(1) Differential movement of two Stations situated one degree of latitude apart.

Every point on the Earths equator rotates during each hour through an arc of $15^\circ \times 60' = 900$ miles in circumference whilst the pole itself has no movement at all. It is obvious that intermediate stations rotate through arcs of intermediate linear extent and, that as there are 90 degrees of latitude between the Equator and the pole, every station on the earth's surface must travel on an average 10 miles per hour faster than those one degree further from the equator. Supposing the earth to be a sphere, ([illegible])

The exact difference due to an interval of one degree, or 60 miles, at any latitude l is expressed by the formula $900\{\cos l - \cos(l+1)\}$ It gives us 14.0 miles for lat: 62° & 10.4 miles for lat 42° which are the limiting parallels of my weather charts. It will be sufficiently exact for my purposes if I take the mean of these values or 12.2 miles per hour as constant throughout the whole of their area. In other words if ~~[illegible]~~ ~~[illegible]~~ CN be a meridian line, & Nn the differential movement of N compared with C in one hour, then

$$\frac{Nn}{CN} = \frac{12.2}{60} = \tan NCn = \tan 11^\circ.30'$$ on the supposition that CNn is to be treated as a plane triangle, accurately $\tan NCn = \frac{\tan Nn}{\sin CN}$

(2) Course of a particle of air within the area of the charts as affected by the differential movement above mentioned.

Suppose a particle of air c stationary above any place C to be abruptly propelled northwards through 1° to N & then be left to hover for an hour. The differential excess of C's velocity (over that of N) (which is shared in by c) will cause that particle to have travelled 12.2 miles to the eastward of N by the close of the hour, supposing its movements wholly unembarrassed. Its course will be along a great

(2.a)

Let us trace the course of a particle ~~moving~~ urged by an uniform? force towards the Pole. Assume its velocity such that it travels [with a uniform velocity of] $\underline{d}$ miles in the hour, the differential movement of the parallel it reaches at the close of the hour is

[CN.. being ... Δ]

$d \tan 10^\circ.30'$ Divide $\underline{d}$ in $\underline{n}$ parts then the differential [deflection of a particle moving with $\frac{1}{n}$ the velocity of the first] movement of two adjacent parts is $\frac{d}{n}$ in one hour or $\frac{d}{n^2}$ in the n^{th} part of an hour.

Suppose the particle $\underline{c}$ to be abruptly propelled through $\frac{d}{n}$ northwards and then allowed to hover for $\frac{1}{n}$ of an hour its deflection will be $\frac{d \tan 11^\circ 30'}{n^2}$. Let the process be repeated another step then its additional deflection will be $2\frac{d}{n} \times \frac{1}{n}$, or $2\frac{d^2}{n^2}$, & its total deflection will have been $\frac{d}{n^2}\{1+2\}$. Proceeding in this way, at the end of the n^{th} interval it will have been

$$\frac{d \tan 11^\circ 30'}{n^2}\{1+2+\cdots n\} = \frac{d \tan 11^\circ 30'}{n^2}\,\frac{n^2+n}{2} = \frac{d \tan 11^\circ 30'}{2} \text{ when } n \text{ is infinite}$$

or the particle will have been deflected through exactly half the differential movement of the parallel it has reached due to the time during which it has been moving.

This is the case of a particle moving with a velocity :: to ... hour.

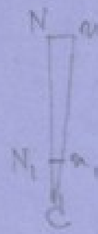
Its course will have been in a parabola to take y along the line d such that $y : d :: r : n$ or $r^2 = y^2 \frac{n^2}{d^2}$

then the deflection of C at $y\ (=x) = \frac{d \tan 11^\circ 30}{n^2}\ \frac{r^2}{2}$ (n being infinite)

$$\text{or } x = \frac{d \tan 11^\circ 30}{n^2} \cdot \frac{n^2}{2d^2}\, y^2 = \frac{\tan 11^\circ 30}{d} \cdot y^2$$

No account is here taken either of the retarding influence of friction or of the interference to free movement offered by the surrounding air

Whether we take d towards the north or towards the South the deflection is the same in amount & is always towards the right hand.



$CN = a$

$CN_1 = \frac{a}{n}$

A particle moving a miles per hour will have a deflection

$= Nn$ in 1 hour

$= N_1 n_1$ in $\frac{1}{n^2}$ of an hour

A particle moving ~~with~~ $\frac{a}{n}$ miles per hour will have a deflection

$N_1 n_1 = \frac{1}{n} Nn$ in 1 hour

$\frac{1}{n} N_1 n_1 = \frac{1}{n^2} Nn$ in $\frac{1}{n}$ of 1 hour circle, which for rough practical purposes & at moderate distances may be considered coincident with a parallel of latitude.

On reversing the conditions of the problem, if c be allowed to hover over C fixed in space during the hour in question and then be instantaneously propelled one degree northwards, its course will lead it directly to N. // The path followed by a particle moving continuously forward and accomplishing 60 miles in the space of an hour, after any law of varying velocity we may please, must necessarily lie between these two extreme cases of a meridian line, on the one hand, and a line making an angle of 11°.30′ with it, on the other. If the onward movement be uniform in velocity, c would reach the parallel of N midway between it and n, say at a point n_1, Joining C & n_1 by a straight line we should have $\tan NCn_1 = \frac{6.1}{60} = \tan 5°.48'$. We may further conclude that so long as the movement be uniform, no matter what the meridional distance x travelled over in the hour may be the deflection per hour is always $x.\tan 5°.48'$, no account being made of retardation by friction. or of the interference of surrounding air.

Whether we take N to the north or S to the South the deflection is the same in extent and is always to the right hand.

(Continued at 2.a.)

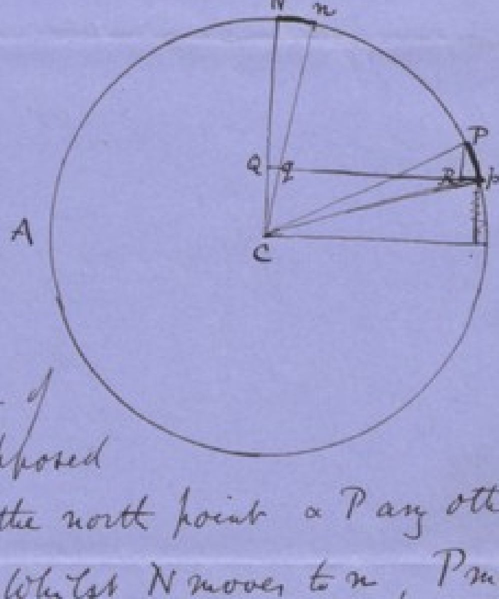
Cyclones &
Anticyclones

(3) Rotatory winds

The gyration of cyclones has been frequently described but I will endeavour to trace the course of a particle of air under their influence with more precision than (so far as I am aware) has hitherto been effected. In the mean time I will explain what I have termed "Anti-cyclones", because they afford a more convenient illustration of rotatory storms.

a. Anticyclones. The state of the weather on the mornings of Dec 2^{nd} 3^{d} & 4^{th} (see special maps) shews the continued divergence of currents from a central area of calms, which is also characterised as an area where the barometer attains its greatest height. I presume this area to be a locus of dense descending currents just as the centre of a cyclone is a locus of light ascending currents. A further reason for this belief lies in the fact that a pure clear sky usually accompanies areas of dispersion indicating that a dry upper atmosphere has been brought down, in the same way that the rains & clouds of a cyclone prove that ~~the~~ damp surface atmosphere has been drawn up & its vapour condensed by the cold of a higher level.

Now suppose two currents of air, both proceeding from the same source, to travel respectively Northwards & Southwards. They must both tend to be deflected to the right hand & it is impossible but that the intermediate mass of still ~~land~~ atmosphere should yield in some degree to their pressure & be deflected also. If winds disperse on every side from a central area, the entire disc of outflow must accept to a calculable degree the right handed deflection that would have been established in their northern & southern portions, supposing them wholly unembarassed. Let us compare the forces actually present with those that would be required to deflect or rotate the whole disc (to the right) to that angular extent, ~~with the forces actually present~~.



Let ANP be one of the circles of which ~~the~~ disc of rotating air may be supposed to be composed N the north point & P any other point in its circumference. Whilst N moves to n, P moves to p; Nn being a small arc.

Resolve the motion of P into PR parallel to the meridian & Rp perpendicular to it. It is clear that the sum of the former set throughout the entire circle, is exactly equal to that of the latter.

$$Rp = Pp \cos NCp$$

Again, the deflection movement acting on a particle during the time it has moved from C towards P in the first instance & finally arrived at p is equal to Qq

$$Qq : Nn (\text{or } Pp) :: QC : NC (\text{or } Cp)$$

$$Qq = Pp \cos NCp = Rp$$

That is to say, we find that exactly one half of the forces requisite to produce a rotation of the each entire circle ~~[illegible]~~ at the full angular velocity due to its northern & southern portions, (which is 12.2 miles per hour with a radius of 60 miles or through an angle of 11°. 4'.) is accounted for and that the other half remains wholly unsupplied. Therefore supposing the circle to move as a whole, it has only a velocity of one half of 11°. 4' or 5°. 32' per hour.

As every circle composing the disc moves with the same angular velocity, the disc must turn as a rigid whole. Abstraction is here made of the retardation due to friction which so far as it follows any law different from that of increase in direct proportion to increase of velocity, would cause the outer circles to move at a somewhat different rate to the inner ones.

Hence, leaving aside friction for the present, the course of every particle of air in an anticyclone within the area of my charts, is compounded of two separate portions, — the one its radial projection outwards which may follow ~~uniform~~ any laws of uniform or of changing velocity, ~~and the~~ so long as all the particles radiated simultaneously share it alike, and the other of ~~an~~ a "direct" angular rotation round its point of departure of 5°. 32' per hour.

f.8

By Spottiswoode's formula.

$$(\cos^2\alpha \sin^2\lambda + \sin^2\alpha) \cos\omega t + \cos^2\alpha \cos^2\lambda = \cos D$$

$\alpha = 0$

$\lambda = 52$ which is that I have assumed as constant throughout my charts.

$\omega t = 15^\circ$

$$\sin^2 52^\circ . \cos 15^\circ + \cos^2 52 = \cos D$$

$\log \sin 52^\circ = 9.896$

$\log \sin^2 52^\circ = 9.792$

$\log \cos 15^\circ = 9.985$

$9.777 = \log .598$

$\log \cos 52 = 9.789$

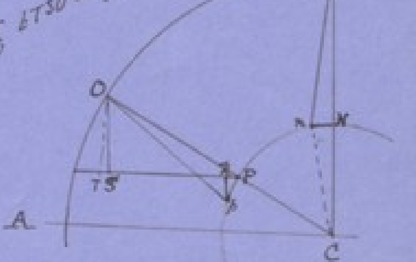
$\log^2 \cos 52 = 9.578 = \log .379$

$\log .977 = 9.990 = \log \cos 12^\circ 10'$

My results gave ——— $11^\circ 30'$

b Cyclones. In a cyclone the winds are centripetal

Suppose N to have started from M towards C & to have been deflected through the small arc Nn due to the meridional distance MN on the one hand & the velocity of its passage on the other. Then P having started from O & moved towards C with the same velocity will have been deflected to a lesser amount due to its meridional distance from O. This is equal to ST, STSO being equal to MN.



or the deflection of P : Nn :: ~~sin~~ cos MCO : 1

~~or is therefore~~ or is equal to Nn cos MCO.

Again PR, the horizontal component of Pp, is also = Pp (or Nn) cos MCO therefore, just as in the case of the Anticyclones, one half of the necessary forces are present to cause the rotation of the entire ring at the velocity expressed by Nn & the other half of the forces are absent; consequently the rotation of the ring, as in the case of the Anticyclones, has only half that velocity. But the angular velocity of each of the rings which compose a cyclone is by no means constant, for the velocity of N, or of P, ~~(...)~~ per hour $= \underline{MC - NC} \cdot 5°32'$ (in arc)

and the angular velocity of the entire ring round $P = \frac{MC - NC}{NC} \cdot 5°32'$; which is zero at M and infinite at C.

Hence in a cyclone, we find the influence of the Earth's rotation to be exerted in a series of concentric circles or rings, rotating in a retrograde sense with angular velocities that increase with extraordinary ~~with~~ rapidity as their radial distances diminish, and that the course of any particle within the cyclone is compounded of its centripetal advance & these circular movements.

f. 9

Differential movement of two stations situated one degree of latitude apart.

Every point on the earths equator rotates during each hour through an arc of 15° × 60' = 900 miles in circumference ~~length~~, whilst the pole itself has no movement at all. It is obvious that intermediate ~~point~~ stations ~~must~~ rotate through arcs of intermediate linear extent & that as there are 90 degrees of latitude between the Equator and the pole every station on the earth's surface must travel ~~s~~ on an average 10 miles per hour slower ~~faster~~ than those ~~situated~~ one degree removed from it on the side towards the Equator nearer to the adjacent pole (~~= 60 miles~~) ~~[illegible]~~ ~~nearer to~~ the nearest pole.

The ~~exact~~ difference at an interval of 60 miles ~~1 degree of~~ is expressed for any latitude l by the formula $900(\cos l - \cos(l+1))$. ~~[illegible]~~ gives us 14.0 mile per hour for lat 62° & 10.4 miles for lat 42° which are the limiting parallels of my weather ~~our~~ charts. It will be sufficiently exact for my ~~our~~ present purposes to assume 12 miles per hour as an average value throughout the whole area they include. In other words if C be the point of departure ~~[illegible]~~ a station to the north of C & ~~the point to which~~ N ... the different ... of N movement during one hour in respect to C, ...

Course of a particle of air within the area of the charts as affected by the differential movement above mentioned.

Suppose a particle of air c stationary above any place ~~station~~ C to be propelled by an abrupt ~~northward~~ movement to a new ~~[illegible]~~ position N situated 1° to the northward of C & there be allowed to hover for the space of an hour. The ~~excess of~~ differential excess of ~~[illegible]~~ C's velocity over that of N will cause c to travel ~~s~~ 12 miles to the Eastward of C (and for practical purposes we may say ~~to the~~ that the path coincides with along the parallel of N, though in reality the movement is along a great circle) On the other hand if ~~the~~ c be allowed to hover over C during the hour in question & then be propelled instantaneously northwards, ~~the~~ it will suffer no deflection whatever but will arrive at N. The course taken by ~~the~~ a particle moving continuously forward for the space of an hour after any law we may please to name, must lie between these two extreme cases, of a ~~[illegible]~~ line due North & South ~~[illegible]~~ & of one making an ~~deflection of [illegible] 60 or [illegible]~~.

If the onward movement be uniform, the deflection at any given point would be the mean ~~half that which is would have been in the first of the 2~~ extreme cases, ~~thus~~ wind moving Northwards at 60 miles an hour would have a would make an angle of 6° with the meridian be deflected ~~6 miles~~ 30 × [illegible] after 30 ... 60 × [illegible] 6° ... to the East after traversing one degree. Similarly on moving Southwards for the same distance & time it would be deflected 6 miles to West. If they travelled 30 miles an hour the deflection would be ... it would be ... & so on ... In ~~both~~ every cases the deflection taking place towards the right hand, being made for retardation by friction

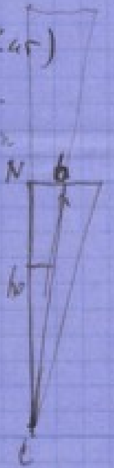
f. 94

$$\frac{122}{600} = \tan\theta$$

$.203333 = 11°.30'$

n :

1 mile	1. 60(5°.45)
2 —	$\frac{1}{2}$ —
n —	$\frac{1}{n}$



$\tan NCn = \frac{6.1}{60} = .101666 = \tan 5°.48'$

$$\begin{array}{r} 60\,/12.2 \\ .203333 \\ \underline{191986} \\ .011347 \end{array} \quad 11°.4'$$

$$\begin{array}{r} .0174 \\ .174 \\ .191 \\ \underline{12} \\ 203 \end{array}$$

compare the amount of force ~~actually~~ present with ~~what~~ w^d be required

~~Let us examine the requirements~~ ~~amount of the~~ amount of force ~~which would be necessary~~ to ~~produce a rotation upon~~ effect an angular deflection of each point in the circumference of any one of the concentric circles (~~of~~ by which the disc may be supposed to be formed) equal to that ~~which~~ ~~acts upon its~~ ~~influences the~~ ~~at~~ on its north & south points, supposing that ~~freely~~ ~~of the circle~~ where the deflecting influence is wholly tangential.

Rotatory winds

The gyration of cyclones has been often described but I shall endeavour to ~~shew~~ illustrate the course of a particle of air under their influence more definitely than has yet so far as I am aware been effected. In the mean time I wish to explain what I have termed anti-cyclones because they afford the most convenient illustration of rotatory winds. ~~The~~ The state of the weather on the morning of Dec 2 3 & 4 see special maps W. ~~which I have represented in detail~~, shews the divergence of currents from a central area of calms, which is also characterised ~~by being~~ as an area where the barometer shews the greatest pressure ~~stands the highest~~. I presume this area to be ~~an~~ a locus ~~area~~ of dense descending currents just as the centre of a cyclone is a locus ~~[illegible]~~ of light ascending currents. A further reason for this belief lies in the fact that a pure clear sky usually ~~usually~~ accompanies ~~these~~ areas of dispersion, indicating that ~~the influence of dry wind just~~ the dry upper atmosphere has been brought down, in the same way that ~~just as~~ the rains and clouds of the cyclone shew that the damp surface atmosphere has been drawn up & its vapour condensed by the cold of a higher level. ~~Examination of the maps,~~

Now suppose two currents of air both proceeding from the same source to travel respectively Northwards & Southwards – they must both be deflected to the right hand & it is impossible but that the intermediate mass of still air should yield to their pressure & be deflected also. In short if winds ~~flow out~~ disperse on every side from a central area the entire disc of outflow must accept to a calculable ~~considerable~~ degree the right handed deflection that would have been established in the northern & southern currents supposing them to ~~have been~~ wholly unembarrassed. Then

~~If we resolve~~ Let us ~~[illegible]~~ examine the requirements ~~the forces~~ which would suffice to impress a rotation upon any one of the concentric circles which compose the disc ~~an rotation angular a deflection of the entire~~ disc, with a velocity ~~[illegible]~~ ~~[illegible]~~ albeit ~~[illegible]~~ ~~[illegible]~~ still ~~equal to~~ that ~~due to an unembarrassed~~ the same Northern (or Southern) of the point of departure where the entire ~~[illegible]~~ three ~~[illegible]~~ current, ~~[illegible]~~ we will resolve them into forces acting ~~parallel N & S & at~~ along the meridian ~~vertically~~ into forces ~~[illegible]~~ parallel to ~~the~~ lines of latitude

From the symmetry of the case it is obvious that these two sets of forces are equal. Now the deflection movement ~~we speak of~~ having has no influence whatever parallel to the meridian but is wholly exerted parallel to the lines of latitude and ~~we shall see that it is~~ proves to be identical ~~in amount~~ at every point of the disc with that ~~portion~~ half of the total force requisite to cause a velocity of gyration ~~due to~~ equal to that of an unembarrassed N – S current. In other words half of the total force is ~~accounted~~ supplied & the other half is wanting therefore the ~~[illegible]~~ ~~of that which~~ rapidity of rotation of the entire disc is only one half of that ~~[illegible]~~ ~~[illegible]~~ obtained by the N–S portion of it.

Differential movement ~~through space~~ of 2 ~~points~~ stations on the Earth's Surface 1° of latitude apart.

~~Having regard to the daily rotation of the earth we know that~~

In the course of each hour, a point on the Earth's equator ~~travels~~ rotates through an arc of $15° \times 60' = 900$ miles, in [illegible] whilst the pole itself has no movement at all

It is obvious ~~and~~ that intermediate ~~points~~ stations ~~has~~ travel through arcs of intermediate ~~distances~~ linear extent.

As there are 90 degrees of latitude between the equator and the pole, ~~it follows~~ on a rude average ~~that~~ ~~any~~ every point on the Earth's surface travels 10 miles an hour ~~slowly~~ faster ~~than~~ ~~another~~ ~~point~~ 1° lat. apart, nearer to the nearest ~~between~~ ~~it & the~~ pole ~~equator or 10 miles an hour faster than one at the same distance between it and the Pole~~

we can easily calculate the rate ~~of the differential~~ between stations whose latitudes are 1° apart, by the formula $900(\cos l^\circ - \cos l^\circ)$

The northernmost parallel ~~latitude~~ in my weather charts, being 62° & the southernmost ~~is~~ 42° at which latitudes, if we calculate

We can easily calculate the difference of movement at each point by the formula [illegible] the results

by the formula ~~the~~

$$900(\cos 61° - \cos 62°) = 14.01 \text{ miles}$$

$$900(\cos 41° - \cos 42°) = 10.41 \text{ miles}$$

$$2)\,24.41$$

$$12.20$$

we find the rate in question to be 12.0 which on ~~a rough basis~~ of 12 miles through

we see that on a rough average throughout the whole chart, ~~any~~ each point within it moves 12 miles an hour through space faster than ~~another~~ others 1° lat to the North of it & ~~12 miles~~ or 12 miles an hour slower than ~~another~~ others ~~1° lat to the South of it.~~ the differ

~~Deflection~~ Course of a particle of air within the charts supposed to be unimpeded, on moving 1° in latitude. ~~within the area of the charts.~~

~~If a par~~

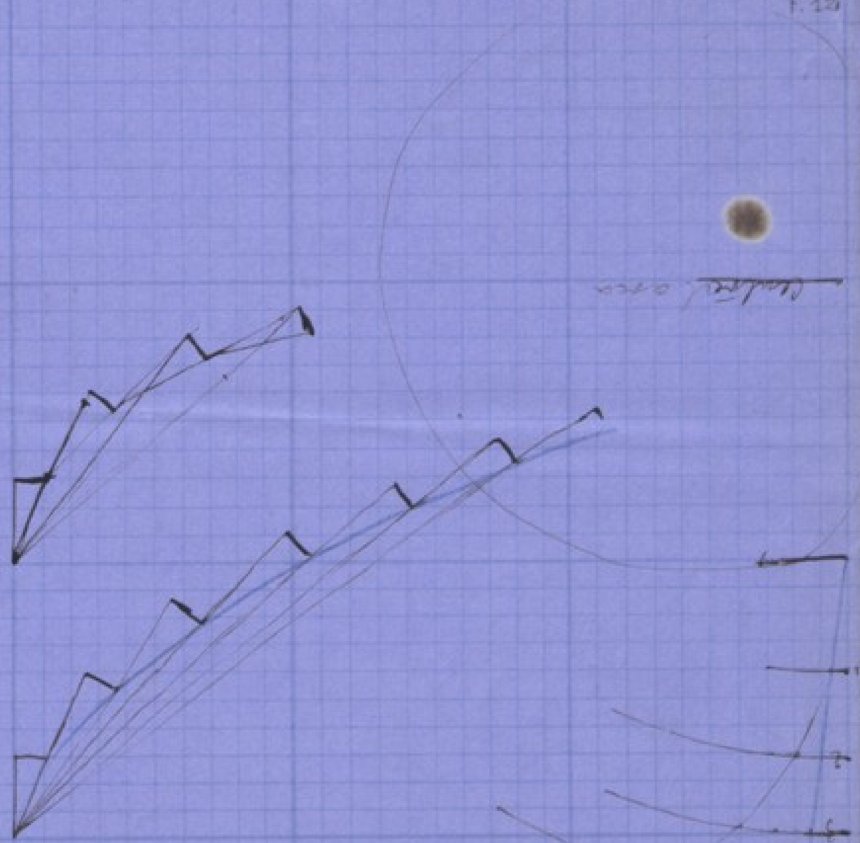
Let C be any station within ~~the~~ charts & N, S. two points on the same meridian ~~respectively~~ 1° lat. ~~apart~~ to the North & to the South of C

If a particle of air C be supposed to be moved instantaneously (Northward) from C to N, or to the position N & there be allowed to hover for an hour, retaining ~~the differential~~ the rotatory ~~movement~~ velocity due to C, it follows that ~~N would~~ the latter have caused it to ~~have~~ travelled 12 miles to the westward of C, or in other words the position of C will ~~appear to be deflected~~ be 12 miles to the right hand side of the line CN.

Next Let ~~the conditions of the problem be changed that~~ so c be supposed to hover for the hour above C & then be transported instantaneously northward by 1°. It is clear it would arrive precisely at N, ~~without any~~ neither [illegible] deflection whatever ~~we~~ would

The same is true, [illegible] to the right hand movement, if we substitute S for N.

Hence we conclude that as every possible form of continuous movement must lie somewhere between these two extreme ~~cases, that as a general rule~~ suppositions, whenever if C moves north ~~ward~~ or South 1° in



$$\pi R_1^2 - \pi r^2 = \pi r^2 \qquad \pi R_1^2 = 2\pi r^2 \qquad R_2 = \sqrt{2} R_1$$

$$\pi R_2^2 - \pi R_1^2 = \pi r^2 \qquad \pi R_2^2 = 2\pi r^2 = \pi r^2 \qquad R_3 = \sqrt{3} R_1$$

$$\pi R_3^2 - \pi R_2^2 = \pi r^2 \qquad \pi R_3^2 - 3\pi r^2 = \pi r^2 \qquad R_4 = \sqrt{4} R_1$$

1
1.414

2/301030
150515

1414

$R^2 - r^2 = \quad R^2 = 2r^2$

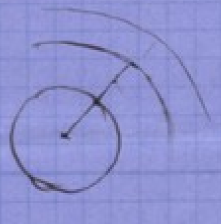
$R = \sqrt{2}$

$R_1^2 - R^2 = 2r^2$

$R_2^2 -$

$\log \sqrt{2} = .150515$

$\log r = .15$



log 2	log 3	log 4	log 5	log 6	log 7	log 8	log 9
2/301030	2/477121	2/602060	2/698970	2/778151	845098	903090	954
150515	238560	301030	349485	389075	422549	451545	477
1414	172	2	223	245	264	283	296 309
			23	22	19	19	9

log 10	log 11	log 12	log 13	log 14	log 15	log 16	log 17	log 18	log 19	log 20	log 21	log 22	log 23	log 24
.500	.520	.539	557	.573	.588	602	615	627	639	650	661	671	680	690
316	331	346	360	374	388	400	412	424	436	447	458	469	479	489
20	15	15	14											

15°

$$\left(\cos^2\alpha \cdot \sin^2\lambda + \sin^2\alpha\right) \cos\omega t + \cos^2\alpha \cos^2\lambda. = \cos D$$

$\alpha = 0 \qquad \cos\alpha = 1 \quad \sin\alpha = 0$

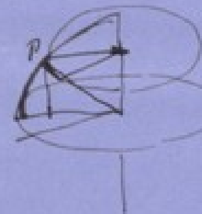
$\lambda = 52^{\circ}$

$$\sin^2 52^{\circ} \cos 15^{\circ} + \cos^2 52^{\circ} = \cos D$$

Sin 52	9.896	Cos 52° 9.789
	9.792	9.578
	9.985	
	9.777	

.598
.379

log .977 = 9.990 = ~~37° 20'~~ = 12°.10'



$r' = r \cos\lambda$

~~Angular~~ arc veloc^y of $P = \omega T . r \cos\lambda$

" " $p = \omega T . r \cos\lambda_1$

differential ~~ang~~ arc: velo: of P & p $= \omega T . r(\cos\lambda - \cos\lambda_1)$

let P move with a velocity ω & therefore traverse ~~ωT~~ in the time T

or $\lambda \pm \lambda_1 = \frac{T\omega}{\cancel{r}}$ & $\qquad \cancel{\cos\lambda_1 = \cos\lambda . \cos\frac{T\omega}{r}}$ $\quad \lambda_1 = \lambda \mp T\omega$

then differential ~~ang~~ arc vel of P & p $= \omega T . r($

$$= \omega T\left\{\cos\lambda - \cos(\lambda \mp T\omega)\right\}$$

tan deflect

a sin

$= \cancel{\ } \left\{\cos\lambda - \cos\lambda \cos T\omega \pm \sin\lambda \sin\omega T\right\}$

from Spot. $\sin^2\lambda \cos\omega T + \cos^2\lambda$

~~$\sin\alpha = \left\{\cos\lambda\left\{1-\omega T\right\} \pm \sin\lambda \sin\omega T\right\}$~~

~~$\sin^2\alpha = \cos^2\lambda\left(1-\omega T\right)$~~

$\sin\alpha = \cos\lambda - \cos\lambda \cos T\omega$

$\sin^2\alpha = \cos^2\lambda - 2\cos^2\lambda \cos\omega T - \cos^2\lambda . \cos^2\omega T.$

$\cos^2\alpha = 1-$

f. 14

3^d (1)
5625
2025
7650
3.8837
1.9418
87.4

4^th (2)
5625
4050
9675
3.9856
1.9928
98.4

5^th (3)
5625
6075
11700
4.0682
2.0341
108.2

6^th (4)
5625
8100
13725
4.1375
2.0687
117.4

7 (5)
5625
10125
15750
4.1978
2.0949
125.6

2025

8 (6)
5625
12150
17775
4.2497
2.1248
133.3

9 (7)
5625
14175
19800
4.2967
2.1483
140.7

10 (8)
5625
16200
21825
4.3388
2.1694
147.7

11 (9)
5625
18225
23850
4.3775
2.1887
154.4

12 (10)
5625
20250
25875
4.4129
2.2064
160.9

~~11 (9) 12~~

13 (11)
5625
2025
20250
27900
4.4456
2.2228
167.0

14 (12)
5625
4050
20250
29925
4.4760
2.2380
173.0

15 (13)
5625
6075
20250
31950
4.5045
2.2522
178.7

16 (14)
5625
8100
20250
33975
4.5311
2.2655
184.3

17 (15)
5625
10125
20250
36000
4.5563
2.2781
189.8

18 (16)
5625
12150
20250
38025
4.5800
2.2900
195.0

19 (17)
5625
14175
20250
40050
4.60260
2.30130
200.1

20 (18)
5625
16200
20250
42075
4.6240
2.3120
205.1

32. 80'

21 (19)
5625
18225
20250
~~40050~~
44090
4.6443
2.3221
209.9

22 (20)
5625
40500
~~46125~~
46125
4.6639
2.3319
214.7

23 (21)
5625
40500
~~44125~~
2025
48150
4.6826
2.3413
219.4

24 (22)
5625
40500
~~4
4050
50175
4.7004
2.3502
224.0

5625
40750
66375
4/82200
2.41100
257.6

Band of Show

Original radius = 60'

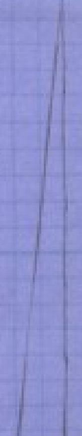
1 r_2 . 75	12.4	87.4	48.2	
2 87.4	11.0	20.8		
3 98.4	9.8			
4 108.2				
5 117.4	8.9X	17.3	32.5	
6 x125.6	8.0			
7 133.3	7.7	15.2		
8 – x140.7	7.4			
9 – 147.7	7.0	13.7	26.3	
10 x154.4	6.7			
11 160.9	6.5	12.6		
12 x167.0	6.1			
13 173.0	6.0	13.7	14.8	
14 x178.7	5.7			
15 184.3	5.6	11.1		
16 x189.8	5.5			
17 195.0	5.2	10.3	20.1	
18 x200.1	5.1			
19 205.1	5.0	9.8		
20 x209.9	4.8			
21 214.7	4.8	9.5	18.6	
22 x219.4	4.7			
23 224.0	4.6	9.1		
24 230.5	4.5			

Therein to 80 the interval

61.1

387

30. (26)
5625
40500
12150
58275
2)4.7655 2
2.38276
241.4



E 15

Area of the first ring $= \pi\{(60+15)^2 - 60^2\} = \pi\{30\times60 + 225$

$= \pi . 2025 \quad = \pi a$ suppose

R original radius (60')

r_2 second " (75')

1. R_2

(2) $r_2^2 - R^2 = \pi a$

3. $r_3^2 - r_2^2 = \pi a = r_2^2 - R^2 \qquad r_3^2 = 2r_2^2 - R^2$

(4) $r_4^2 - r_3^2 = \frac{\cancel{2r_2^2 - R^2}}{r_3^2 - r_2^2} \qquad r_4^2 = 2r_3^2 - R_2 = 2\{2r_2^2 - R^2\} - R_2$

5 $r_5^2 - r_4^2 = r_2^2 - R^2 \qquad r_5^2 = 2\{2r_2^2 - R^2\} + r_2^2 - R^2$

R original radius 60'

2nd circl r_2 second 75'

$r_2^2 - R^2 = C = 2025 \qquad r^2 = 5625$

3rd $r_3^2 - r_2^2 = r_2^2 - R^2 \qquad r_3^2 = 2r^2 - R^2 = r^2 + (r^2 - R^2)$

4th $r_4^2 - r_3^2 = r_2^2 - R^2 \qquad r_4^2 = (2r^2 - R^2) + r_2^2 - R^2 = r^2 + 2(r^2 - R^2)$

5th $r_5^2 - r_4^2 = r_2^2 - R^2 \qquad r_5^2 = (2r^2 - R^2) + (r_2^2 - R^2) + (r_2^2 - R^2) = r^2 + 3(r^2 - R^2)$

6th $r_6^2 - r_5^2 = r_2^2 - R^2 \qquad r_6^2 = r^2 + 4(r^2 - R^2)$

nth $\qquad r_n^2 = r^2 + \overline{n-2}(r^2 - R^2) = 5625 + \overline{n-2}(2025)$

$$\begin{array}{r} 75 \\ 75 \\ \hline 375 \\ 525 \\ \hline 5625 \end{array} \qquad \begin{array}{r} 5625 \\ 3600 \\ \hline 2025 \end{array}$$

circle	rad
1.	60
2.	75
3	5625 + 2025

$$\begin{array}{r} 5625 \\ 2025 \\ \hline 7650 \end{array}$$

$$r_1^2 - R^2 = \frac{A}{\pi} \qquad r_1^2 = 75^2 = 5625$$
$$R^2 = 60^2 = 3600$$
$$2025 = \frac{A}{\pi}$$

$$r_n = \sqrt{n.\frac{A}{\pi} + R^2} = \sqrt{n \times 2025 + 3600}$$

1	2025
2.	4050
3.	6075
4	8100
5	10125
6	12150
7	14175
8	16200
9	18225

1	2	3	4	5	6	7	8	9	10
3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
	4050	6075	8100	10125	12150	14175	16200	18225	20250
	7650	9675	11700	13725	15750	17775	19800	21825	23850
	3.88366	3.98565	4.06819	.13751	.19728	.24981	.29667	.33895	.37749
	1.94183	1.99282	2.03409	.06875	.09864	.12490	.14853	.16947	.18874
	87.4	98.3	108.1	117.1	125.5	133.3	140.7	147.7	154.4

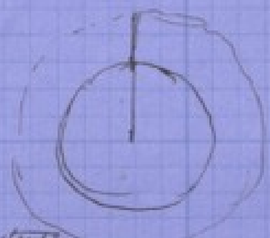
11	12	13	14	15	16	17	18	19	20
3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
20250	20250	20250	20250	20250	20250	20250	20250	20250	~~20250~~
2025	4050	6075	8100	10125	12150	14175	16200	18222	40500
25875	27900	29925	31950	33975	36000	38025	40050	42072	44100
41288	44560	47603	50447	53116	55630	58007	60260	62398	64444
20644	22280	23801	25223	26553	27815	29003	30130	31199	32222
160.9	167.0	173.0	178.7	184.3	189.7	195.0	200.1	205.1	210.0

25	30	35	40
3600	3600	3600	3600
40500	60750	60750	81000
10125		10125	
54225	64350	74475	84640
73420	80855	87200	92758
36710	40427	43600	46379
232.9	253.7	272.9	290.9

98.3

12.4
10.9
9.8
9.0

60		
75	15.	2.6
87.4	12.4	1.5
98.3	10.9	1.6
108.1	10.3	8
117.1	9.0	6
125.5	8.4	6
133.3	7.8	4
140.7	7.4	4
147.7	7.0	3
154.4	6.7	2
160.9	6.5	3
167.0	6.2	2
173.0	6.0	2
178.7	5.8	2
184.3	5.6	2
189.7	5.4	1
195.0	5.3	2
200.1	5.1	.1
205.1	5.0	.1
210.0	4.9	
		22.9
232.9		
		20.8
253.7		
		19.2
272.9		
		18.0
290.9		



$\pi\, h o^2$

$\pi\{(ho+10)^2 - ho^2\} = $ ~~Constant area~~ $= A$

$$\frac{\begin{array}{r}4900\\3600\end{array}}{1300}$$

$r_1^2 - R^2 = \frac{A}{\pi}$

$R \quad \pi R^2$

$r_1 \quad \pi\{r_1^2 - R^2\} = A \qquad r_1^2 = \frac{1}{\pi}\{A\} + R^2 \qquad r_1 = \sqrt{\frac{A}{\pi} + R^2}$

$r_2 \quad \pi\{r_2^2 - r_1^2\} = A \qquad r_2^2 = \frac{A}{\pi} + r_1^2 = \frac{2A}{\pi} + R^2 \qquad r_2 = \sqrt{\frac{2A}{\pi} + R^2}$

$r_3 \quad \pi\{r_3^2 - r_2^2\} = A \qquad r_3^2 = \frac{A}{\pi} + r_2^2 = \frac{3A}{\pi} + R^2 \qquad r_3 = \sqrt{\frac{3A}{\pi} + R^2}$

$r_n \qquad r_n = \sqrt{\frac{nA}{\pi} + R^2} = \sqrt{n \times 1300 + 3600}$

1	1300
2	2600
3	3900
4	5200
5	6500
6	7800
7	9100
8	10400
9	11700

	r_2	r_3	r_4	r_5	r_6	r_7	r_8	r_9
	2600	3900	5200	6500	7800	9100	10400	11700
	3600	3600	3600	3600	3600	3600	3600	3600
	6200	7500	8800	10100	11400	12700	14000	15300
	3.79239	3.87506	~~3.94489~~	4.00432	4.05690	4.10380	4.14613	4.18469
	1.89619	1.93753	~~1.97489~~	2.00216	2.02845	2.05190	2.07306	2.09239
	78.74	86.60	93.8	100.61	106.77	112.7	118.3	123.7
			3.94448					
			1.97224					

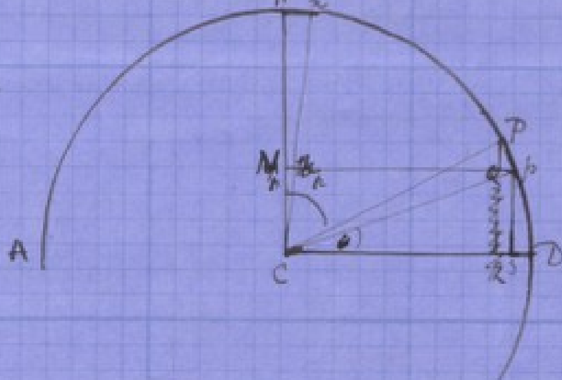
r_{10}	r_{11}	r_{12}	r_{13}	r_{14}	r_{15}	r_{16}	r_{17}	r_{18}	r_{19}
13000	13000	13000	13000	13000	13000	13000	13000	13000	13000
	1300	2600	3900	5200	6500	7800	9100	10400	11700
3600	3600	3600	3600	3600	3600	3600	3600	3600	3600
16600	17900	19200	20500	21800	23100	24400	25700	27000	28300
4.22011	4.25285	4.28330	4.31175	4.34044	4.36361	4.38738	4.40993	4.43136	4.45179
2.11005	2.12647	2.14165	2.15587	2.17022	2.18180	2.19369	2.20496	2.21568	2.22589
125.9	133.8	138.6	143.2	148.0	152.0	156.2	160.3	164.4	168.2
			4.33846	147.7					
			2.16923						

r_{20}	r_{25}	r_{30}	r_{35}	r_{40}
26000	26000	39000	39000	52000
	6500		6500	
3600	3600	3600	3600	3600
29600	36100	42600	49100	55600
4.47129	4.55751	4.62941	4.69108	~~4.75282~~
2.23564	2.27875	2.31470	2.34554	~~2.37641~~
~~193.~~				2) 4.74507
				2.37253
172.1	190.0	206.4	221.6	235.8
20.1	17.9	16.4	15.2	14.2

65

Cyclones &
Anticyclones

Let us examine the requirements which would suffice to impress a deflection of ~~each~~ every point P in the entire disc with an angular velocity equal to that which would affect a free particle of air N situated exactly to the North or the South of the point of departure C



* Let ~~the fig~~ ANPD be ~~one~~ of the circle, & let us ~~would~~ ~~any~~ point at any ~~or~~ ~~given~~ ~~C~~ distance from C and at any angle from the meridian ~~figure~~ resolve the forces that act on P into PQ parallel to the meridian & pQ perpendicular to it ~~parallel to the line of latitude~~. ~~with the sum~~ It is clear from the symmetry of the figure that the sum of the former throughout the entire circle ANP ~~or disc~~ will ~~obviously~~ equal the latter.

Again the deflection force acting on any point P during the time it has moved from C to P is equal to ~~through~~ ~~the small~~ ~~arc Pp is in direct proportion to~~ QR which bears the same proportion to Nn (or Pp) that ~~Ac~~ CA or ~~CM~~ SM does to CN

that is AB = Pp sin θ

~~Again~~ ~~Also the deflection~~ We may see that the value of x is one of them pQ = Pp sin θ

therefore AB = pQ. That is to say, we find that exactly one ~~or the~~ half of the force requisite to produce a rotation of the entire disc at the full angular velocity ~~due to the unimpeded motion~~ of N is ~~exactly~~ accounted for & that the other half remains wholly ~~to be~~ unsupplied. ~~It results~~ Therefore since ~~that as~~ we have only half enough force (unimpeded deflection) to cause a general rotation ~~to the~~ ~~fork~~ equal to that due to the ~~motion~~ of N the nearly rotation of the circle will be through $\frac{1}{2}$ of not the 120 ~~the rotation will be only half that calculated for N.~~ 25. ~~it will be 3 miles in~~ through an ~~hourly~~ angle whose arc is ~~such that~~ ~~its arc will be 3 miles to a radius of 40 miles~~ 25. of about 30

This takes no account of the retarding influence of friction which ~~would cause~~ I have no means of rightly estimating but to which we shall recur. For the present, suffice it

(definite)

On these data we may readily protract the course of a particle of air in an anticyclone whenever we can assume ~~are able to determine~~ ~~determine~~ a rate of progression from the centre [illegible] at the expiration of each hour (or other interval of time) [illegible] ~~[illegible]~~ radial ~~[illegible]~~ distances, attained ~~radially by a particle of air~~. Suppose it to move with uniform velocity through each of the successive [illegible] ~~hours~~ in which case it will deflected as shown in (2) because of [illegible] through half the ~~angle due to the~~ amount ~~[illegible]~~ of the total ~~differential~~ movement ~~which is shown to be~~ [illegible] that ~~is through 3° station at the commencement of the hour~~ [illegible] of the average determined by (3) ~~hence from (3), (i), (4)~~

f. 19

conclude that no account being taken of friction ~~[illegible]~~ [illegible] by the area between 62 & 64 the ~~explicit~~ course of any particle of air in an anticyclone is compounded of two separate portions, the one its radial movement outwards whose velocity ~~which~~ may ~~in each~~ follow any law, so long as ~~all it is common to~~ all the particles radiated simultaneously share it alike & secondly of an angular rotation round its point of departure of about 6° per hour.

we will take as our example ~~On these data we will protract the movement of a particle of air under~~ the conditions of divergence observed in the morning of Dec. 3. There we find a central area of about 1° in radius where the winds are undecided, as we see on reference to previous preceding maps thence, light airs moving ~~say at 10~~ miles an hour steal off continuously ~~while the~~ on all sides. ~~It Calculation shews~~ Calculation ~~[illegible]~~ that rate the ~~[illegible]~~ air that at beginning of any moment ~~filled~~ left the central area would have ~~become~~ filled ~~[illegible] transferred~~ to a ring outside it that is ~~whose~~ bounded by a circle whose radius is about ~~40~~ miles. Now ~~let~~ if we calculate the radii of a set of concentric circles such that the areas of the rings they enclose shall be equal to each other & identical with the area of the first ring we find them to form the following series.

No.
1

It follows that if the air which disperses from the central area receives no accession of volume nor any loss of volume by dispersion into higher levels from upper currents, the particle of air that left the first circle at the beginning of the first hour would reach the second at the beginning of the second hour & so on through all the rings. The rings in fact form hour circles ~~[illegible] small chart does not admit more than~~ ~~one second ring~~ ~~the 2~~ ~~circles being given~~.

(2) f. 20

an hour its deflection ~~owing to the rotation of the earth~~ must lie between somewhere 12 miles and zero & is always to the right hand.

To ~~calculate~~ [illegible] the deflection, throughout any interval, when the movement is uniform we may suppose the 1° of latitude to be divided into n equal intervals, to be severally traversed in equal times by [illegible] ~~so that each of them equals $\frac{1}{n}$ 60~~. Suppose the motion to take place in ~~jerks~~ alternate jerks & hoverings [illegible] over each interval & ~~calculate~~ [illegible] consider the result under each of the two extreme cases mentioned above. We must recollect that as each interval occupies $\frac{1}{n}\cdot 60$ miles in length the hourly differential movement of the two points that limit it is ~~only~~ $\frac{1}{n}\cdot 12$ miles & that the same movement during $\frac{1}{n}$th of an hour is only $\frac{1}{n^2}\cdot 12$ miles.

~~We have (1)~~ When the jerk precedes the hovering, the ultimate deflection is represented by the series

$$\frac{1}{n^2}\cdot 12\left\{1+2+3 \cdots n\right\} = 6\cdot\frac{n^2+n}{n^2}\ \text{miles} = 6+\frac{6}{n}$$

and ~~(2)~~ where the hovering precedes the jerk

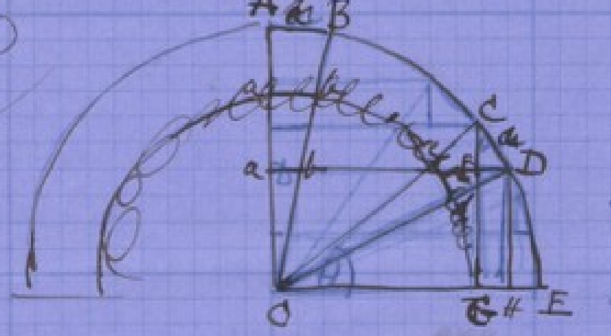
$$\frac{1}{n^2}\cdot 12\left\{0+1+2 \cdots n-1\right\} = 6\,\frac{n^2-n}{n^2}\ \text{miles} = 6-\frac{6}{n}$$

~~Within these values the ultimate deflection necessarily lies. The greater n becomes the more nearly does the motion become uniform & between which limits, the deflection the~~ ~~when it is infinite, in which case the motion is uniform & n disappears in the face of n^2 [illegible] the above values, which both of them become identical and equal to 6 miles~~

The ultimate deflection necessarily lies between these values and the greater n is taken ~~becomes~~, the more nearly will ~~be~~ the motion approach ~~become~~ uniformity. When n is infinite it being ~~n disappears in the presence of n^2~~ & both the above values become ~~identical~~ & equal to 6 miles, which is therefore the deflection due to a uniform motion through 1° of latitude in one hour. In the latitudes embraced by the charts, ~~a~~ the angular deflection is 1 in 10 is equivalent to about 6° which we may accept as another way of expressing the same result.

leaving the ~~meridional~~ N & S impulses to the agency of ~~precisely~~ the same cause that produce a circuit in the case we first considered.

25 – miles 170
21 Emilia – South winds
28 moderate



$a \sin\theta = d$

$D : a :: \sin\theta : 1$

$a \sin\theta = D$

Let ABCDE be a portion of a rotating ring. Take ~~any~~ ~~the~~ small arc CD equal to AB then when A moves to B C moves to D & the ~~lateral~~ Easterly component of the movement of C is FD

Again ab represents the lateral deflection of any particle at D in the parallel of D during the same time that A is moved to B

Then in order that the Eq. W. ~~conditions~~ conditions of uniform rotation be observed throughout the ring of ~~air~~ FD should be equal to ab, which it is for

(1) C8 sin 8OE = FD

a ab : AB :: 8H : 8O   AB × 8H = 8O ab

(2) n AB sin 8OE = ab

~~Hence~~
Hence we conclude that when air flows outwards on all sides from a central area of high barometric pressure we have necessarily a ~~symmetrical~~ regular rotation of the atmosphere round that area which is more or less rapid at different radial distances according to the supposed velocity ~~of~~ outflow.

Let us endeavour to construct ~~make~~ a graphic representation of ~~the~~ the most typical case named that where the air flows outwards with a uniform velocity from its point of departure and we will ~~follow~~ the conditions of the morning of Dec 3rd as regards the velocity of outflow & accept the area of pressure as taken from

We observe a central area of 60 miles in radius whence light airs proceed radially on all sides we will suppose them to have the ~~usual~~ velocity usually ascribed to light airs, namely ~~of~~ 15 miles an hour. Let us then draw two circles of 60 & 75 miles radius respectively the ring between ~~which~~ them which represents the space which the outflowing air from the central area would fill in the course of ~~one~~ single hour. Further let us draw a system of concentric ~~circles~~ rings such that the superficial area of each of them is equal to that of ~~the~~ the first ring. A simple calculation shows the radii of the circles which enclose the latter series ~~of them~~ to be as follows

60	173
75	178
87	184
98	190
107	195
117	200
125	205
133	210
140	215
148	219
156	224
161	230
167	

It follows that the air which at any moment may be contained in any one of these rings will have been transferred bodily to the next outer ring in the course of an hour, and that the air which had ~~reached~~ the margin of the circle O at the beginning of an entire day will have exactly arrived at the circle 24 at the close of it. Draw 2 lines OA OB including an angle of 6° then the arcs intercepted by each of these lines as they cut the several circles ~~represent~~ represent the hourly ~~deflection~~ rotation, with ~~approx~~ tough accuracy as we can attempt.

f 21v

We will suppose in the first instance the air ~~to be expelled outward~~ & to ~~retain~~ lose none of its rotatory movement through the influence of friction. ~~& imagine~~ In the first hour it will be expelled radially ~~outwards~~ through the first ring & be deflected as shewn by the interval between the 2 intercepting lines. In the 2nd hour it will be expelled radially outwards from its new position & be deflected additionally through an arc equal to that contained by the ~~the extent~~ intercepting lines where they cut the 2nd circle & so on as drawn in the diagram until the outer circle is reached. It will be observed that ~~to avoid~~ confusion only every second circle is drawn ~~is alone marked, after the~~ with the exception of the 1st & 3rd.

Now the result of the diagram shews the ~~line~~ particles of air whose course we are tracing to make an ~~immense~~ right handed sweep with a velocity that slightly increases as it moves forward. Friction would retard this increase & because it would ~~would also~~ retard the angular ~~movement~~ velocity of rotation ~~because~~ of the outer circles which ~~expose~~ a ~~the~~ larger circumference ~~surface~~ to friction ~~than the inner one~~. The proportion of ~~surface~~ circumference ~~between~~ the innermost the 12th & the outermost is in direct proportion to their radii

60 × 15 ~~×~~ 161 × 6 × 244 or 135. 270 × 448.

225
60
13500

36
25
180
72
2700

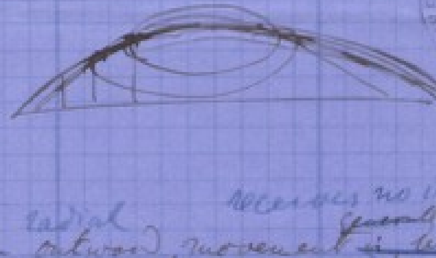
45
45
225
180
20.25
4480

60

15
60
900

45

161
6
966



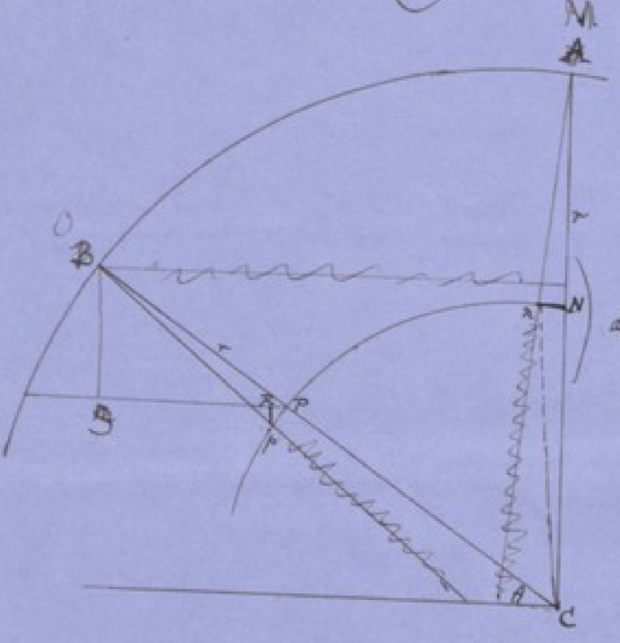
We are not justified in assuming that the radial outward movement ~~is uniform~~ generally receives no increase of impulse throughout the area. If the barometer is high over a large area ~~rises to a gradual rise to a culminating point then the~~ which subsides uniformly ~~uniformly~~ in every part, the outflow of air nearly its circumference ~~would~~ may not equal ~~or exceed~~ ~~the outflow~~ may be increased in volume ~~be equal~~ to that ~~in the~~ near its centre for although they ~~tend of distortion~~ widen the area of supply ~~not~~ increased in an equal ~~greater~~ degree. They are in fact as the ~~segment~~ entire disc to which the rings form the circumference.

advancing circle extends its circumference it would be fed by accessions in every part of the area of the sector ~~segment~~ included it lying in a bounding ~~that the bound~~

It ~ certainly occurs that the rapidity of subsidence of the barometer is uniform over a great extent of country though we can hardly suppose it to be uniform over the entire area of barometric elevation. If such a case ~~happened~~ occurs, & if the winds were wholly due to the outflow caused by such subsidence, the radial velocity would increase as the square of the radial distance & we thus have furious gales — However

(b)

f. 23



b Cyclones.

In a cyclone the winds are centripetal. Suppose P to have started from B and N from A, & ~~as already explained~~ let Nn be the deflection of A due to its passage through AN. Let us as in the case of an anticyclone ~~com~~pare the forces that exist with those that would be required to cause the entire ring NnPp to rotate (the left) with the velocity expressed by Nn.

the deflection of P due to its passage through the meridional distance BM

~~XX~~ : nN (or pP) :: ~~r~~ sin θ : r

that is it is equal to ~~XX~~ nN. sin θ.

~~Again~~ RP (the horizontal component of Pp) = pP. sin θ. = the deflection of B

Therefore ~~∴ the two are equal~~ as in the case of the anticyclone. we find one half of the necessary force or the other half absent & ~~present~~, & conclude that the rotation of the entire ring would have half the velocity expressed by N.

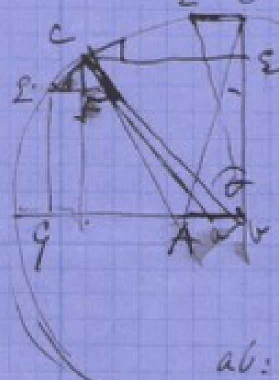
~~but~~ The angular velocity (of a cyclone) is not the same in all the rings which compose the ~~There is however a~~

for the velocity of N or P per hour $= (AC - NC) . 5^\circ 32'$

and the angular velocity round C $= \dfrac{AC - NC}{NC} . 5^\circ 32$

which is zero at A & infinite at C.

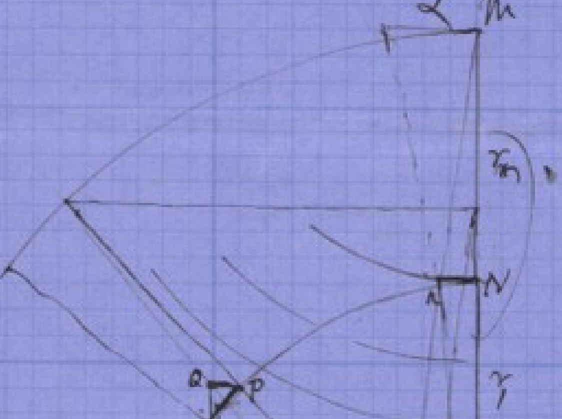
Hence in a cyclone we have the ~~differential~~ influence acting in (of the Earth's rotation) a series of concentric ~~whose~~ circles, rotating in a retrograde sense & with rapidly increasing angular velocity as their ~~centre is near~~ radial distance diminishes. ~~and~~ the course of any particle within it is compounded of its centripetal advance and this circular movements.



$ab : AB :: EB : Cb \quad ab = AB \times \frac{EB}{Cb}$

$AB \times \cos\theta$

$EF = EC \cos\theta$.



CB = deflection in a small interval of time.

$PQ = Pp \cos\theta$

$Pp : \alpha :: nC : mN$

also $PQ : CA :: mN : NC$

$CA : Nn :: CM \cos\theta : (CM - mN)$

$CA = \alpha$

$CA : r\cos\theta :: CB : r$

$CA = CB \cos\theta$

$PQ : CA :: r - r_1 : r$

$PQ = CB . \cos\theta . \frac{r - r_1}{r}$

$\theta = \frac{\alpha}{r_1 - r}$

$\phi = \frac{\alpha}{r_1 - r}$

$\alpha = r\theta$

$= (r_1 - r)\phi$

$\alpha = \cancel{\ }$

$= mn + \theta$ hour

$PQ = pP . \cos\theta$

$Pp = Nn$

$Nn : CB :: r - r' : r$

$Nn = CB . \frac{r - r'}{r}$

$Pp = CB . \cos\theta . \frac{r - r'}{r}$.

Hence the velocity of any point P is half that due to MN. & is inversely as its distance from C, to protract drawn circles

On the nature of the rotatory lateral deflection

Suppose a ~~particle~~ volume of air to ~~have to~~ move from ~~N towards the right hand~~ under the ~~deflecting~~ influence of which we are speaking, its place must be filled by other air which its movement has displaced in other words any movement of a portion of air when all around is still necessarily creates a circuit ~~of movement~~. This must take place either on the side towards S or on the opposite side. ~~Similarly~~ A circuit produced by the deflection of S has an equally limited option. It follows that the establishment of a circular movement in a ring embracing N & S has the recommendation of producing the required effect by the greater facility of maintaining ~~creating~~ one circuit rather than two separate ~~ones~~ subject however to such increase of friction & ~~mass~~ length of column with air to be moved as may be implied by the rotation of a thin ring of large diameter when compared to that of small eddies. If however air flow Northwards & Southwards ~~from on all sides~~ from a central area of calms (a high barometer), we have no longer to consider the case of ~~not~~ an isolated volume of air ~~but~~ two continuous lines of air radiating from a common centre both urged ~~impelled~~ at each point of their course with a lateral ~~movement~~ impulse ~~increasing~~ exactly proportionate ~~according to the~~ in amount to ~~the~~ distance ~~from any point~~ from the centre, ~~& therefore sweeping the intervening mass on either side so as to compel it to act exactly accordant with the conditions that would make these lines~~ share in their ~~movement~~ deflection. It is impossible to doubt that in this case the a ~~~~joint~~~~ rotation of the disc of air traversed by these lines would be effected rather than that the moved air should be replaced by some complex & multiform systems of small eddies. Still more is this probability increased when we consider the usual case of air flowing equally on all sides from a central area of calms & high barometer then every ~~portion~~ particle of the northern ~~half~~ portion having a tendency to move to the East which increases with the distance from the centre & (similarly) every particle of the southern ~~half~~ portion having a tendency to move to the west some description of simultaneous rotation is necessarily effected.

~~It will be found that the~~
~~No portion of the deflecting force~~

~~To investigate the lateral deflection at any point~~

The movement of the entire mass resolves itself into that of a series of concentric rings each moving at a slightly ~~[illegible]~~ different velocity than its neighbours but the ~~conditions~~ of uniform rotation are identical in respect to the amount of ~~lateral~~ impulse at ~~every~~ each point of any one ring:

Circle which for rough practical purposes & at moderate distances may be supposed coincident with a parallel of latitude. On reversing the conditions of the problem, if c be allowed to hover over C for the hour in question & then be instantaneously propelled one degree northwards its course will lead it directly to N. The path followed by a particle moving continuously forward and accomplishing 60 miles in the space of an hour after any law of varying velocity we please to name, must necessarily lie between these two extreme cases of a meridian line on the one hand and a line making an angle of $11^\circ 30'$ with ~~it~~ N on the other.

~~If the onward movement be uniform, c would reach the parallel of N at a point such that joining C & n_1 by a straight line the angle NCn_1 = $\frac{1}{2}(11^\circ.30') = 5^\circ.45'$.~~

~~Generally if the movement be uniform and at the rate of m miles per hour, $\tan NCn_1 = \frac{60}{m}\tan(5^\circ.45')$ represents the angle of deflection in one hour, with sufficient justness for the values of $\frac{60}{m}$ = not less than 10 or 20 miles, which are those with which we have to deal.~~

Whether we take N a point to the north or S a point to the S the deflection is the same & in both cases to the right hand.

If the onward movement be uniform & therefore at the rate of 60 miles per hour c would reach the parallel of N midway between it & n_1 or, joining N & n_1 by a straight line, $\tan NCn_1$ $= \frac{6.1}{60} = \tan 5^\circ.48'$ & generally so long as the movement is uniform no matter what the meridional distance travelled over in the hour ($= r$) may be, the deflection is always $r. \tan 5^\circ.48'$. no account being taken of retardation by friction.

If we desired to illustrate the movement of an unconfined particle of air propelled with a velocity varying according to any law we should [illegible] the parallels of latitude at intervals h_1 h_2 -- corresponding to the end of the first second &c how then

Definitions.

42 Rutland Gate, S.W.
May. 20 1881

It is as difficult to define well as it is important to do so. I certainly do not much like the definitions you enclosed (and which I return); and after many trials think it scarcely possible to succeed by treating the terms altogether dictionary fashion, but rather to incorporate them in a general explanation. This I have done as well as I can; please submit it to the members of the Council. I am very anxious to get it done quite well, before it is published.

(Sd) Francis Galton.

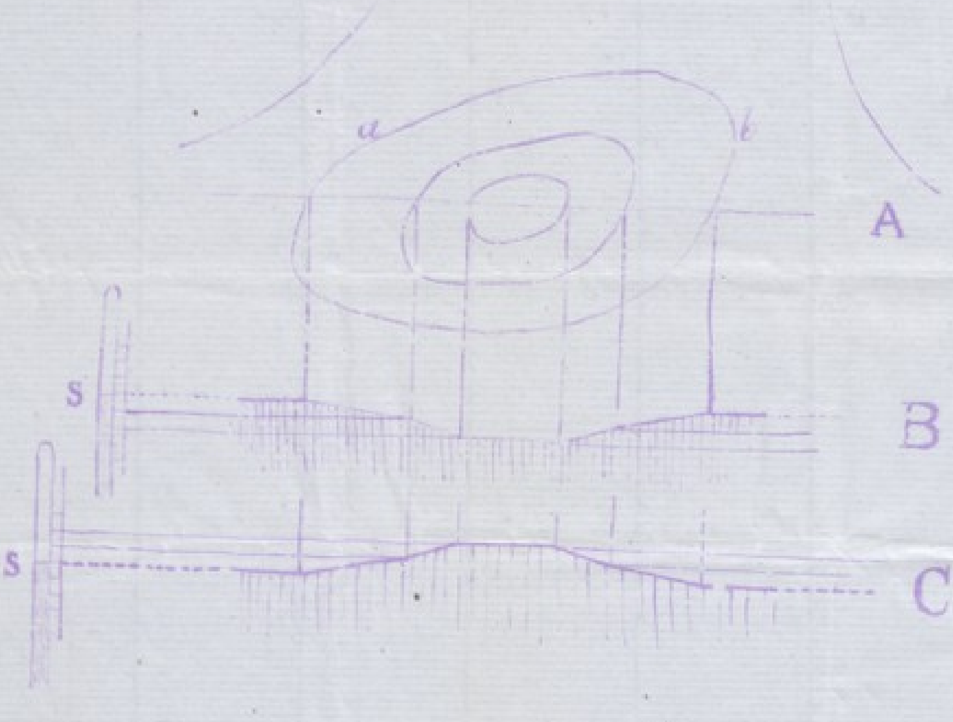
The variety in the distribution of isobaric lines is infinite, nevertheless there are two well defined forms which are rarely absent from any synchronous chart of a considerable portion of the globe. The changes in their shape, direction of movement and rate of progress can easily be traced day by day in successive synchronous charts, and the arrangement of all the other isobars is more or less closely dependent on them. They are therefore cardinal features in all descriptions of the distribution of barometric pressure.

They consist of a concentric series of closed isobars like those shown at A in the diagram, though often more irregularly disposed. In one of the two forms, the isobars decrease in value towards the centre, indicating a depression ~~section~~ in the adjacent barometric surface, as shown in the section at B. In the other form, they increase towards the centre, indicating an elevation, as shown at C. Both of the forms are bounded by the outermost closed isobaric line, a b, so that their "size" is defined as the area included within that boundary. Their "depth" or "height" as the case may be, is the difference between the value of their innermost and outermost isobars

isobars, usually drawn to the nearest tenth of an inch. Their "central area" is that which is enclosed by the innermost isobar, and their "gradient" at any point is the slope of their section through that point, it is measured radially in hundredths of an inch for 15 nautical miles.

The phrases used in speaking of the depressions are "areas of depression" or "areas of low barometer", or again they may be expressed in terms derived from the peculiarity of the winds with which they are invariably associated, as "cyclonic areas". In speaking of the elevations, the phrases used express precisely converse conditions, namely "areas of high pressure" and "anticyclones".

F.3



A. Isobaric plan of an area either of low or of high pressure.
B. Vertical section of an area of low pressure.
C. " " " " " high "
S. Barometric scales divided into tenths of an inch.

f.2

Abercromby

65a

Cyclones Abercromby

Upper
Middle
Surface.