

科學圖書大庫

光學儀器叢書

(一～六全一冊)

譯者 王大庚 曹培熙

本叢書含下列各書：

1. 望遠鏡光學
2. 自製望遠鏡
3. 光學遊戲
4. 望遠照相鏡頭大全
5. 準直儀與準直
6. 紅外線及其應用

徐氏基金會出版

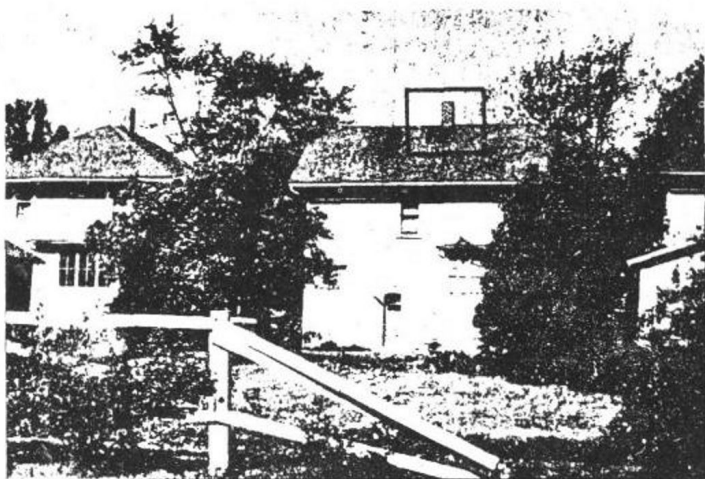
望遠照相鏡頭大全

譯者 王大庚

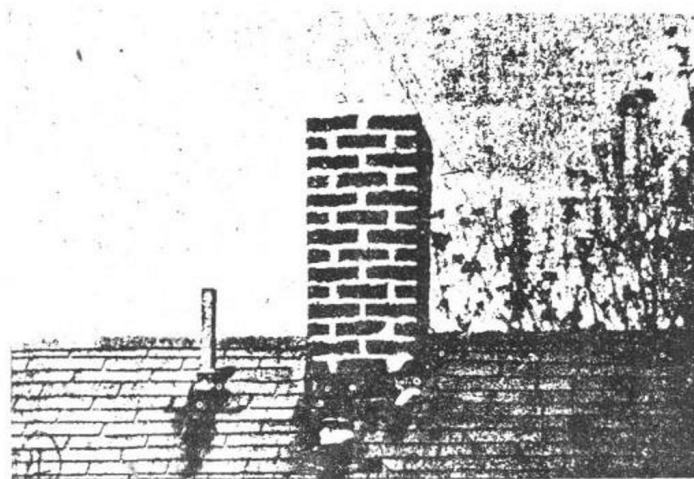
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通俗光學圖書館



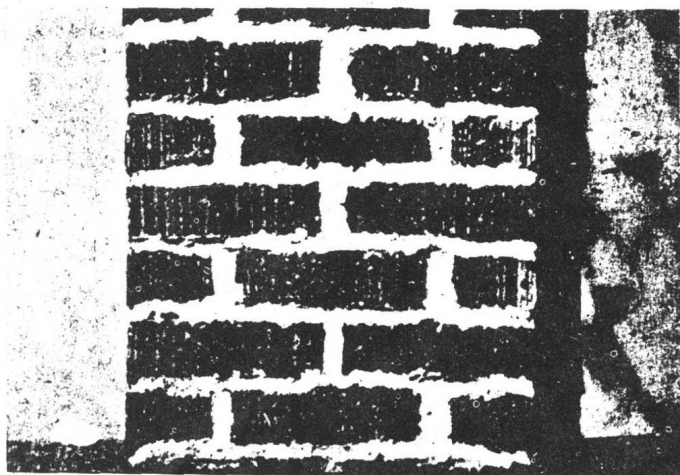
35毫米相機裝用二吋無像散鏡頭，以相機距物體約75碼能攝取一廣大區域。三X底片，於 $f/11$ 下曝光 $1/500$ 秒。



十八吋消色鏡使物體升起而突出，以相機置於相同距離將產生一巨大影響。三X底片，於陽光下，無濾色鏡，用 $f/8$ 曝光 $1/500$ 秒。



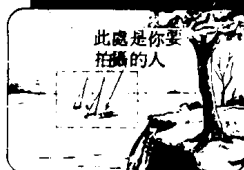
用十八吋消色鏡作兩倍之投射，中央部份顯示極佳鮮明度，而四角部份亦相當清晰。



用十八吋消色鏡作四倍之投影，以72吋之等效焦距作成超級特寫鏡頭，K 2濾色鏡，於 $f/32$ 下曝光 $1/50$ 秒，三X底片。

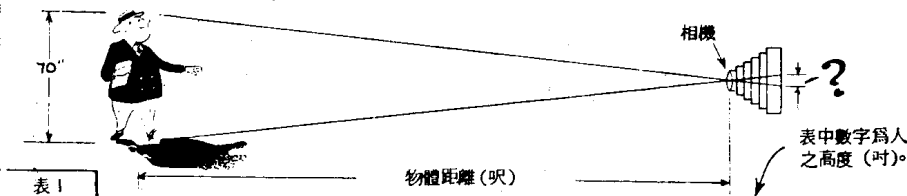
一個人有多大？

進入照片中的人物是要受到約束的！倘使諸位有一具某種焦距的相機鏡頭，在某種距離攝影，這張簡表將告訴諸位一個人的平均身長在底片上有多高。這張表的主要用途在計劃望遠照相裝備 - 使你對透距離照片上將可攝取到什麼不必猜測。下圖所示各例均係典型問題，諸位很容易將表中資料應用於其他各種組合。



此處是你
拍攝的人

儘量使人影不少於 $1/8$ 吋，放大八倍後，此君將成一時大小的巨人 - 大得足以辨認了！

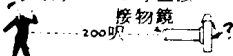


各種鏡頭在各種距離下之人體影像尺寸

焦距		與人之距離 (呎)。								
吋	毫米	50	100	200	300	400	500	1000	2500	5000
2	50	.24	.12	.06	.04	.03	.024	.012	.004	.002
4	102	.46	.23	.12	.07	.06	.046	.023	.010	.005
6	152	.70	.35	.18	.12	.09	.070	.035	.011	.007
8	203	.92	.46	.23	.15	.12	.092	.046	.018	.009
10	254	1.16	.58	.29	.19	.15	.116	.058	.024	.012
15	381	1.74	.87	.44	.29	.22	.174	.087	.034	.017
20	508	2.32	1.16	.58	.38	.29	.232	.116	.046	.023
30	762	3.48	1.74	.87	.58	.44	.348	.174	.070	.035
40	1016	4.64	2.32	1.16	.77	.58	.464	.232	.092	.046
50	1270	5.80	2.90	1.45	.97	.75	.582	.291	.116	.058
60	1524	6.96	3.48	1.74	1.16	.87	.696	.348	.138	.069
80	2032	9.28	4.64	2.32	1.55	1.16	.928	.464	.186	.093
100	2540	11.60	5.80	2.90	1.93	1.45	1.164	.582	.232	.116

例一 - 直接物鏡

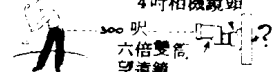
一具35毫米相機，配以8吋焦距鏡頭以代替標準2吋鏡頭，距離人體200呎，問底片上人的影像尺寸為何？



解：在上表中之左邊一欄，找到8吋焦距位置，在同行之200呎欄下讀如：.23" = $1/4$ " (約)，人體影像。

例二 - 無焦點附件。

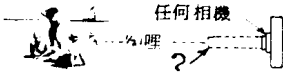
在正規之4吋焦距鏡頭前使用一具六倍望遠鏡，在300呎處拍攝，問底片上人的影像有多大？



解：求該相機鏡頭之正常影像高度並乘以附件之放大倍數：4" (在300呎下) = 0.07" $\times 6 = 0.42$ " = $7/16$ " (影像)。

例三：

設於半哩 (2,500呎) 外攝取人像。如欲獲得 $1/8$ 吋的人影像，問需要之焦距或等效焦距為何？



解：在2,500呎欄找到最接近 $1/8$ 吋之數字.116吋，在同行之左邊欄讀數為50吋焦距。
附註：此一焦距可以7吋相機鏡頭與7倍望遠鏡組合而獲得 ($7 \times 7 = 49$ 吋)。

DIRECT OBJECTIVE SYSTEMS

PAGE 8

- Design 1 - 8" focal length anastigmat f/4.5 #40,522
- Design 2 - 105 mm enlarging lens #50,389
- Design 3 - 33 x 245 Achromat - Not available

PAGE 8

- Design 12 - 6194 - Not available
- Design 13 - Objective 32 x 171 mm #6316 Mounted, Coated.
Black flock paper #60,068 27 x 36" sheet
(See brass tubing list on back page.)
- Design 14 - Objective 32 x 171 #6316 - Mounted, Coated.
K2 filter 38mm Dia. #40,351
(See brass tubing list on back page)
- Design 15 - Objective 32 x 171 #6316 - Mounted Coated.
Rack and pinion telescope eyepiece holder, #50,077
K2 filter 38 mm Dia. #40,351
(See brass tubing list on back page)

PAGE 7

- Design 16 - 1/4 x 2" pinion wire. Two 7/8" dia. knobs #40,164
6290 Substitute #60,428
Rack 1/8" wide 4" long #40,080
- Design 17 - #6195 - No longer available. Substitute #60,428
Black flock paper 27 x 36" sheet #60,068
Rack 1/8" wide 4" long #40,080
3" outer diameter alum. tube 16-7/8" long.

PAGE 8

- Design 18 - Achromat in cell 48 x 360 mm #60,428
Iris diaphragm #30,118
- Design 19 - Achromatic objective #30,201
Blackened brass tubing #117, 3" x 1-3/16" I.D.
Blackened brass tubing #118, 2" x 1-1/4" I.D.
Black flock paper 27 x 36" sheet #60,068

TELEPHOTO LENSES

PAGE 11

- Design 5 - Achromat #6232 (spaced)
DCV lens 25 x 48mm #94,501
K-2 filter #871
- Design 6 - Achromat #40,429 (mounted)
Achromatic Barlow #30,448
- Design 8 - Achromat (mounted) #40,429
Achromatic Barlow #60,122
- Design 9 - Achromat #6232
Negative Lens #30,175

Note: K2 filter not available.
(Substitute #40,351 on designs 5 & 8)

SCAL SYSTEMS

PAGE 15

- #1 Camera binocular holder - #70,223
- Individual focus - 7x50 American made binocular #1544
- Individual focus - 7x50 Japanese made binocular #1524
- Individual focus - 7x35 American made binocular #964
- Individual focus - 7x35 Japanese made binocular #1512

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PAGE 16

- 7x50 Imprinted Monocular #4,696
- 5x30 American made Mon

PAGE 18

- Design 12 - Objective 32 x 132 #5182 - Coated
22 m focusing eyepiece 6x30 - #6301
- Design 13 - Objective 32 x 171 mm Mounted - #6316
Other parts not available.
- Design 14 - Objective 32 x 171 mm Mounted - #6316
Eyepiece 3/4" F.L. #30,316 - Mounted
(See brass tubing list on back page)

PAGE 19

- Design 17 - 7" F.L. Cooke triplet - Not available,
substitute 8" F.L. #60,624
- Design 18 - Objective 52 x 220 #6188
Rack and pinion eyepiece holder, #50,077
Neg. Meniscus lens 50x-100, #94,603
- Design 19 - Objective 52 x 220 #6188 - Coated - not
available, substitute #5216
Neg. Meniscus 50x-800 mm #94,602
K2 filter 51.3 Dia. #40,350, Not available,
substitute #40,351

AFOCAL GALILEAN NEGATIVE ATTACHMENTS FOR 35mm CAMERA

PAGE 23

- Design A - 39 x 63 Achromat #6246 - Coated
Double concave 18 x 28 mm - Not available,
substitute 19 x 30 #94,457
- Design B - 34 x 65 Achromat #6215 Coated
Double concave 19 x 30
- Design C - 34 x 65 Achromat #6215 Coated #94,457
Double concave 19 x 35 #94,461
- Design D - 26 x 104 Achromat #6181
Double concave 19 x 50 #94,476
- Design E - 32 x 132 (unmounted) #5182 Coated
Double concave 25 x 48

PROJECTING SYSTEMS

PAGE 25

- Design A - Two 30 x 65 Achromats #6317 Coated
(See brass tubing list on back page)
- Design B - #50,130 Not available
- Design C - 3/4" symmetrical e. eyepiece #30,316
- Design D - 28 mm Kellner type 3 #5223
- Design E - 28 mm Kellner type 3 #5223
- Design F - 27.5 mm Kellner type 1 (7x50 binocular) #5203
- Design G - 22 mm Kellner type 1 (6x30 binocular) #5201
- Design H - 1" Erfle #60,225
- Design I - #5160 - Not available - substitute #60,225

PAGE 27

- 18 - 1/4" F.L. Achromat - Not available,
substitute #40,802 61x356

PAGE 28

- Design 12 - 7x50 Monocular #70,639
Rubber sleeve #60,100

7X PROJECTION MAGNIFICATION

PAGE 29

- Design 13 - #50,216 - Not available, substitute 8"
Cooke #60,624
3/4" eyepiece #30,316
- Design 14 - 6-3/8" Anastigmat (not available from us
at this time)
- Design 15 - Achromat in cell 51 x 180 #6188
3/4" eyepiece #30,316
- Design 16 - Achromat in cell 32 x 171 mm #6316
Eyepiece #30,316

NEGATIVE SLIP-ON LENSES

PAGE 31

- Design 3 - Two 40 x 180 mm plano concave - Not available,
substitute one 33x - 80 mm #94,414
- Design 5 - PCV 39x-100 - Not available
- Design 6 - 42x-167 Neg. meniscus - Not available,
substitute 52 x - 169 #94,597

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3/16	1-1/2
1/4	1-8/16
5/16	1-5/8
3/8	1-11/16
7/16	1-3/4
1/2	1-13/16
9/16	1-7/8
5/8	1-15/16
11/16	2
3/4	2-1/16
13/16	2-1/8
7/8	2-3/16
15/16	2-1/4
1	2-5/16
1-1/16	2-3/8
1-1/8	2-7/16
1-3/16	2-1/2
1-1/4	
1-5/16	
1-3/8	

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望遠照相鏡頭大全

拍攝遠方物體的“大型相片”是件有趣的事情。無論在沙灘上、看球賽、狩獵途中、在高山上……諸位都會遇見許多稍縱即逝的景物，如拍成長距離照片的近視特寫畫面將使照片顯得格外美妙有趣。當然，像這類照片幾乎任何一種相機都能拍出，但要以35毫米單鏡頭反光照相機最適合這一旨趣。本書中所展示的大多數系統，幾乎都以此類相機為設計的構想。雖如此，但大多數的觀念仍然可以應用於其他各種相機。

“凡透鏡皆可成為望遠照相鏡頭”。凡是焦距大於你的相機之標準鏡頭的任何透鏡，都可當作這具相機的望遠照相鏡頭來使用。倘如諸位有一具35毫米相機，使用二吋焦距的正常鏡頭，若換上一只四吋焦距鏡頭，那麼你會獲得二倍的望遠照相裝置——在任何特定距離以內，這具相機都可拍得比二吋鏡頭所得影像大二倍的相片。表二所列，為各種相機的正常鏡頭資料。通常，正常鏡頭都有約與所用底片對角線等長的焦距。在這種情形下，此鏡頭將可涵蓋53°的視域。而

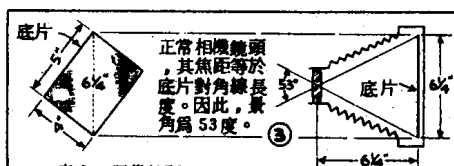
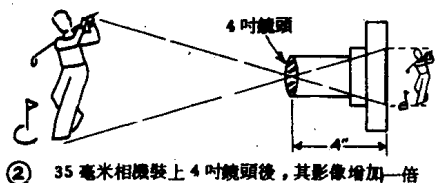
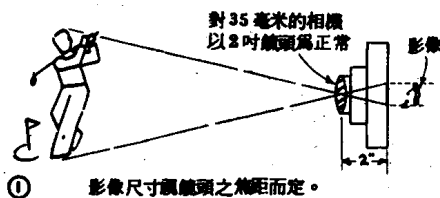
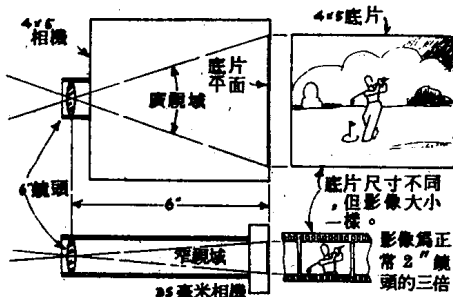


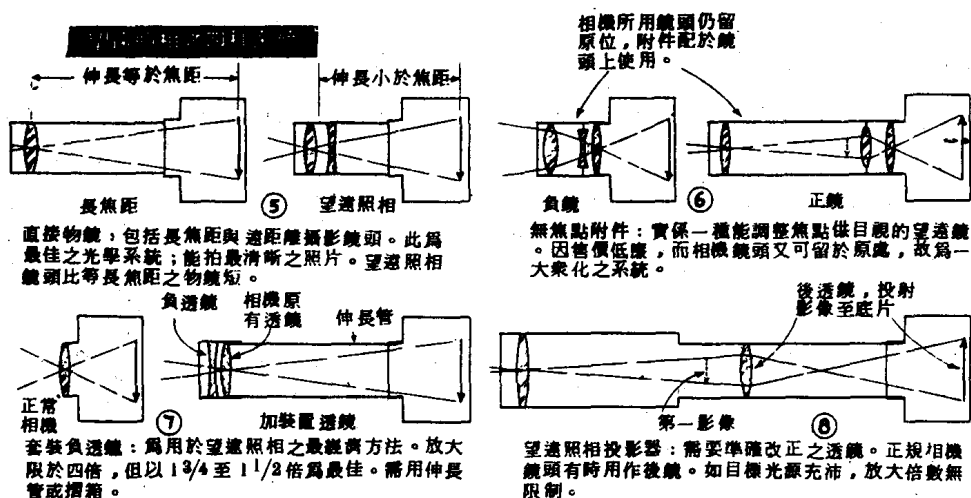
表2 - 正常鏡頭

底片或相機	底片對角線	正常鏡頭之焦距	正常景角	35毫米
8毫米電影機	1/4"	1/2" (13毫米)	26°	—
16毫米電影機	1/2"	1" (25毫米)	26°	—
35毫米電影機	1 1/4"	2" (50毫米)	34°	—
35毫米照相機	1 3/4"	2" (50毫米)	47°	47°
1 1/2" x 1 1/8"	1 1/8"	1 1/8" (41毫米)	60°	—
1 1/2" x 2 1/2"	2 1/2"	3" (75毫米)	51°	32°
2 1/4" x 2 1/4"	3 1/8"	3" (75毫米)	55°	32°
2 1/4" x 2 3/4"	3 3/8"	3 3/8" (80毫米)	53°	31°
2 1/4" x 3 1/4"	3 3/4"	4 1/8" (105毫米)	49°	24°
3 1/4" x 4 1/4"	5 1/4"	5 1/4" (135毫米)	53°	19°
4" x 5"	6 1/4"	6 1/4" (160毫米)	53°	16°
5" x 7"	8 1/2"	8" (203毫米)	56°	13°
8" x 10"	12 1/2"	12" (305毫米)	56°	9°



④ 當使用比正常鏡頭長之鏡頭時，視域將被減小。

2 望遠照相鏡頭大全



這種廣角度視域，亦唯有一種無像散鏡頭 (anastigmat) 方可攝得清晰畫面的相片。

圖4所示，為一只6吋鏡頭配於35毫米相機。這具鏡頭如果裝在一架4×5的相機上，那屬於正常，但就以35毫米的底片觀之，它可當作一具三倍的望遠照相鏡頭使用。請注意，比正常鏡頭長的鏡頭，即意謂視域角的變窄。在一種特別的裝置下，6吋鏡頭將有16度的視域角，此值見表2的右欄所示。但如用8½吋鏡頭時，視域角將減至13度；20度時，則僅有5度。這種視域角變窄的現象，却有一件事實值得注意，即大大的減少了對價格昂貴的無像散鏡頭的需要。倘使在窄視域角之外，再加用一只濾色鏡，那麼你對影響照相影像的所有像差，將可獲得最佳程度的控制。

拍攝望遠照相像片顯著的最佳系統，簡單的說，即是使用比正常鏡頭焦距更長的物鏡。雖長達20吋焦距的鏡頭，只需使用一只合適的加長管，聚焦匣或摺箱，便可以很方便的裝在35毫米相機上使用。直接物鏡唯一的缺點，是使得整個相機笨重而顯眼。但這一問題，在商業上的解決辦法則是：使用一種在正（聚光）透鏡之後裝上負（發射）透鏡的常用望遠照相鏡頭。這類鏡頭有各種焦距尺寸，極易購到。通常，有效焦距約為所需機械伸長度的兩倍。望遠照相鏡頭，一般把它分類為直接或主要物鏡。

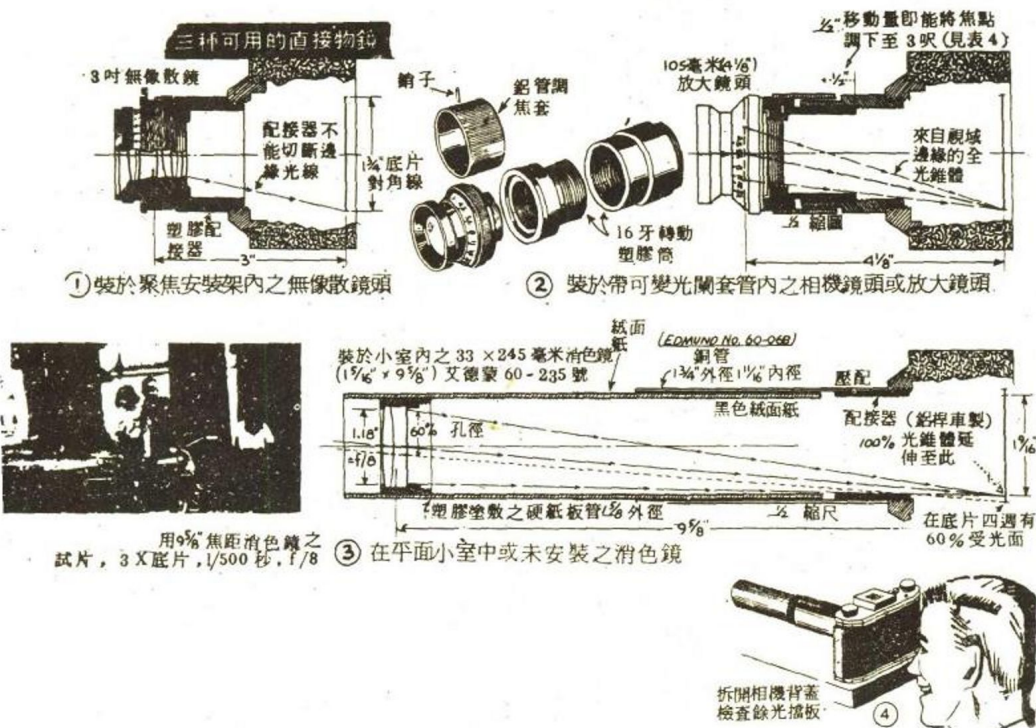
雖然長焦距直接物鏡極適合於可以互換鏡頭的相機裝用，但是，大多數的相機，僅有一只物鏡永久裝於其上不能移動，在這種情形下，唯一能夠可行的望遠照相系統，即為一種配裝於正規的相機鏡頭前之附件。一只望遠照

相附件與一具望遠鏡的結構，沒有什麼不同，可以分類為伽利略 (Galilean) 或負透鏡式，或正透鏡天文式兩種。負透鏡望遠鏡結構的最佳特徵，是其體積小巧。通常兩倍的設計，可縮裝成約 1 吋半的長度。跟一般使用情形一樣，這種鏡頭不可能獲得超過兩倍以上太多的放大倍數，因為視域較窄。而另一方面，天文式或正透鏡附件，能獲得任意選擇的十倍、廿倍、卅倍，甚至更大的強力放大倍數。這兩種附件，其與相機頭組合後的焦距，等於望遠鏡附件的倍數乘以相機鏡頭的焦距。

第三種望遠鏡照相系統，係於正規相機鏡頭之前方加裝一負透鏡，見圖 7 所示。這種裝置必須使用能伸縮之摺箱或與此等效的加長管。這是所有各系統中最價廉物美的一種，普遍為擁有伸縮摺箱相機的人喜愛採用。放大倍數最高限於相機鏡頭本身焦距的三倍。

最後一種，即所謂的“大漢”型望遠照相鏡頭—投影系統。業餘攝影家曾經很成功地用過高達相當 1,000 吋的焦距。欲拍好的照片，這種鏡頭如縮小至相當程度，或許是除直接物鏡以外最佳的一種。本地出品，屬於“袖珍”型一類，但也能攝得很好的像片。這種系統，為後方的正透鏡或“目鏡”，投射前方透鏡所形成的影像。因此，整個系統的等效焦距，為物鏡的焦距乘以投影之放大倍數。

4 望遠照相鏡頭大全



直接物鏡

直接物鏡望遠鏡頭，除體積較大外，無論任何一方面都是從事望遠照相最佳的工具。光量的傳遞為最大，並有最佳的鮮明度。能夠使用的鏡頭種類繁多，即使簡單的平凸透鏡或正新月形鏡，如將光圈縮小至 $f/22$ 或 $f/32$ ，均可攝得良好的相片。

35 毫米反光相機專用之望遠照相鏡頭組，通常自標準之中等焦距無像散鏡頭開始，但以 3 吋為常用的一種。通常，這種鏡頭係裝於一具可調整焦距的安裝架內，因此唯一需要的“額外”零件，是一件整體的鋁質或塑膠伸長管，以螺紋配裝於相機上使用；見圖 1。

備有一具聚焦用之安裝架後，自鏡頭至底片的正確距離調整，便很容易

表3 任一指定 f /值下之
鏡頭直徑(吋)表

焦距	$f/4$	$f/5.6$	$f/8$	$f/11$	$f/16$	$f/22$	$f/32$	$f/45$
3"	.75	.54	.37	.27	.19	.13	.09	.06
4"	1.00	.72	.50	.36	.25	.18	.13	.09
5"	1.25	.90	.62	.45	.31	.23	.16	.11
6"	1.50	1.08	.75	.54	.38	.27	.19	.13
7"	1.75	1.26	.87	.64	.44	.32	.23	.15
8"	2.00	1.44	1.00	.72	.50	.36	.25	.16
9"	2.25	1.64	1.12	.82	.56	.41	.28	.20
10"	2.50	1.80	1.24	.90	.62	.45	.31	.22
12"	3.00	2.16	1.52	1.08	.76	.54	.38	.27
14"	3.50	2.56	1.74	1.28	.88	.64	.44	.31
16"	4.00	2.88	2.00	1.44	1.00	.72	.50	.36
18"	4.50	3.24	2.24	1.64	1.12	.82	.56	.40
20"	5.00	3.60	2.48	1.80	1.24	.90	.62	.44
25"	6.25	4.56	3.12	2.28	1.56	1.14	.78	.55
30"	7.50	5.44	3.76	2.72	1.88	1.36	.94	.66
35"	8.75	6.36	4.36	3.18	2.18	1.59	1.09	.78
40"	10.00	7.20	4.98	3.60	2.48	1.80	1.24	.88
45"	11.25	8.20	5.60	4.10	2.80	2.05	1.40	1.00
50"	12.50	9.12	6.24	4.56	3.12	2.28	1.56	1.11

例題：設焦距為 20" 之鏡頭，其直徑為 $1\frac{3}{4}$ "，問 f /值為何？
解：在焦距欄下找到 20"，橫過 20" 行找到最接近 $1\frac{3}{4}$ " 之 1.80" 欄，向上讀出 $f/11$ 。

$$\text{計算：} \quad f/\text{值} = \frac{\text{焦距}}{\text{鏡頭直徑}}$$

$$\text{鏡頭直徑} = \frac{\text{焦距}}{f/\text{值}}$$

表4 在定距離下聚焦所需之擋套管伸長度

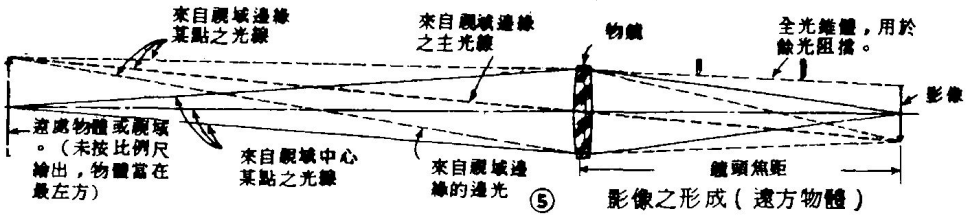
焦距	30"	36"	5 $\frac{1}{2}$ "	10"	20"	50"	100"	500"
3"	3.33	3.27	3.16	3.07	3.04	3.01		
4"	4.61	4.50	4.28	4.14	4.07	4.02	4.01	
5"	6.00	5.81	5.45	5.21	5.11	5.04	5.02	
6"	7.50	7.20	6.66	6.31	6.15	6.06	6.03	6.01
7"	9.13	8.69	7.92	7.43	7.21	7.08	7.04	7.01
8"	10.91	10.29	9.15	8.57	8.32	8.11	8.05	8.01
9"	12.86	12.00	10.89	9.73	9.35	9.14	9.07	9.01
10"	15.00	13.85	12.00	10.91	10.43	10.17	10.08	10.02
12"	20.00	18.00	15.00	13.33	12.63	12.24	12.12	12.02
14"	26.25	22.91	18.26	15.65	14.87	14.33	14.16	14.03
16"	34.28	28.80	21.82	18.46	17.14	16.44	16.22	16.04
18"		36.00	25.71	21.71	19.46	18.56	18.28	18.05
20"			30.00	24.00	21.82	20.69	20.34	20.07
25"			42.86	31.58	27.91	26.08	25.53	25.10
30"			60.00	40.00	34.28	31.58	30.77	30.15
35"				49.41	40.97	37.17	36.05	35.21
40"					60.00	48.00	42.86	41.38
45"						72.00	55.38	48.65
50"							63.16	54.54

例題：用 20" 焦距鏡頭，距位置，橫過此行在與 10" 對物距為 10 呎，物體與準度為 24.00 吋。此值減鏡頭焦距 20 吋，得聚焦點之活動行為 4.00 吋。

在室內調整決定。即在鏡頭前方定一適當的對焦點距離（例如 15 呎），然後前後移動相機前面的鏡頭，至距離某目標物為 15 呎整，且在相機磨砂玻璃上現出最清楚之影像時為止。僅需要大略的準確度即足。因為以磨砂玻璃對焦點，並不依靠距離刻度尺。

採購適度的望遠照相鏡頭，最好選擇一種 105 毫米，工作於 $f/4.5$ 的無像散放大鏡頭。這種鏡頭備有掣子擋光片，但你仍須自備聚焦的零件。如圖 2 中所示的螺紋短管。

焦距在 6 吋以上的照相物鏡，其費用方始逐漸昂貴。約於 6 吋左右，因窄視域角的關係，目視消色鏡也將開始產生極好的作用。平均的目視消色鏡，係設計僅涵蓋一相當窄的視域角，很少超過 15 度。超過此一角度，在視域的邊緣很可能顯現極差的鮮明度。這種情形的另外一種說法，便是欲保持視域角在良好的極限以內，消色鏡應具有 $6\frac{1}{2}$ 吋，或更長的焦距。圖 3 所示，為簡單的滑動調焦典型裝置。固定的 $f/8$ 速度，將使你能以 $1/500$ 秒拍攝

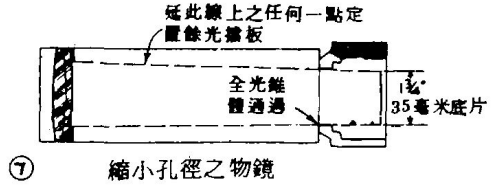


；幾乎可應付任何樣的動作。勿需預備三角架，使用特殊的管子長度，這套配備將可聚焦點至最近距離約 5 呎。倘使你想設計一種既適合極近，又適合長距離攝影的鏡頭系統，必須參考表 4 的資料。

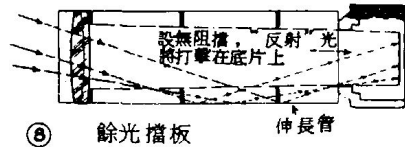
光線。一具新物鏡，除須確定鏡頭與相機的正確間隔之外，其配合與否亦為主要考慮的因素。例如是否能獲得有用的光線到達底片上，同時並將對照片無益的光線阻擋。此情況的光學說明



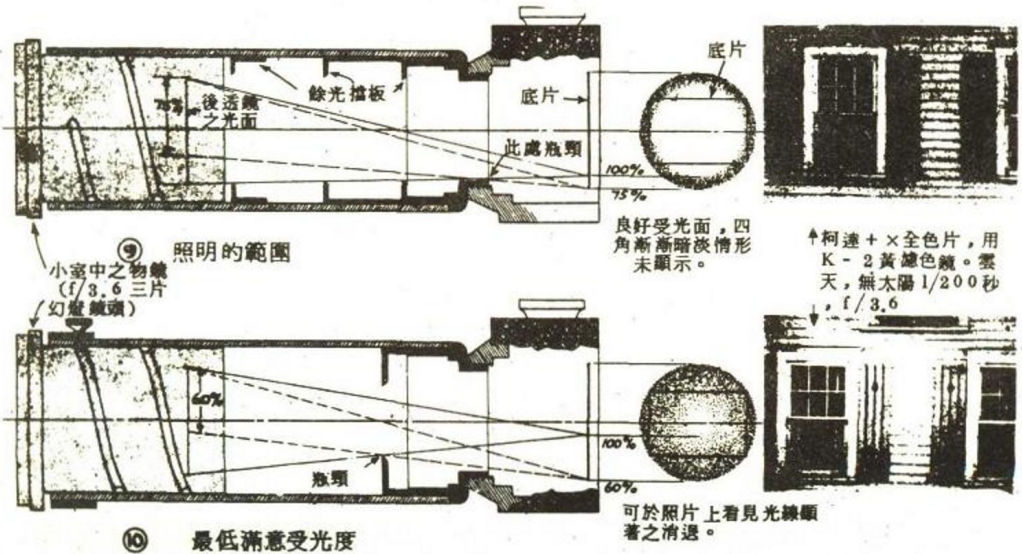
⑥ 全光錐體



⑦ 縮小孔徑之物鏡



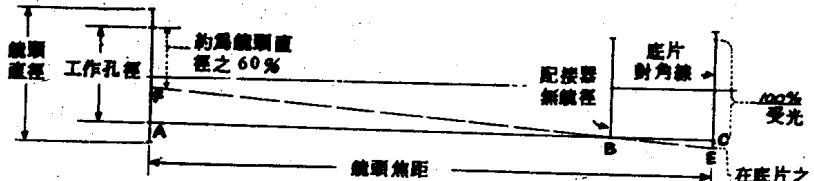
⑧ 餘光擋板



⑨ 最低滿意受光度

①

直接物鏡
光學圖解

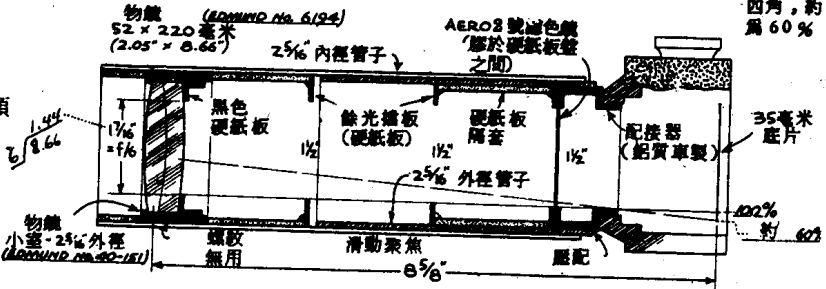


②

滑動聚焦鏡頭
之典型結構

有效焦距 = $8\frac{1}{8}"$

速率 = $f/6$



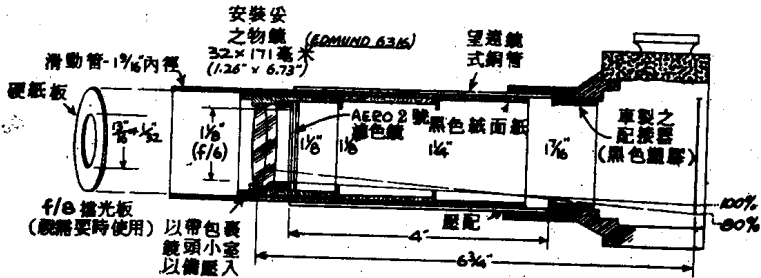
全部直徑均為
 $\frac{1}{8}"$ 細尺

③

滑動聚焦點
之直接物鏡

等效焦距 = $6\frac{3}{4}"$

速度 = $f/6$

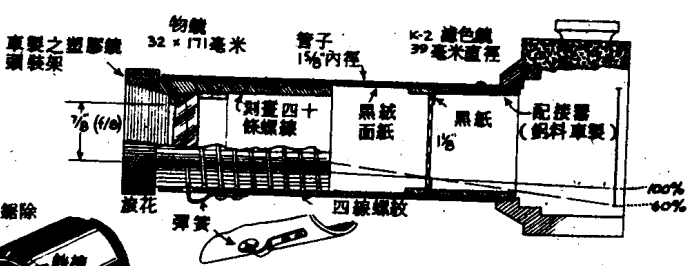


④

簡單之螺旋
聚焦裝置

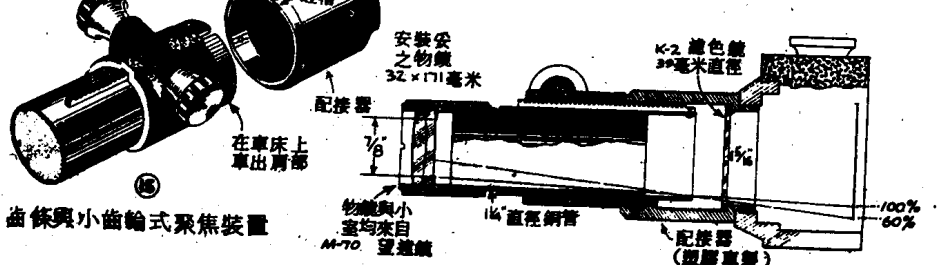
等效焦距 = $6\frac{3}{4}"$

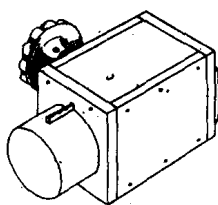
速度 = $f/8$



⑤

齒條與小齒輪式聚焦裝置

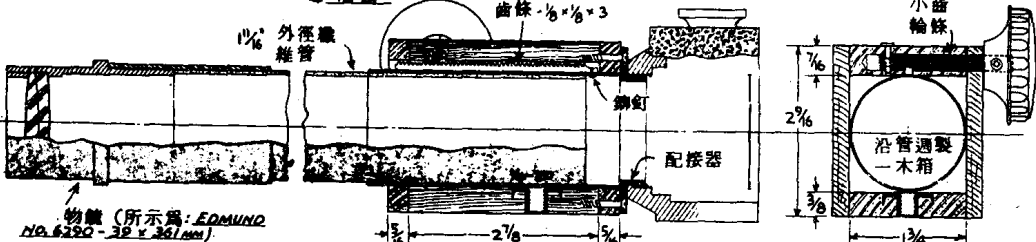
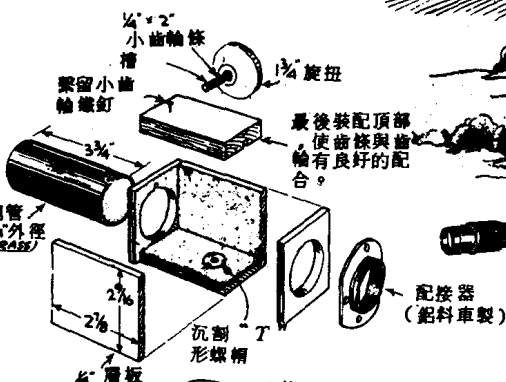




用粒狀皮面紙
覆蓋箱面

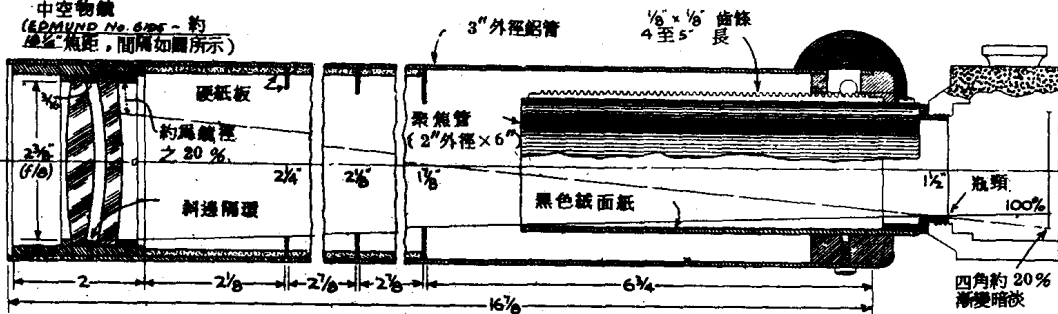
①⑥

圖，能用於各種物鏡
之聚焦箱

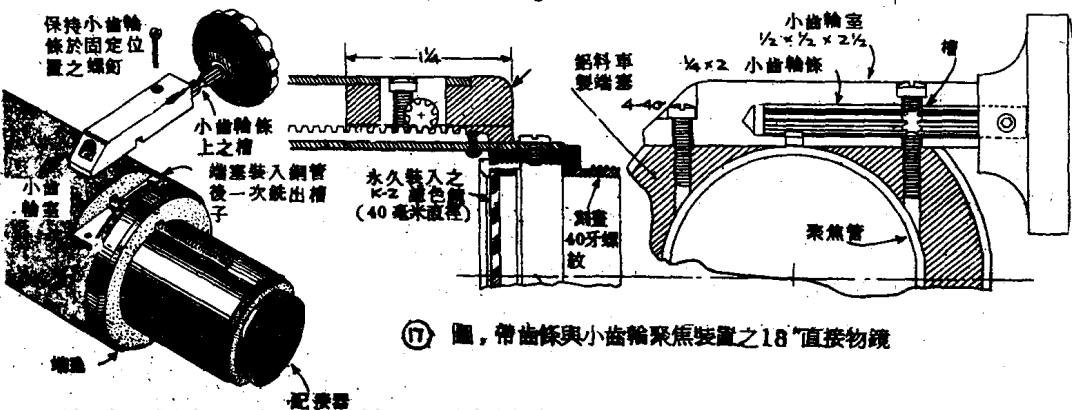


物鏡 (所示為: EDMUND
NO. 6290 - 32 x 361mm)

中空物鏡
(EDMUND No. 6295 - 約
1/2" 焦距, 間隔如圖所示)



保持小齒輪
條於固定位
置之螺釘



①⑦ 圖，帶齒條與小齒輪聚焦裝置之 18" 直接物鏡