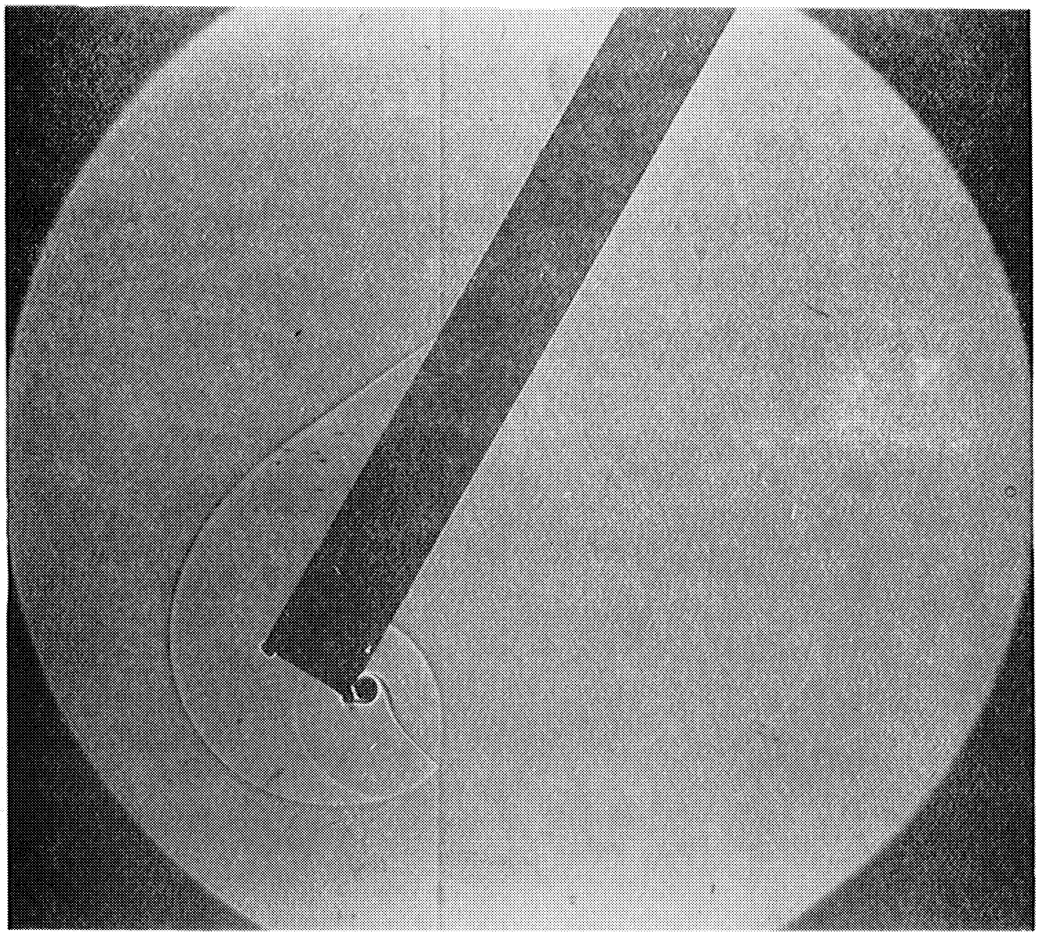

Fig. 36

M = 1.3
t = 51

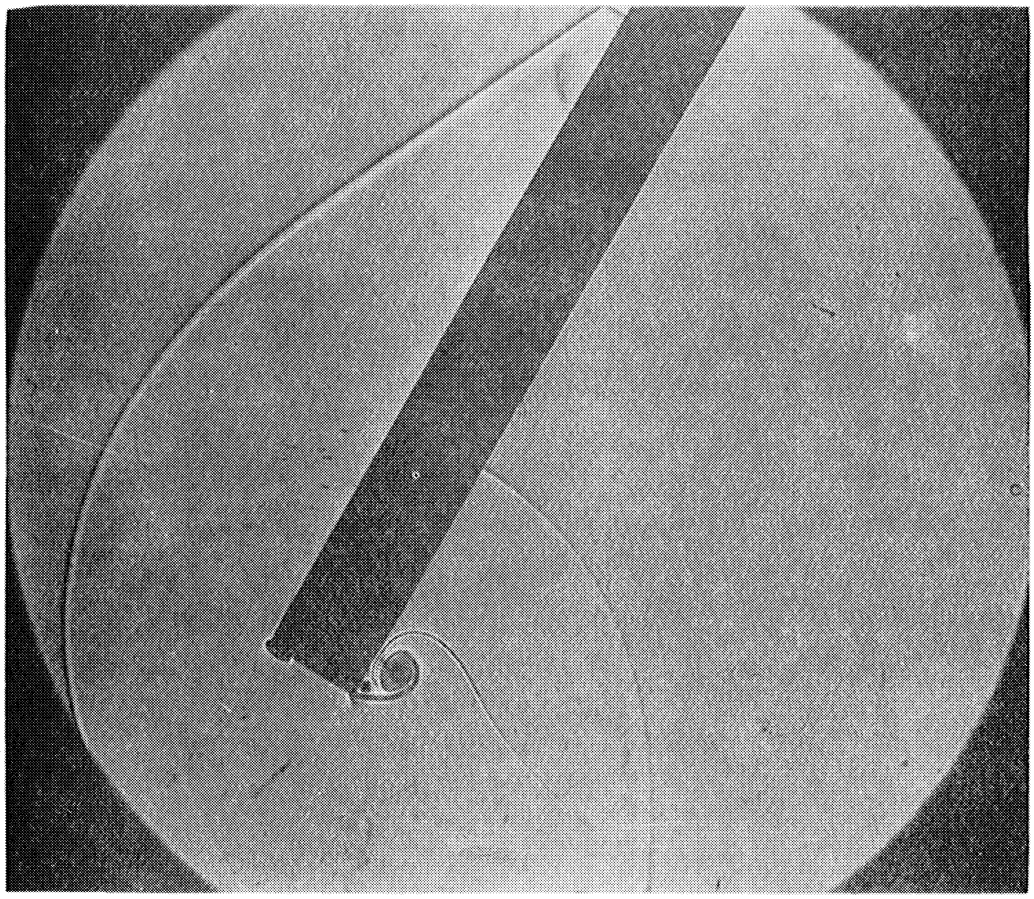

Fig. 37

M = 1.3
t = 110

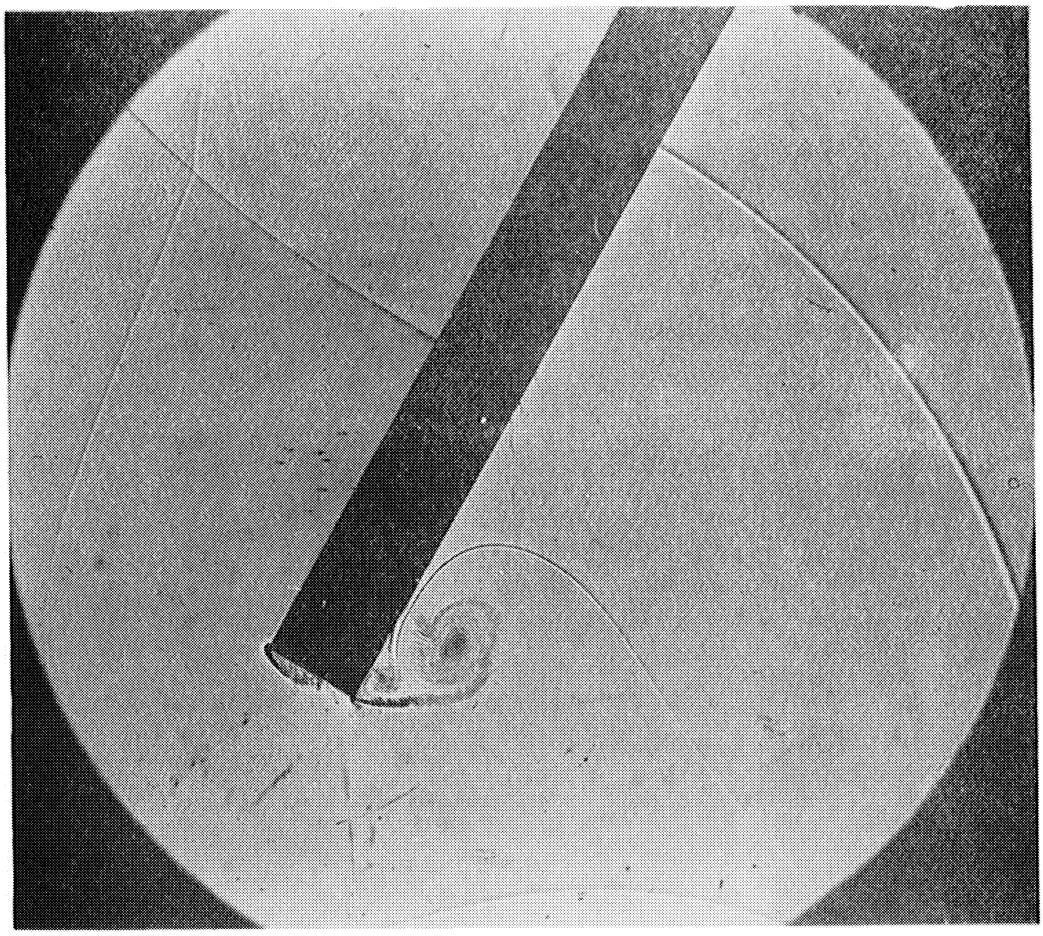

Fig. 38

M = 1.3
t = 229

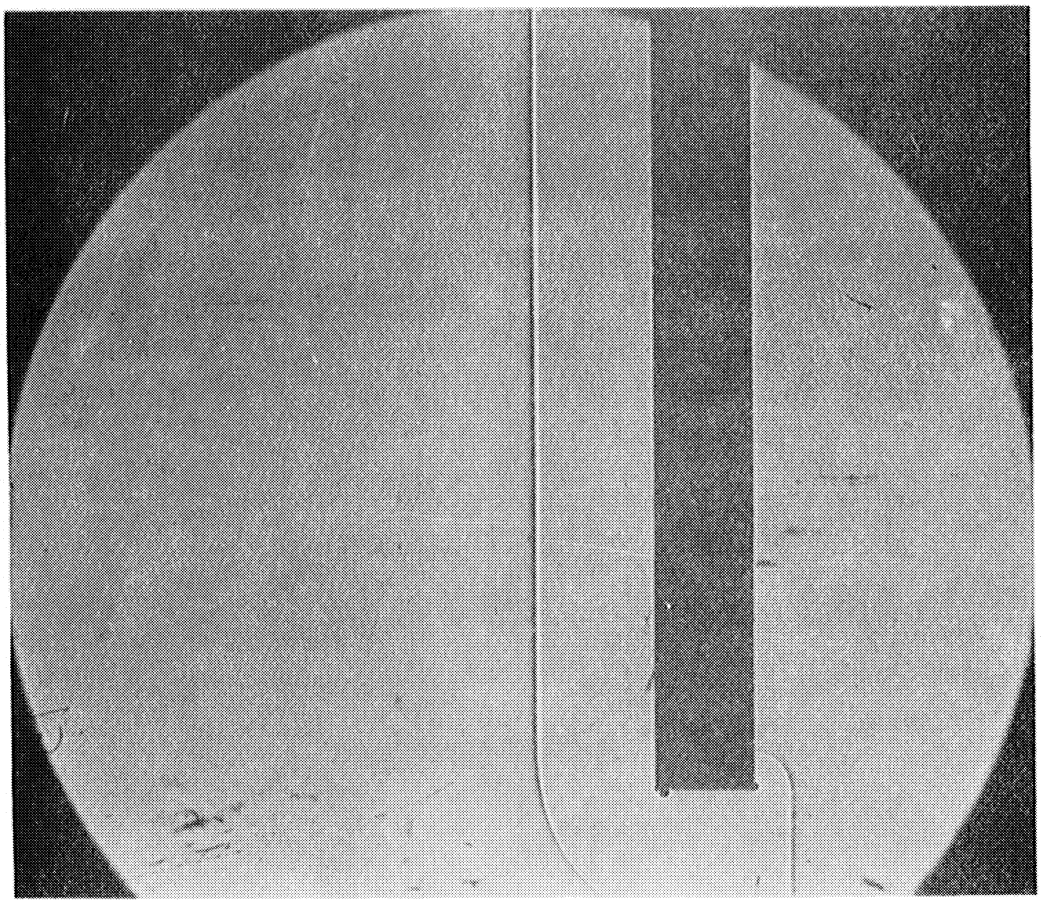

Fig. 39

M = 1.1
t = 49

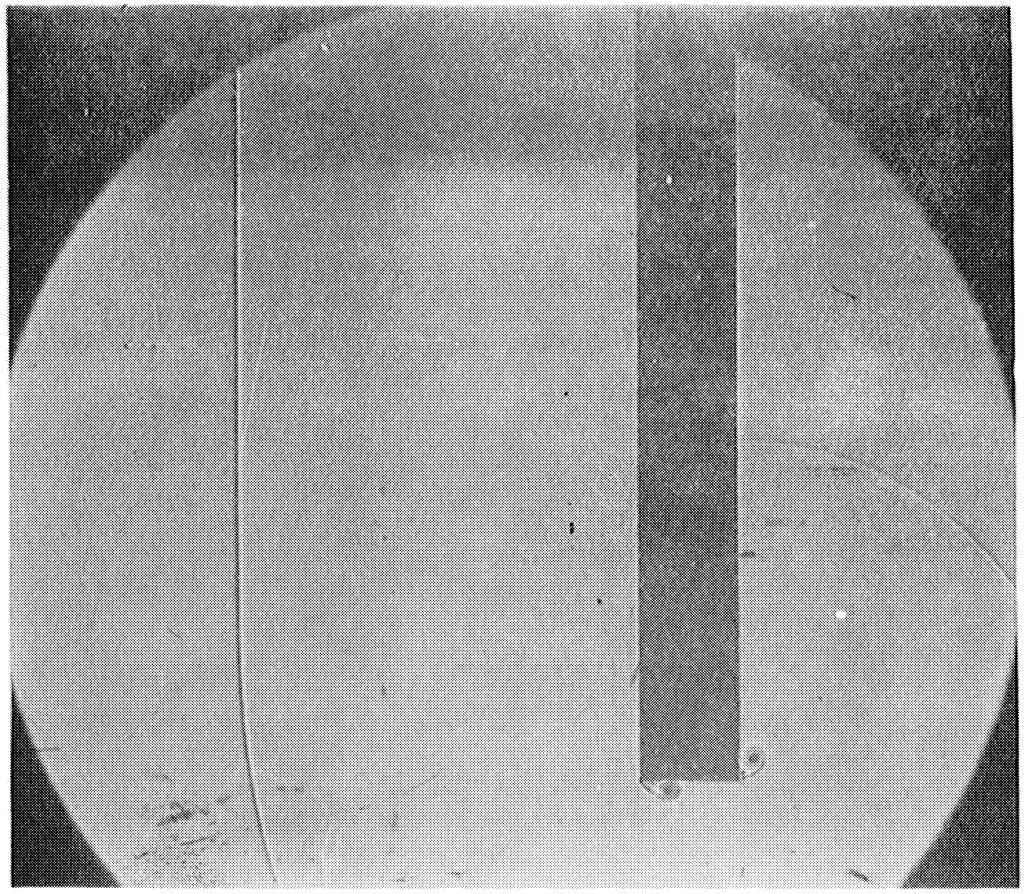

Fig. 40

M = 1.1
t = 159

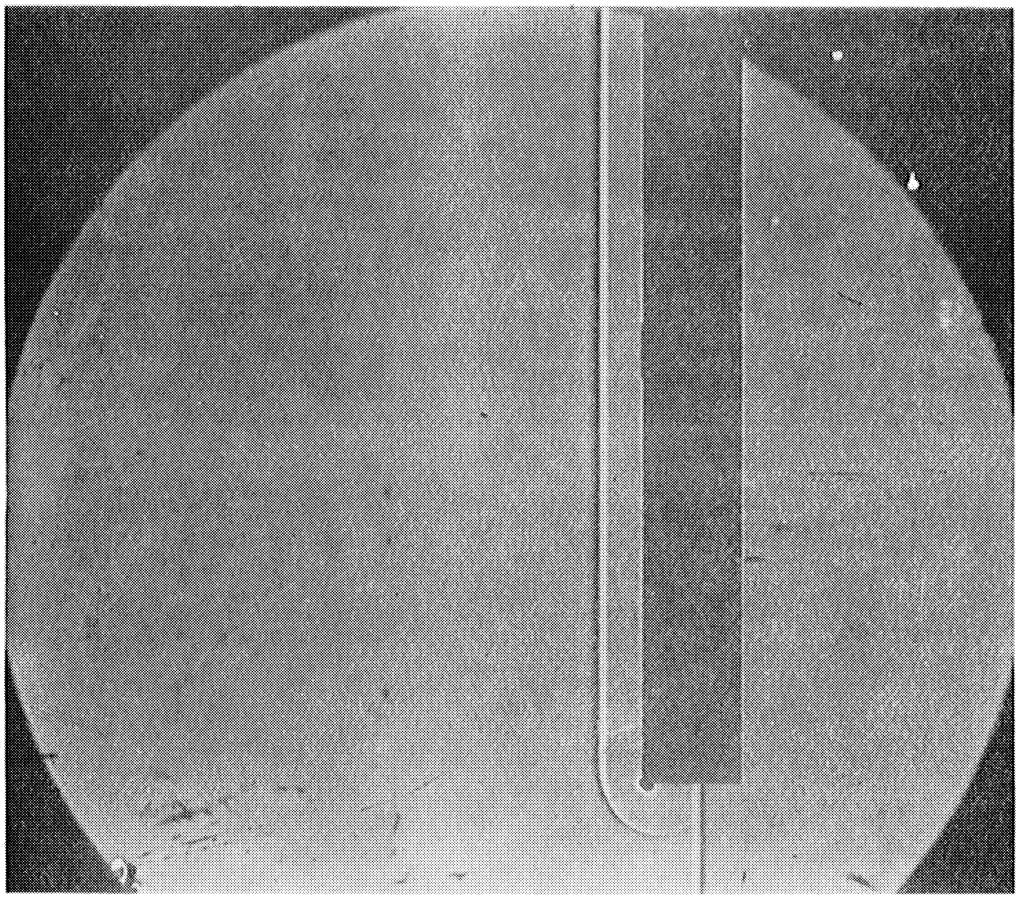

Fig. 41

M = 1.2
t = 19

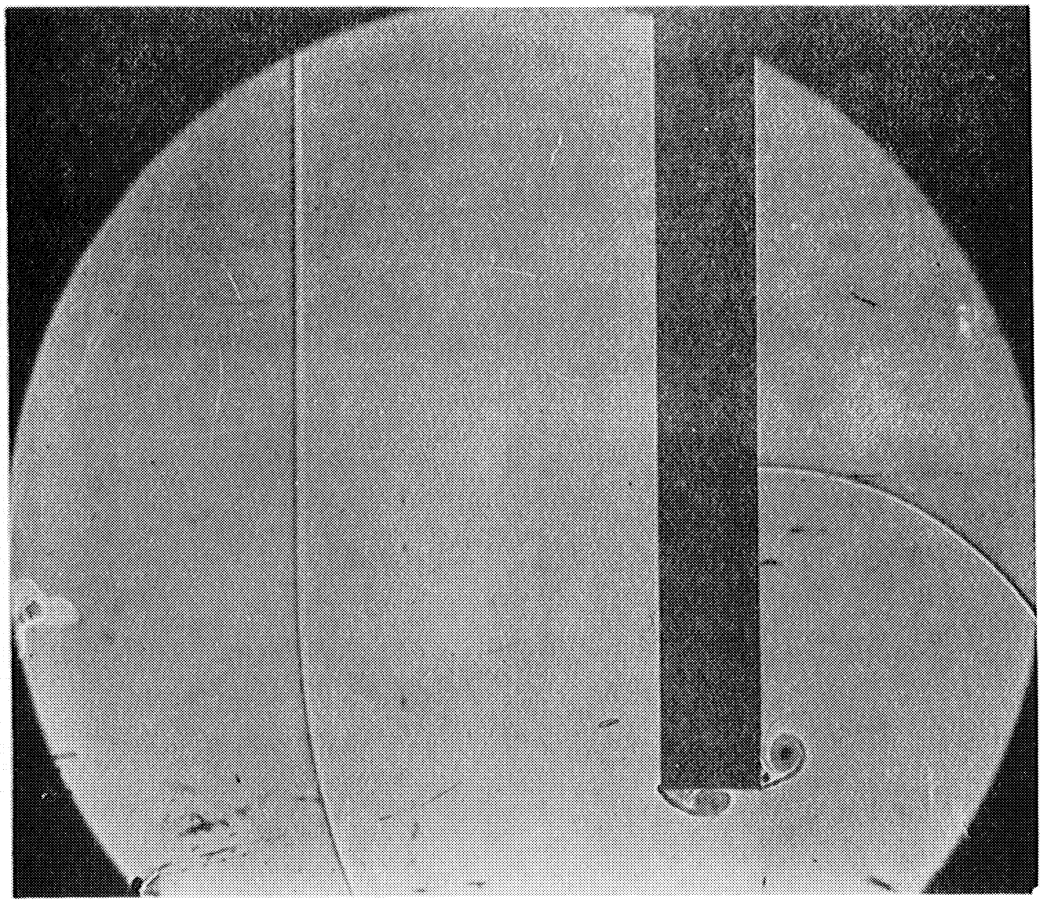

Fig. 42

M = 1.2
t = 121

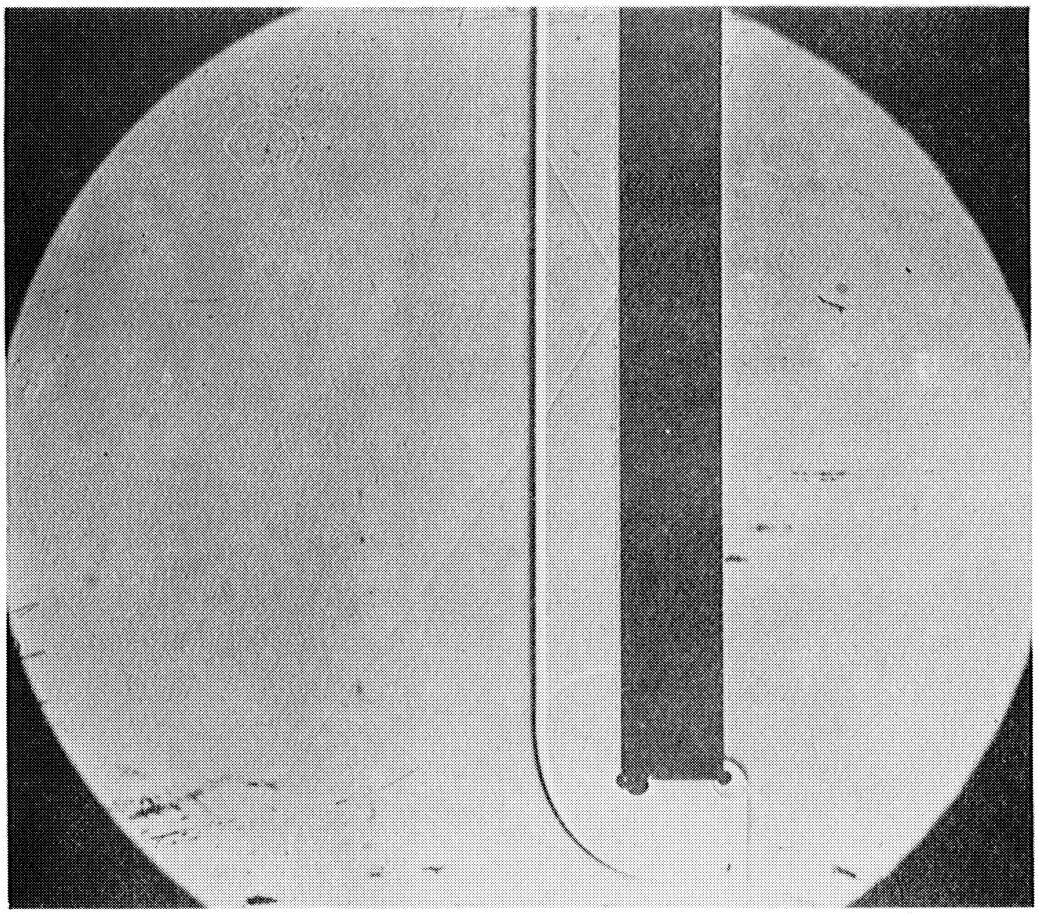

Fig. 43

M = 1.3
t = 37

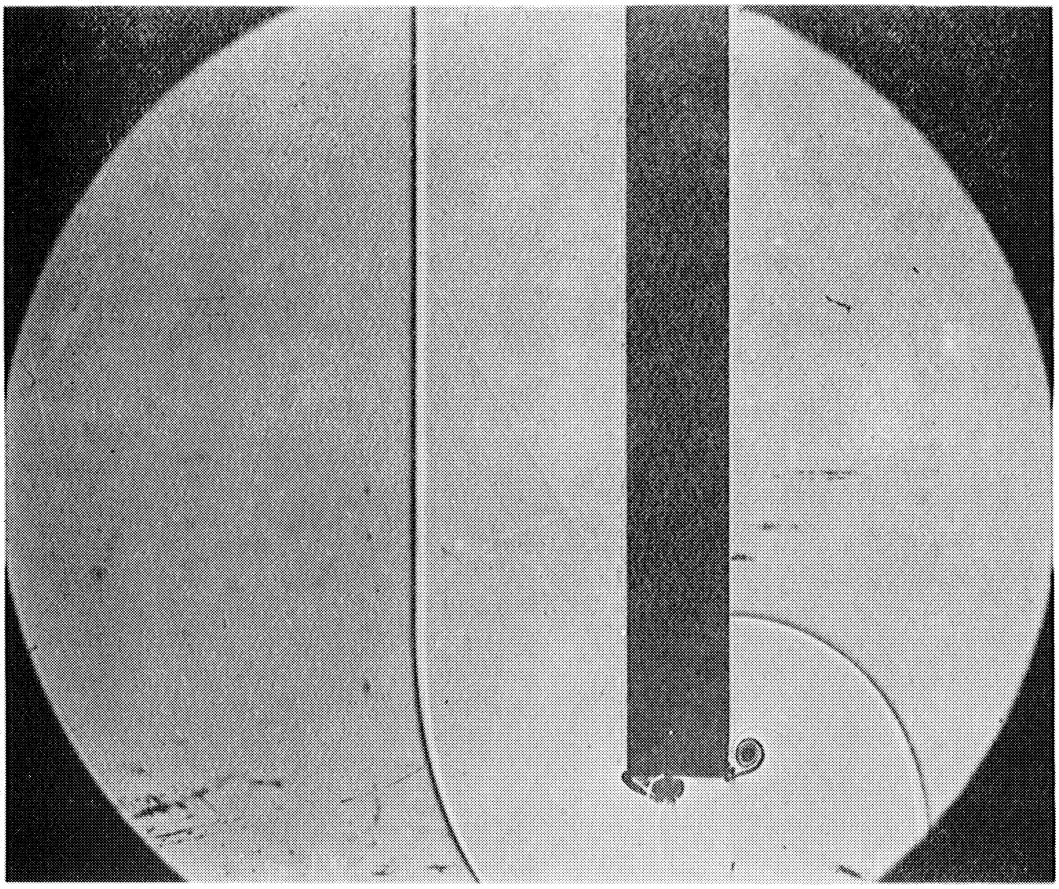

Fig. 44

M = 1.3
t = 89

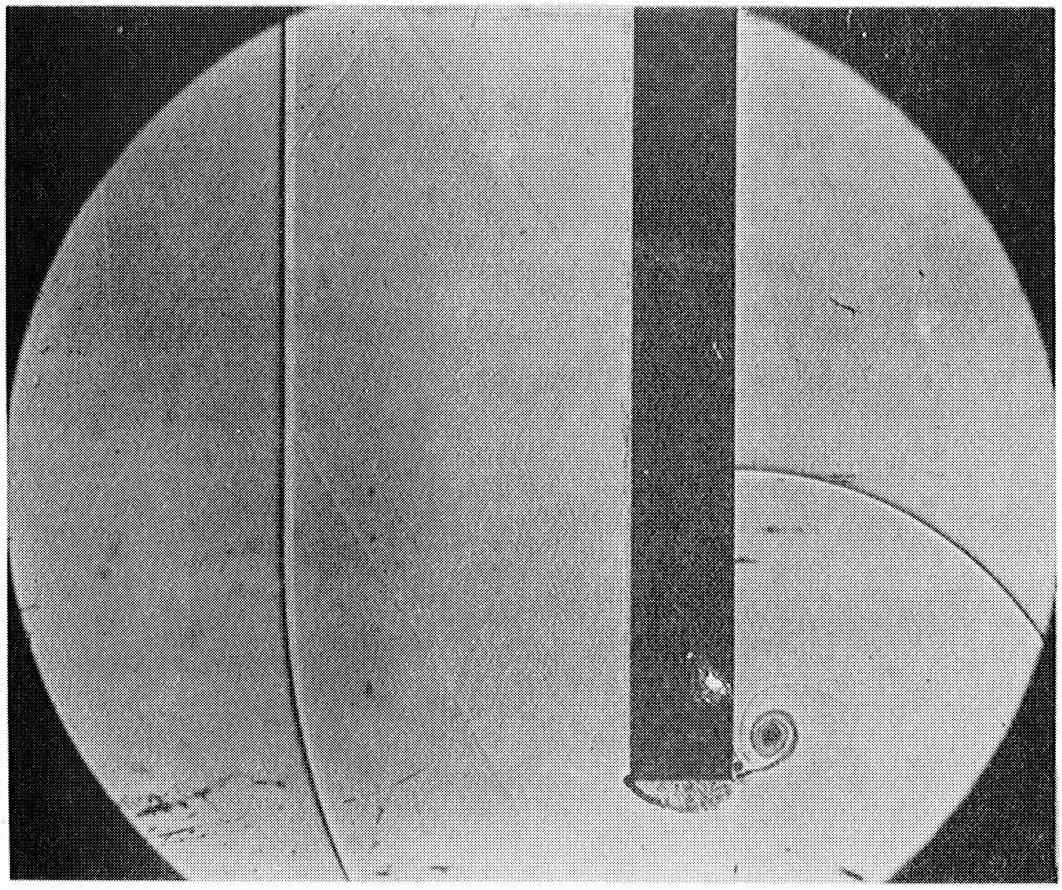

Fig. 45

M = 1.3
t = 106

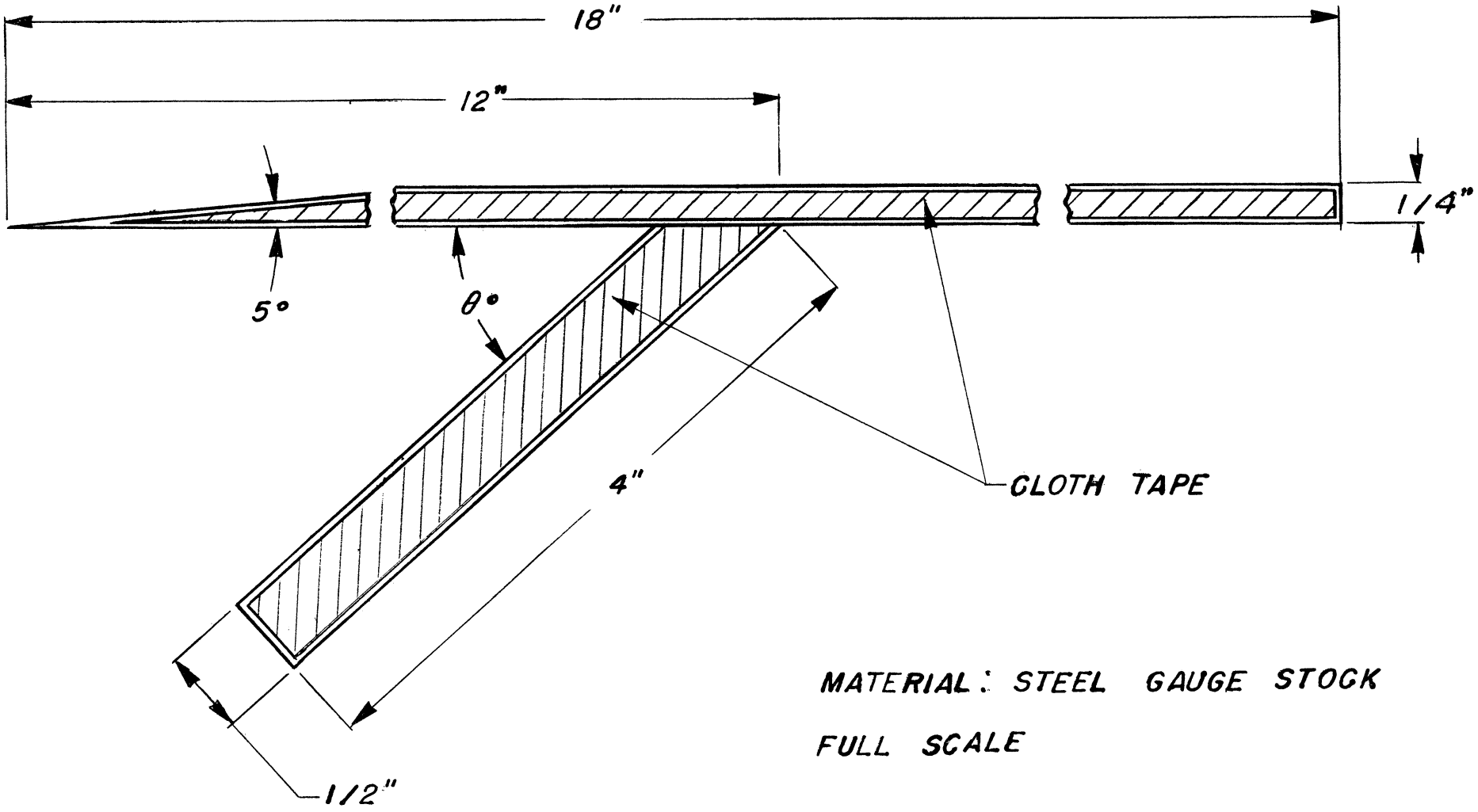

FIGURE 46

METHOD OF MOUNTING MODEL

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